Cognitive Complexity Interview Method: A Technique for Identifying Cognitive Challenges in Healthcare Work

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ABSTRACT

The healthcare environment has been described as a macrocognitive work system, with healthcare professionals (HCPs) engaging in cognitively complex work. Despite this, HCPs are generally unaware of the macrocognitive functions (MCFs) as they relate to the work they perform. Although evidence-based approaches offer benefits, they lack in accounting for and addressing the cognitive challenges embedded in healthcare work. Similarly, healthcare systems fail to establish formalized feedback processes that allow frontline HCPs to provide critical feedback on existing guidelines and future guideline improvements to support the cognitive complexities embedded in healthcare work. In this article, we will describe a novel approach for eliciting feedback and identifying macrocognitive complexities and share our experiences using the method with frontline healthcare professionals.

KEYWORDS

Embedded cognition; healthcare; cognitive complexities; knowledge elicitation.

INTRODUCTION

Academic literature has acknowledged the cognitively complex work in which HCPs engage and often describes the healthcare environment as a macrocognitive work system (Moon, Hoffman, Lacroix, Fry, & Miller, 2014). Macrocognition investigates cognitive functions as they occur in the "real world" rather than in simulated laboratory environments with a limited participant demographic pool (Klein, Ross, Moon, Klein, & Hollenagel, 2003). Despite existing literature highlighting the need to account for and support MCFs embedded in healthcare work, systems fall short on implementation and execution. Klein et al. (2016) demonstrated that although evidence-based approaches are data-driven and widely relied upon to inform guideline development, cognitive challenges still arise and are often underrepresented in guideline design considerations. HCPs frequently find it challenging to identify and articulate the cognitive complexities that exist or occur when following established and often rigid guidelines and systems, which may not be proficient in extracting those kinds of insights. Some healthcare systems do not have formalized feedback processes for HCPs to provide critical feedback on the guidance (e.g., guideline, policy, protocol, procedure) and how well they align with and support their work. Additionally, researchers are interested in how work, as imagined (e.g., how a policy or protocol describes the task and steps), compares with how work is actually performed. Therefore, it is imperative to consider the realities of work in complex environments, which involve MCFs like sensemaking, planning, detecting problems, and adapting to evolving situations.

Under a broader multi-year, multi-site program (Gurses et al., 2023, in preparation) focused on airflow management and infection prevention and control (IPC) in the perioperative setting, extensive interviews and observations were conducted with healthcare professionals working directly in operating rooms (ORs). These interviews and observations again highlighted the clear need to use a cognitive lens to identify embedded cognitive complexities and to develop and implement appropriate supports to aid HCPs in completing tasks and adhering to rigid IPC guidelines and practices. In a 2009 paper, Gurses et al. introduced a five-step tool to identify barriers to

guideline adherence. Our paper presents a novel cognitive task analysis (CTA) method that is easy to implement, effective in eliciting cognitive complexities in healthcare work as perceived by frontline HCPs, and serves as a feedback mechanism allowing frontline workers to provide input and aid in guideline and support system modification and development. Gurses et al. (2009) focused on exploring factors that contribute specifically to non-compliance. However, our method takes a deeper look at the ways HCPs perceive and cope with challenges that arise when adhering to guidelines, how they make sense of complex situations, what cues they notice, how they adapt, what workarounds they develop, and how they communicate with others to complete the tasks while ensuring patient safety.

METHODS

The research team developed the Cognitive Complexity Interview Method (CCIM). This three-stage CTA method was designed to help elicit HCPs' insights about challenges they have experienced when completing a particular task and get them to rate their agreement with specific prompts. Stage one of the interview acts as a filtering mechanism to identify highly cognitively complex tasks and guidance that may warrant further examination using a cognitive lens. There are seven prompts relating to the characteristics of the task or guideline: analyzability, complexity, criticality, frequency, interdependence, variability, and special/unusual conditions. Participants respond by rating their agreement to the prompt as 1 – disagree, 2 – somewhat agree, 3 – agree. Participants are also encouraged to provide insights about their thought processes and rankings. Cognitively complex tasks, which yield higher ratings in stage one, proceed to stage two, with different prompts for key MCFs.

