Thinking like an expert: surgical decision making as a cyclical process of being aware

Sayra M. Cristancho, Ph.D.^{a,*}, Tavis Apramian^b, Meredith Vanstone, Ph.D.^c, Lorelei Lingard, Ph.D.^d, Michael Ott, M.D.^e, Thomas Forbes, M.D.^f, and Richard Novick, M.D.^{g,h}

^aDepartment of Surgery and Centre for Education Research & Innovation, University of Western Ontario, London, Ontario, Canada

^bCentre for Education Research & Innovation, Schulich School of Medicine & Dentistry, University of Western Ontario, London, Ontario, Canada

^cDepartment of Clinical Epidemiology & Biostatistics, Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, Ontario, Canada

^dDepartment of Medicine and Centre for Education Research & Innovation, University of Western Ontario, London, Ontario, Canada

^eDivision of General Surgery, Department of Surgery, University of Western Ontario, London, Ontario, Canada

^fDivision of Vascular Surgery, Department of Surgery, University of Toronto, Toronto, Ontario, Canada

^gDepartment of Critical Care, University of Calgary, Calgary, Alberta, Canada

^hDepartment of Cardiac Sciences and Surgery, University of Calgary, Calgary, Alberta, Canada

Abstract

BACKGROUND—Education researchers are studying the practices of high-stake professionals as they learn how to better train for flexibility under uncertainty. This study explores the “Reconciliation Cycle” as the core element of an intraoperative decision-making model of how experienced surgeons assess and respond to challenges.

METHODS—We analyzed 32 semistructured interviews using constructivist grounded theory to develop a model of intraoperative decision making. Using constant comparison analysis, we built on this model with 9 follow-up interviews about the most challenging cases described in our dataset.

RESULTS—The Reconciliation Cycle constituted an iterative process of “gaining” and “transforming information.” The cyclical nature of surgeons’ decision making suggested that transforming information requires a higher degree of awareness, not yet accounted by current conceptualizations of situation awareness.

*Corresponding author. Tel.: +1-519-661-2111; fax: +1-519-850-2421. sayra.cristancho@schulich.uwo.ca.

The authors declare no conflicts of interest.

CONCLUSIONS—This study advances the notion of situation awareness in surgery. This characterization will support further investigations on how expert and nonexpert surgeons implement strategies to cope with unexpected events.

Keywords

Reconciliation cycle; Situation awareness; Decision making; Surgery

Experts' ability to collect, interpret, and use information to make decisions is under exploration in medical education research¹ and beyond.² However, much of this research has focused on routine situations.^{3,4} As a result, we know little about how experts adapt to novel challenges. Surgery offers a rich setting to begin addressing this gap in knowledge because surgeons regularly encounter complexity that necessitates changing from the planned course of action. In previous work, we used a constructivist grounded theory approach to propose a process-oriented model of intraoperative decision making.⁵ The model describes how experienced surgeons define what the problem is, understand what a reasonable solution would look like, take action to reach a specific goal, and evaluate the effects of their action. We found that surgeons pursue these activities in a cyclical, as opposed to a linear, fashion. Within the model, we identified the Reconciliation Cycle as the process by which experienced surgeons perceive and interact with the environment.

Expertise has been shown to be inherently linked to an appreciation of the complexity of a situation.^{6–8} Environmental and sociocultural factors are a source of this complexity. Clinical experts describe the ways they make decisions as deeply reliant on the social context in which they are working.^{9–11} For instance, cardiac surgeons in one such study noted that the configuration of the tools in the operating room and the nature of the ongoing interpretive process between the staff managing those tools intraoperatively exert an important influence on their surgical decision making.¹⁰ Research by our group⁵ and others^{12–14} suggests that surgical experts use decision-making strategies that implicate social and environmental factors when facing challenging or unexpected situations. This body of literature^{5,12–14} also emphasizes the need to move from a “product-oriented” to a “process-oriented” conceptualization of decision making.¹⁵ Process-oriented models recognize how sociocultural factors fundamentally change the ways individuals perceive their environments.^{16,17} In surgery, sociocultural factors, such as the implications of seeking help, are particularly important when experienced surgeons attempt to respond to uncertainty during unanticipated and nonroutine situations.^{16–18}

The Reconciliation Cycle is drawn from a process-oriented model of intraoperative decision making during challenging operations. In this study, we aim to explore the processes involved in the Reconciliation Cycle and their potential implications for surgical education.

