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Cognitive challenges of junior residents attempting to learn surgical skills by observing procedures

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ABSTRACT

Background: Surgical observation is an integral part of surgical training. Junior residents, who have limited understanding of the procedures being performed, use observation to gain an initial exposure to surgical techniques. This study explores the challenges junior residents face from a cognitive standpoint when they are observing surgery.
Methods: Four focus groups were conducted with 18 general surgery junior residents. Transcripts from these focus groups were analyzed using a qualitative interpretative approach and the findings were explored through the lenses of discovery learning and cognitive load theory.
Results: Surgical observation is perceived by residents as a learning activity with rich potential. However, two main challenges were identified: directing their attention to the most pertinent element during observation and making sense of what is happening during procedures.
Conclusions: This study can inform strategies to help junior residents observe surgeries more efficiently to help make surgical observation a better learning experience.

Introduction

Performing surgery requires a combination of technical and cognitive skills.[1] Cognitive skills can be defined as the thinking processes used to solve problems. In surgical education literature, cognitive skills are often referred to as surgical decision-making or judgement.[2,3] A recent study illustrated the central role of decision making in surgical outcomes: in a review of 252 bile duct injuries, the most frequent etiology of bile duct injury was misperception. The operating surgeon did not read the situation appropriately and made unsafe decisions based on what he or she perceived.[4] With this in mind, it becomes clear that cognitive skills or judgement are an important part of the content that should be imparted during surgical training.[5]

Current surgical training relies heavily on the operating room (OR) as the main venue for teaching both technical and cognitive surgical skills.[6] It has been suggested that a better understanding of how learning happens in the OR could help develop strategies to improve this learning.[7] This interest in the OR as a learning environment has led to many projects exploring learning in the operating room and what conditions contribute to the quality of the experience for the trainee.[7–18] A wide variety of both technical and non-technical skills have been identified as potentially learnt in the OR through both observation and active performance of procedures.[10] In terms of conditions necessary to create good learning experiences, authors have shed light on the importance of the relationship between the learners and the other members of the team and have described the key role of the interaction between the attending surgeons and the residents.[16,17,19,20] However, to our knowledge, no studies have focused specifically on the cognitive aspects of learning in the OR. Understanding what limits and promotes learning from a different lens could potentially lead to new strategies to improve learning in the OR.

When reviewing studies on the OR as a learning environment we note that most studies focused on the experience of the operating resident, most often an experienced learner[8,9,17]; as such we decided to focus this study on junior residents. Authors have described differences between the experience of junior and senior residents in the OR[10]; for example, junior residents experience more distraction and generally perceive less opportunity for

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learning.[12] Futhermore, a study by Scallon et al.[21] suggested that surgeons were less aware of the second assistant, likely an observing junior resident, and were therefore less likely to teach them compared to their first assistant. Futhermore, it has been shown that making sense of visual cues present during the operation is an ability learnt in the OR.[10] It this context, it is possible that junior trainees have limited ability to "read" a procedure well enough to be able to distill learning for themselves.

To prepare for surgical observation it is generally suggested that residents review the procedure in textbooks or watch videos of the procedure. Although useful for clarifying the anatomy and the steps of the procedures, these modalities have not been shown to help with developing the cognitive skills required to safely perform surgery. For example, they rarely focus on prevention and management of complications and they rarely explain how to find an appropriate dissection plan.[22,23]

The objective of this study was to understand the cognitive factors impacting resident learning, considering that the learners were new to surgery as an area of expertise. We decided to use cognitive load theory and discovery learning to guide our qualitative, exploratory analysis. This study is meant as a first step towards improving the learning of junior residents.

Material and methods

The study was approved by the Ethics board of our institution. An interpretative phenomenological approach was used for this project as the goal was to make sense of the experience of junior residents as they are observing surgery.[24,26] While phenomenological projects are usually conducted using interviews as a data collection strategy, we chose to use focus groups to provoke deeper discussion through interactions amongst the participants.[25]

Participants

Nineteen (19) junior residents (PGY 1, 2 and "first research year" which follows PGY2 in this cohort) from a general surgery program were invited to participate in the study at the end of the academic year. A total of 18 participants were enrolled in the study.