Stage 1: Identifying policies/protocols/procedures requiring in-depth evaluation

Category	Description	Rating 3 – Agree 2 – Somewhat agree 1 – Disagree	Comments
Analyzability	The tasks/steps consist of following clearly defined steps.		
Complexity	The tasks/steps depend on several interactions between people and equipment (e.g., tools, technology, and physical environment).		
Criticality	Failure to adhere to the procedure can jeopardize patient and/or HCW safety.		
Frequency	The task/steps within this procedure are routinely performed.		
Interdependence	The tasks/steps require individuals to work with other individuals/departments to accomplish the work (communication/coordination).		
Variability	Successful completion of the tasks/steps require users to navigate different variations in execution of the task and in the overall environment the task is completed in.		
Special/Unusual Conditions	Unique or unexpected conditions might arise that interfere with following this procedure.		

Figure 1. Stage 1 of the CCIM – Identifying a guideline requiring in-depth evaluation

Stage two is intended to help participants consider and identify complexities when performing a specific task in terms of the MCFs. As with stage one, stage two has seven prompts to rate in the same manner: adapting/workarounds, changing competing goals, expertise, information sharing (communicating/coordinating), sensemaking/situation assessment, time/attention management, and other. This stage elicits insights about specific challenges HCPs encounter when completing the tasks and attending to other patient-centered priorities.

Stage 2: Cognitive Complexity Assessment

Category	Description	Rating 3 – Agree 2 – Somewhat agree 1 – Disagree	Comments
Adapting/Workarounds	I must often anticipate and adapt to barriers and/or develop workarounds in real-time that might not align with the standard procedure but help me complete the tasks/steps within the procedure.		
Changing/Competing goals or patient needs	When completing these tasks/steps there can be other priorities that I or others may perceive as more important, or that change unexpectedly and become more important than completing the tasks within the procedure at that time.		
Expertise	My ability to recognize patterns and cues from past experiences helps me complete the tasks/steps within the procedure.		
Information Sharing (Communicating/ Coordinating)	To successfully complete these tasks/steps I must coordinate and communicate effectively with several team members and understand each team members' role.		
Sensemaking/situation assessment	When completing these tasks/steps I must often navigate complicated or ambiguous situations that arise and are not outlined in the procedure.		
Time/Attention Management	These tasks/steps require me to be mindful of the time it takes to complete each (often simultaneous,) task and be able to manage and recover from frequent interruptions/distractions.		
Other	Additional complexities/challenges (that have not already been mentioned) that exist (or arise) and can make completing these tasks/steps difficult or add extra tasks/steps.		

Figure 2. Stage 2 of the CCIM – Cognitive Complexity Assessment

Stage three is supplemental to the previous two stages and allows participants to inventory and evaluate existing support systems such as job aids, checklists, tools, or other resources. Participants are also encouraged to suggest improvements to existing supports or ideas for implementing new supports. Each stage provides essential information about opportunities for stakeholders (policymakers, administrators, and frontline workers) to better support complex cognitive tasks and improve the aids available to those doing the work.

Support Systems for HCWs

Please list and describe any existing support systems in place including written resources, job aids, physical tools (whiteboard, sponge counter bag, etc.), or any other resource available to aid in your completion of a given task. Additionally, please provide a brief description about how this support system aids in, or hinders your task completion, and any recommendations you have for improvements or implementing additional resources that would be useful in completing the task.

Existing Support System	Benefit/Drawback	Recommendations

Figure 3. Stage 3 of the CCIM – Support Systems Inventory

As part of a multi-year, multi-site study, an interdisciplinary research team of human factors engineers, cognitive psychologists, and healthcare professionals reviewed several guidelines (e.g., policies, protocols, and procedures) from a large academic hospital and a smaller community hospital. Dierks et al. (2004) identified the tools, instruments, sponges, and soft goods count protocol as a cognitively demanding protocol frequently used in surgical settings. The surgical count, often called the count protocol, is a manual counting method in which all surgical items used in the surgery are counted. The protocol aims to reduce instances of unintentionally retained surgical items, also referred to as foreign objects. Surgical counts typically occur several times throughout a surgical procedure and are performed jointly by the circulating nurse and the surgical technician. Dierks et al. (2004) investigated the reliability of the count protocol and whether the protocol inadvertently increased

complexity for the surgical team and the risk of harm to the patient or provider. Our researchers chose the same protocol based on observing its frequency of occurrence, the involvement of multiple surgical team members, the significant impact on patient safety, and the level of cognitive complexity. Using the CCIM, the research team conducted thirteen semi-structured interviews with frontline healthcare workers. Since the selected protocol consisted of tasks completed by nurses (in particular, circulating nurses) and surgical technicians, eight nurses and five surgical technicians were interviewed. In-person observations also occurred at both sites and helped shape the design of the CCIM.