Methods

This study involved a focused analysis of data collected as part of a larger constructivist grounded theory study, previously published in this journal, in which we examined how experienced surgeons assessed and responded to challenging intraoperative moments.⁵ The constructivist paradigm views knowledge as actively constructed and co-created between

researchers and research participants. Within the constructivist paradigm, the goals of research shift from the positivist goal of discovering truth toward the development of understanding and construction of adequate models for specific, situated purposes.¹⁹ As a qualitative research methodology, constructivist grounded theory²⁰ allowed us to engage in the exploration of the tacit knowledge that arose from the surgeons' reflections about their approaches to decision making in the operating room. In this way, we were able to explore the nature of perceived challenges, as expressed by the participating surgeons, rather than dictating a particular definition of a "challenge," which may not reflect surgeons' experience or opinions.

In this study, we conducted purposive follow-up interviews on 9⁹ of the most challenging cases described in our larger dataset (32 cases)⁵ and conducted data analysis using the method of constant comparison.²⁰ We selected these cases as they represented challenging operations where surgeons had explicitly emphasized their need for a higher degree of awareness to deal with the complexity of the situation. To gather rich accounts of the surgeons' experiences with those challenging operations, we sought depth rather than breadth in this study. We therefore opted to analyze those 9 cases to allow us to engage the participating surgeons in ongoing and long discussions as part of the analytical interpretation.

Before the individual follow-up interviews, the surgeons reviewed the surgical report for each case to refresh their memory on the surgical approach followed at the moment of the surgery. During the follow-up interviews, interviewees were informed by the original postoperative interview conducted immediately after the case. These follow-up interviews were done one-on-one with each surgeon individually. During these follow-up interviews, we focused on discussing the process by which surgeons acquired and used information during the operation, which are commonly known to be key steps in the decision-making process.⁵ A focused coding of the follow-up interviews yielded an initial narrative description of the internal components within the Reconciliation Cycle. The results of the focused coding were brought to the participating surgeons 3 times for discussion. One-to-one interviews were also conducted with 2 additional key informants (key informants are considered expert sources; in our study, they were experienced surgeons regarded as highly insightful by their peers) to further refine the description of the cycle before each meeting with the participating surgeons. Once a consensual description of the Reconciliation Cycle was achieved, the discussions between the participating surgeons and the research team focused on analyzing the suitability of existing decision-making concepts to inform our interpretations.^{16,17,21} This work was conducted over 3 additional analytical meetings with the participating surgeons and the research team. The mix of expertise in our research team (education researchers, methodological experts in qualitative research, and experienced surgeons) was a strength of our analytic process because it supported a balanced interpretation of the data.

Results

Participating surgeons' perspectives of the relevance of the Reconciliation Cycle in the decision-making process were fundamentally described in terms of how they perceived and

interacted with the environment. The analysis of the follow-up interviews depicted the Reconciliation Cycle as a continuous, iterative process of “gaining” information and “transforming” the information found—by comparing it against what is expected or typical and/or against the planned course of action—to obtain a new meaning that is useful for solving the situation (Fig. 1).