Data collection

Four focus groups were held involving 3 to 5 junior residents. A qualitative approach was chosen, as the goal of this project was to explore the perception of the junior residents regarding surgical observation; the content that was taught; the methods used by surgical teachers to enhance their learning; and the perceived barriers to learning.

A semi-structured protocol was developed by the study team and the final version was piloted with two residents who were not involved in the research project prior to the first Focus Group. Partial analysis of the data from the first focus group was used to inform the protocol of the second group and this iterative process continued throughout the focus groups. These were led by an experienced and impartial moderator who also contributed to the development of the protocol, and the confidentiality of the process was emphasized with the residents.

Analysis

The focus groups were audio-recorded and the recordings were transcribed. One transcript was compared to the recording to ensure accuracy. The analysis team consisted of one research coordinator and one research assistant (both having a master's degree in education) and a practicing surgeon, each of whom coded the entire content of the transcripts. All members of the team had been involved in projects with surgical residents before and understood the surgical culture, although only the physician co-investigator had direct experience in the OR as a learner and educator.

The transcripts were first read to get a global sense of the data. The first transcript was then used to establish an initial provisional list of themes. This list was based on the data, linking it to the research questions and existing theories. It was then used to code the other transcripts and adjusted to reflect all the data. The material was then coded a second time, using the finalized coding schema. Every member of the analysis team coded all the material; the final coding was discussed at the analysis meeting. Any disagreements among coders were discussed and resolved through consensus.[27] The theoretical framework of the cognitive load theory and discovery learning theory were used to guide the analysis once initial categories had emerged from the data. Themes were defined and listed in a document made available for future reference. A member check was conducted with two residents after the analysis and the findings were discussed during research meetings. The model proposed by Lincoln and Guba[28] as described by Shenton[29] was used to ensure the trustworthiness of the results.

Results

Our results can be broadly broken down into two components. Firstly, we discuss the perspectives of junior residents regarding surgical observation and the role of observation as a learning strategy. Secondly, we explore the two main challenges identified by learners and suggest some strategies to overcome them, relating these challenges to discovery learning and cognitive load theories.

Junior residents' perspectives on surgical observation (97 sense units)

Thirty-four sense units described a large amount of material ("content") potentially learnt through observation. Residents mentioned the specific role of surgical observation in their training, validating surgical observation as a potentially valuable learning activity (11 sense units). They also mentioned that observation, while useful, was generally perceived as a second choice and that they would rather perform than observe procedures (12 sense units). Many mentioned that there was a limit to what it is possible to learn through observation as a novice (6 sense units).

When asked to explain learning that happens during observation they discussed how they use it as a technique to consolidate learning via other modalities, such as textbook readings or previous experiences in the OR. They described an iterative learning process in which observation played a role amongst many other strategies

Fig. 1. Junior residents' perception of observation.

(34 sense units). Fig. 1 presents a summary the different codes discussed by the participants in relation to their perception of surgical observation as an educational tool.

Quote – focus group 2

F2: And I think it must be a different centre in your brain, in your memory or something, you can read something in a book as much as you want but there are all these gaps that are still there in your understanding and your memory. But once you're there and you've gone through the steps, there's something about when you're asked to recall how to do a procedure, if you've seen it at least you can just kind of go back to that place and remember it. … And once you've read about something you have (…) a framework of understanding and then in the situation you're (…) just piecing things into the empty spaces of that understanding. (…) It's like a tree and you're just filling out all the leaves to understand the whole picture of it. That takes time and you (…) spiral upwards to learn more as you revisit each procedure or situation.

Challenge 1: directing attention (170 sense units)

Residents mentioned that there is usually no explicit objective for them when observing surgeries and that in most situations they decide their own learning objectives for that day (12 sense units).