During the interview phase, researchers guided participants through all three interview stages. Researchers prompted participants to focus on real-world challenges they experienced when executing the tools, instruments, sponges, and soft goods count protocol. This protocol is performed by the circulating nurse and the surgical technician several times throughout a surgical procedure to track and account for every tool, instrument, sponge, or soft good introduced into the sterile field (e.g., the surgical tables, instruments, draped areas, surgical site, patient, and HCPs who are scrubbed in) or placed inside a patient. Depending on the type and complexity of the procedure, this may require counting hundreds of items in a short amount of time while continuing to attend to other tasks throughout the case. The researchers guided participants through each category, allowed them to assign a rating for each category in stages one and two, and then discussed challenging situations they experienced that may make following the protocol difficult. Stage three provided participants the opportunity to give feedback about existing support systems and suggestions they may have for alternative support systems that may be beneficial in reducing the cognitive complexity they face in completing the count protocol. The CCIM categories for stage one were partly developed based on literature from Parker (2020) and Kim and Soergel (2006). The categories for the second stage were developed based on in-person observations and interviews with HCPs for the broader project.

The thirteen HCP interview transcripts were analyzed and coded. Through inductive coding, an initial codebook was developed during preliminary thematic analysis. The coding categories and associated definitions were further refined, producing 11 complexity categories. The coders also coded for feedback about the CCIM. Two coders coded each transcript. Coders coded two transcripts independently and met to discuss and establish initial alignment. Once consensus was reached, coders proceeded with coding the transcripts.

RESULTS

Analyses highlighted several notable themes and insights about the challenges HCPs encounter when executing the count protocol. HCPs cited challenges relating to competing demands/divided attention (e.g., patient needs, time/production pressures), distractions/interruptions, HCP preferences, lack of standardization (e.g., inconsistent implementation or execution of the count protocol or use of existing support systems), multiple surgical sites/sterile fields or tables, responding to count discrepancies, size/type of equipment or tool involved, teamwork (e.g., communication/coordination, handoffs/covering breaks, inexperienced team members, and lack of common ground), traveling HCPs, trauma/emergent cases, and other.

Participants rated and recounted instances where challenges arose across stages one and two of the interview. The most frequently discussed complexities related to teamwork (inexperienced team members, communication/coordination), competing demands (time/production pressures), and lack of standardization (inconsistent implementation or execution of the protocol). Table 1 shows the most commonly cited complexities HCPs identified when completing the count protocol. Below, we discuss the most common themes and complexities the CCIM elicited.

Table 1. The most commonly identified complexities HCPs articulated in interviews.

Complexities Identified	Nurse (n= 8)	Surgical Technician (n = 5)	Total (N = 13)
Teamwork			
Inexperienced team members	8	5	100%
Communication/coordination	7	5	92.3%
Lack of common ground	4	4	61.5%
Handoffs/ covering breaks	3	2	38.5%
Competing demands/divided attention			
Time/Production pressures	7	4	84.6%
Patient needs	3	3	46.2%
Other	2	3	38.5%
Lack of standardization			
Inconsistent implementation/execution	6	5	84.6%
Inconsistent use of existing supports or job aids	1	0	7.7%
Other	5	4	69.2%
Size/type of equipment/tool involved	5	3	61.5%
Responding to discrepancies	5	3	61.5%
Multiple surgical/sterile fields or tables	4	3	53.8%
Trauma/Emergent cases	4	3	53.8%
Traveling HCPs	5	2	53.8%
Distractions/ Interruptions	3	2	38.5%
HCP preferences	0	2	15.4%

Teamwork

HCPs discussed instances where less experienced team members may not be proficient in quickly executing the count while managing other responsibilities, such as attending to the surgeon's needs, monitoring the patient, and maintaining appropriate IPC practices. One nurse said:

> "When we have a fresh graduate, not to undermine their capacity to make good decisions all the time. But it's different when you have a seasoned nurse in the OR as opposed to having a new nurse in the OR. We try to orient them as much as we can, but it's tough for fresh graduate not to have OR experience at all during the course of their education. And just have first-hand experience of the OR to get things done. As opposed to those who have been in the OR, experienced a lot of stuff, been to a lot of stuff."
> **- Nurse #4**

A critical component of the count protocol is the communication and coordination among the surgical team, particularly the circulating nurse, surgical technician, and surgeon. The circulating nurse and surgical technician are involved in every count that occurs for a given case, except when they are on a break, in which case their replacement would tend to the count in their absence. The surgeon is heavily involved in communicating when items have been introduced to the surgical field and where the item was placed, particularly if left in the patient's body. While HCPs stated communication is typically positive and productive, they acknowledged that challenges usually arise when communication breakdowns occur at any stage in the surgical procedure. Items introduced to the field or packed inside a patient cavity without an announcement of the insertion time and placement location can lead to a count discrepancy, causing a preventable delay in the procedure. When count discrepancies occur, the procedure is paused, and each surgical team member assists in trying to find the missing item. One nurse said:

> "The orientees, there are so many people in the room. And you'll have people that are still learning, and they don't really understand opening stuff onto the field, countable items and not telling the nurse, because we're the one that's responsible for the count. And we'll say, 'Where did this extra suture come from?' And the med student will say, 'Oh, I put that up a while ago.'" **- Nurse #6**

Competing Demands/Divided Attention

HCPs frequently cited time and production pressures as challenging when executing the surgical count. Completing the case efficiently and reducing the time the patient is under anesthesia is critical in maintaining patient safety. Though counting constitutes an essential task, it often occurs during times in the surgery when other critical tasks are also happening, such as when the patient's surgical site is being closed by the surgeon. HCPs tasked with performing the count protocol described managing other responsibilities simultaneously, such as providing additional sutures to the surgeon (which also need to be counted). Participants noted difficulty maintaining an accurate count when items are still being used and moved around the table.

> "It's all about time in the OR. We want to be as efficient as possible while being safe. So, a lot of times, at the end of the case, the surgeons are ready to move on to their next shift. Or they're ready to go home. So they're closing quickly, and you have 600 instruments you have to count. You have to count, count,

> count, count, and you have to make sure they're right. You also have to stand up to the surgeons. If they're closing too quickly, and the count's not correct, or the count's not finished yet, and they're trying to put dressings on, you have to tell them they need to stop. So you have to be fast, but you have to be safe." **– Nurse #6**

One surgical technician said the time pressure for initial counts was high because the count had to be completed before the patient was brought back into the OR. This requirement imposes added pressure on the surgical technician and the circulating nurse to get set up and count relatively quickly while the room may still be being cleaned and set up for the surgery.

> "They changed the count policy to having to complete our count before they bring the patient back to the room. I don't think that anyone else understands how much pressure that puts on the tech because it's like we opened everything, and everything's a mess; we still have to arrange our table. Everywhere I've worked, I've been able to set up my table completely and have everything ready to count when they come back. I just feel like this really sets us up for failure because I was so worried about setting up and getting my countables ready that I found a hypodermic needle underneath the towel on my Mayo stand. It wasn't in the original count and at some point during the surgery could have wound up somewhere it didn't belong. I really, really don't like that, and I can imagine that it's a struggle for other people, too, because it's go, go, go, and when you're panicking and rushing, you're more likely to make a mistake or look over something." **– Surgical Technician #3**

Lack of Standardization

HCPs identified differences and inconsistencies in the execution of the count protocol. Some participants stated that the correct way to count always begins with a single item (e.g., sponges) at the surgical field, then moves to count the same item on the Mayo stand (a type of table used in healthcare to hold tools and equipment), then the same item on the back surgical table, and finishes with whatever the circulating nurse may have on hand. Other participants described counting all items on the surgical field and then all items on the Mayo stand instead of one item at a time. One surgical technician stated:

> "A lot of the new people don't follow the correct protocol when starting on the field, going to the Mayo stand, going to the back table, and then letting the count continue with what the nurse has. If I have an orientee, I say, 'Please don't start counting there because I'm not finished. I still have items on the field.' If I am the relief person, it's hard to put yourself in that situation and say, 'Listen, you guys are doing this incorrectly, but can you at least count over, and can we count everything on our field before you guys start counting what's off the field?' And that, unfortunately, is something that still goes on." **– Surgical Technician #1**

Some items are individually packed, while others may come in packs of five or ten. HCPs noted that confusion can occur when team members do not count these items separately and instead count by multiples (i.e., instead of 1, 2, 3, they are counted 5, 10, 15). The latter method can also lead to miscounts, creating the need for recounts and potential case delays. HCPs from the community hospital also cited instances where a traveling nurse may request to count an item not typically counted at that hospital. In such situations, the community hospital accommodates the request to count the item. Surprisingly, participants from the larger academic hospital did not discuss this as a challenge or an occurrence at their facility.

Feedback about the CCIM

Participants were also asked about their impressions of the CCIM and feedback about their experience completing the interview method. Overall feedback was positive, with many HCPs expressing that it was an effective exercise to get them to reflect on the cognitive challenges embedded in their work. HCPs from the community hospital stated they found it beneficial to provide feedback and thought it would be helpful to implement it in their facility.

> "I think it's great. I was part of a committee [at another hospital] that would pick a policy, usually prompted by a situation that happened recently. If there was a count discrepancy or an issue, we talked about the policy; what's best practice based on AORN standards? Do we think we need to revise this? It's more than three people on the committee, so lots of different perspectives and ideas. I'm all about this. I actually mentioned starting a best practice committee here at this hospital, so we could potentially use your tool to help us with that, absolutely." **- Surgical Technician #3**

One HCP described it as a more proactive approach to implementing policy changes than the current approach, which seems reactive in nature – often resulting from an unfavorable, unintentional incident. Some HCPs saw value in it, specifically because it directly provided frontline workers with a voice in policy development, but suggested a concern and desire for anonymity.

> "I think it's extremely helpful and I think you guys are also allowing the staff to speak up and be like, Hey, we noticed that some things are just not adding up here. We need to look at this as a bigger whole. I do feel like sometimes the people who are making these policies and procedures are probably people that have never even stepped into the OR." **- Surgical Technician #4**
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> "I think it's easy to use. I think everybody can, especially with the comments, everybody can put their opinions on it. If it's anonymous, that's even better because people are more likely to be forthcoming." **- Nurse #5**

DISCUSSION

The CCIM proved to be an effective method for understanding the cognitive challenges arising when guidelines are implemented in real environments. It successfully highlighted complexities and implementation differences when applied to a relatively straightforward protocol, the count protocol. Our method is similar to other CTA techniques, like applied cognitive task analysis (ACTA), designed to aid in eliciting skills required to successfully complete a task (Militello & Hutton, 1998). The CCIM is designed to be more streamlined and focused on one specific guideline and the tasks within. It allows HCPs to highlight the cognitive challenges they experience in their daily work that are often absent from established guidelines. The data gleaned from the CCIM could be used to improve existing guidelines, bridge gaps between work as done and work as imagined, provide policymakers and institutions a better understanding of the cognitive complexities embedded within healthcare work, and establish a process for frontline workers to engage in providing critical input about those complexities.

Next steps

We believe there are three important next steps. The first is to expand the application of the CCIM in healthcare with guidelines beyond the count protocol. Although our researchers piloted the CCIM with other healthcare guidelines, the interviews focused on the count protocol because of its direct impact on patient safety and its cognitively complex nature. Given its effectiveness with this protocol, we believe it could be effective with other guidelines. The second step is to create a standalone, self-administered, anonymous version of the CCIM. During interviews, several HCPs noted that participants may be more forthcoming if they could provide feedback anonymously. Developing a self-administered version would reduce the need for a trained interview facilitator, perhaps making it more practical to implement in various settings. Finally, the third step would be to employ the CCIM in other cognitively dynamic domains outside of healthcare. As with other CTA techniques and methods, we believe the CCIM could be an effective elicitation method that can benefit guideline development and modifications in various domains.

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