Quote – focus group 1

M2 … we've never received:" we expect you to know how to put in a port and why it goes here". I think those are intuitive things that you figure out yourself.

Mod: So quite general, not very focused.

M2: Yeah you're given general, not specific objectives.

They set their own objectives based on what they understood during their last experience of that procedure. Also, most residents mentioned that what they were paying attention to varied with their experience of different procedures (17 sense units.)

Quote-focus group 1

M2: And it's interesting you bring up the ceiling effect because I find there is kind of a ceiling effect but there are different, but the ceiling is different as you go through your training. So like at any one observation or surgery perhaps you can only sort of observe or learn up to a certain point, you go back to practice, you know, you get some opinions about how you're handling things and you incorporate what you've learned. And then next time you observe your ceiling is different. So for sure, every, any single observation there is a ceiling effect, but that changes over time as well.

When discussing strategies used to optimize observation, most residents mentioned the key role of preparation, indicating that knowing clinical details relevant to the case and understanding technical aspects of the procedure helped them focus their attention on relevant elements present in the procedure (76 sense units).

Quote- focus group 4

M1: … you're only going to get out of watching, what you know to look for. Like if you're well prepared and you are aware of what's happening, you're going to learn. If you're woefully unprepared and you just show up in an Operating Room …

However, despite preparing for procedures, many residents mentioned having difficulty distilling learning moments during procedures. They explained how they felt like they were missing key elements. They mentioned that experience and guidance from other members of the surgical team could help them by focusing their attention on relevant elements (65 sense units).

Quote- focus group 3

F2: So I think if the goal is for you to be able to do what you're observing, then you should understand. They should be telling you what they're doing, right. Because if you're just looking at it and trying to figure it out for yourself, when it comes time for you to do it you may not have understood well when you were observing. But if the point is for you to take over the person's role, then if they're explaining to you what they're doing you'll be able to do it better.

Fig. 2 presents a breakdown of the sense units describing the first challenge reported by the residents: their difficulty in directing their attention to pertinent learning points during procedures.

Challenge 2: making sense of the procedure (151 sense units)

Most residents mentioned using a surgical atlas or videos to prepare for surgery (30 sense units). Those modalities offer them a knowledge of the anatomy (7 sense units) and the steps of the procedure and a global framework to guide their observation (15 sense units).

Quote-focus group 1

M2: Well as mentioned before ideally you review the anatomy, and you should be comfortable with knowing what you'll be doing from start to finish; what tissues they'll be going through, what you might run into, what things you have to be cautious of, that sort of thing.

However, many residents mentioned that it is often challenging to understand the decision-making that goes on during a procedure. They valued the cognitive aspects of surgical expertise but indicated that it was difficult for them to make sense of the events during a procedure (16 sense units). Because they struggled with

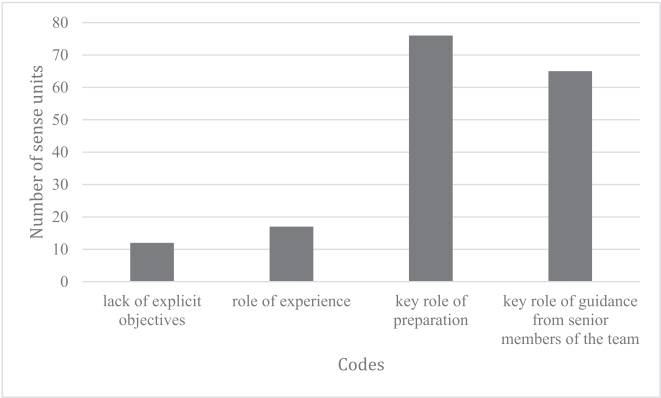

Fig. 2. Directing attention.

decision-making, identifying anatomy, and following the steps of a procedure, the role of the more senior members of the team to help them understand those subtleties was critical (48 sense units).

Quote - focus group 1

M1: Some things, as you mentioned, the subtleties are sometimes too subtle and it goes unbeknownst to you. And the whole operation can go by and you didn't [notice] some of the smaller things that were happening and it's nice when the surgeon just says, this is what I'm doing here just to make my life easy, maybe now or down the road. So it's nice when it's explicitly told to you as well.

They also mentioned that it was easier for them to understand certain decisions made during the procedure when they had been allowed to perform this specific procedure before (17 sense units).

M2: So when you first start […], what you observe is how people hold their instruments, how they handle their instruments, you know, the way they load their needles even, and the way they come through tissue, how they're tying knots; these small things. But as you gain these experiences yourself and you improve on these technical skills, you gradually pay more attention to the bigger picture. So what are they doing next? You think about the next step, you think about why they're doing this.

Fig. 3 is a representation of the second challenge discussed by the junior resident, their difficulty in making sense of what is happening during procedures.

Discussion

The goal of this study was to gain a better understanding of the experience and perceived learning process of junior residents when they observe surgery. Surgical observation was perceived as a useful teaching modality by the residents. However, two main challenges were described by the residents: focusing their attention appropriately and making sense of the procedure. It is possible to link those challenges with some elements in existing learning theories, in this case, discovery learning and cognitive load theories. We will also link our results with other studies on the operating room as a learning environment. Potential applications of our findings will be discussed. Finally, the limitations of this study will be presented.

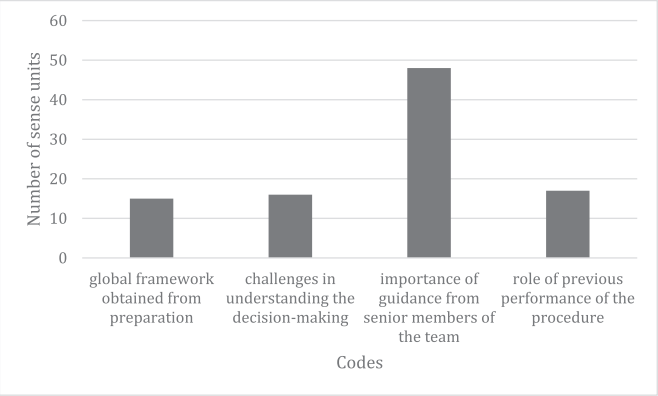

Fig. 3. Making sense of the procedure.

Discovery learning and cognitive load theory

First, the challenges junior learners face when deciding the focus of their attention in a busy OR can be understood when reviewing cognitive load theory and guided discovery learning. During surgical training, observation occurs in a context that has been described as discovery learning[6] where, as discussed by the participants, there are no clear instructions. In a review of discovery learning, Kirschner et al. indicated that empirical evidence suggests that students learn more efficiently when provided with instructions.[30] Participants in this study described instructions as the guidance they receive from the senior members of the team and identified them as a critical element of observation. In a review of the role of instructions in learning, Lee and Anderson explain the expertise reversal effect, which is defined as the impact of experience on the usefulness of instructions.[31] Evidence suggests that experts learn better and are more likely to reach their learning goals when provided with less instruction, and novices do better when provided with more detailed instructions.[32] This difference might explain why it is so easy for experienced surgeon to learn through observation while it can be so challenging for junior residents with limited experience of a procedure.[33]

Cognitive load theory can also explain the challenge of directing learners' attention. It describes how working memory is a limited resource that can manipulate only a few elements at a given time.[34] In our context, we can imagine that a junior resident's working memory could easily be overwhelmed with the amount of information available in the OR. To process this amount of complex information, it is necessary to use declarative knowledge and heuristics stored in the long-term memory in the form of schema. However, junior residents might not have well developed schema for a given procedure. The "central executive function" of schema is used by Sweller to explain the role played by previous knowledge and skills to triage new information and make sense of new concepts.[32] Before the creation of an initial framework, pertinent information is select randomly and attempts at creating a schema are made through mental simulation or trial and error.[32,35] Our participants described this random selection when discussing the content learnt in the OR. Their focus was quite varied, and some were paying attention to aspects that were perceived as irrelevant by the clinician on the analysis team.

Link with current literature on the operating room as a learning environment

Many studies have been conducted to better understand the OR as a learning environment and improve learning (as suggested by McKendy et al.[7]). This study contributes to our understanding by exploring issues noted by other authors through a new lens. For example, Zundel et al. noted that surgeons narrating their procedure helps with learning for novice trainees.[18] The findings of this study support the role of surgeons' explanations as a strategy to both guide the trainee's attention and to help them make sense of what is happening during the procedure. In fact, guidance from more senior members of the operating team was one of the most important strategies named by our participants. Interestingly, Chen et al. found that only 6.3% of teaching interactions in the OR were done deliberately by either explaining thought processes or allowing the trainee to learn from a mistake.[9] In the Chen et al. study, most of the teaching strategies during a procedure were directed toward the operating resident, the first assistant. Recognizing that junior residents will spend a significant portion of their time in the OR observing procedures,[14] it is important to suggest tools to improve this experience. By being more aware of the challenges faced by junior residents trying to learn how to read a

procedure in the OR, surgeon educators will be better equipped to help them.

Roberts et al. have suggested the BID model, which includes the definition of objectives, explicit teaching around this objective during the procedure and debriefing afterwards, to help guide teaching in the operating room. This model has been associated with improved teaching outcomes.[36] By defining the objectives for a specific procedure, this model can help the trainee focus his or her attention on relevant elements for their learning. Also, by promoting explicit teaching, this model has the potential to help trainees make sense of the procedure. As mentioned earlier, Samuelsen et al. show that reviewing videos or textbook materials can be useful in helping trainees with the knowledge component but not with the judgment component of procedures; this finding was echoed by participants in our own study.[22]

Reviewing literature on the OR as a learning environment, there is ample evidence of the key role of social interactions to promote learning.[6,11,16,17,20,21] Relatively little is known about how to transmit cognitive expertise from surgeon educators to trainees,[13] and it can be difficult for expert surgeons to know what would be a useful teaching point for a novice during a long procedure. We believe the findings of this study suggest ways of making those interactions more meaningful.

Potential applications

This study highlights some challenges experienced by junior residents when observing surgery. With those challenges in mind, it is possible to think of concrete interventions that could make observation better for junior learners. Residents should prepare for procedures by reviewing anatomy and surgical steps. This preparation should aim at creating an initial framework to guide their observation. Keeping a log book of this framework and adding elements to it during training could help guide the iterative process of learning procedural skills. Taking a few minutes before procedures to identify concrete learning objectives for residents could help them direct their attention, or programs could identify objectives for common procedures. Being aware of the difficulty novices have understanding certain actions, a surgeon educator could aim to explain at least one or two key decisions during a procedure and could attempt to be more explicit with the decision-making process. Cognitive aids in the form of pre-determined questions could help direct attention to key elements of procedures and could foster understanding the decision-making process during procedures.

Limitations

This study has some limitations. It was conducted in one university with residents from one program. The transferability of the findings could have been improved by including participants from other programs in other universities or with participants from other specialties. Including more senior trainees or staff could have enriched the findings, however the goal of this project was specifically to understand the experience of junior residents.

Conclusion

This research confirms the potential value of observation as a learning modality but uncovered challenges experienced by junior residents when observing surgery. The findings can be used as a first step in designing interventions to promote learning through observation. It is unlikely that operating surgeons will be able to explain their thought process constantly during surgery. However, if there was a better understanding of the educational needs of junior trainees, it would be possible to take them into account during procedures. Surgical observation will always be part of surgical training, and this study provides a starting point to optimize time spent in observation by offering a better understanding of the challenges experienced by junior residents.

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