Gaining information

Once the surgeon has assessed the situation in terms of the feasibility of the preop plan in addressing the challenges that they are about to face, gaining information is the process by which the surgeon purposefully collects specific facts from the context. While most of the time this is an active exploration from the role of the surgeon, for example, by asking questions, performing technical maneuvers to identify anatomical landmarks, or gathering information from intraop equipment, gaining information may also be a reactive experience. This is particularly evident when the surgeon is implementing the plan and something unexpected arises that requires the surgeon to quickly deliver a response, while at the same time engaging in the collection of new or additional information necessary to revise the plan according to the consequences of the current actions. For instance, major bleeding may be an indication of having incorrectly identified a plane. In this case, the surgeon must control the bleeding while at the same time figuring out where the bleeding was coming from and where it was located with respect to the correct plane.

With this in mind, there were 2 methods of gaining information identified: “active seeking” and “perceiving.” From our return-of-finding (return-of-finding refers to follow-up meetings with the research team in which preliminary findings are discussed to achieve consensus in the interpretation and analysis of the data) discussions, there seemed to be no strong boundary between active seeking and perceiving. Instead, the use of both methods resembled intertwined processes, in which the processes can be referred to as “knowing exactly what pieces of information are missing and looking to fill those gaps” (ie, active seeking) and “filtering information while engaging in some action” (ie, the surgeon is open to perceive things that stand out without having identified a gap in knowledge). While sometimes the 2 methods were used separately, more often they were described as happening simultaneously with various amounts of overlap: “There was one point when we were dissecting laterally on the tumour and I felt like I had gone as far as I possibly could and the anatomy was a little disorientating. It took me a few minutes to figure out that what I was feeling was the ischial tuberosity, which is the bony part of the pelvis. And once I figured that out I knew that that’s as far as you can go you can’t go any further. But I must say at the moment working up to that point I didn’t necessarily recognize exactly where I was in the anatomy and then all of the sudden once I felt that I was curious as to what that was.”

Given the nature of our data (ie, expert surgeons’ accounts of challenging situations), the notion of intertwined processes allowed surgeons to reflect on issues such as “sometimes I am not able to say that I am actually seeking for X in any given moment the way I can in some situations.” Thus, surgeons seemed to be always filtering, that is, often they are in a situation where they need to go from the “known to the unknown” while having questions in

their heads, and as the situation evolves some information gets filtered. According to our key informants, this filtering is not random, it is very purposeful: “it is the type of filtering that implies doing things and, while doing, always having the sense of seeking, even though not seeking for a very specific piece of information”. Furthermore, our participating surgeons commented that the notion of “filtering” probably has something to do with the notion of “progress”: “if you are always moving forward then perceiving information and looking for it is always a byproduct of the forward movement of the operation”.

Transforming information

In our preliminary model of intraoperative decision making,⁵ in addition to gaining information, we described 2 other processes: “weighing” and “projecting.” During our analytical meetings, we refined the model by combining these 2 processes into a high-level process that we called transforming information. Transforming implies the use or manipulation of the information gained—through active seeking or perceiving—to get a “new meaning” that is useful for solving the situation. For example, one surgeon described his experience of facing a wrong diagnosis: “First thing I’m going out to scrub and X says, ‘professor there is no sinus of Valsalva aneurysm’. We’ve got this weird mass in the ventricular septum. And the pre-op diagnosis is wrong. So I then spent about 20 minutes with X looking at the transoesophageal echo and thinking that this was something I’d never seen in three decades ... The first major challenge was figuring out what exactly we were dealing with and whether we should actually proceed ... so I made the decision that we were going to proceed. When you have one thing that’s uncertain it’s not a big deal but when you have a bunch of things that are uncertain ... In the end we recognized it was a congenital thing that was growing bigger as the guy aged. So one, what’s the aetiology? What exactly is it? How are we going to expose it? How are we going to deal with it? And how can I make sure that I do more good than harm, which is actually not a trivial question to be answered because this guy was asymptomatic.”

According to our participating surgeons and key informants, the original concepts of weighing and projecting did not properly capture the nature of obtaining new meaning. Thus, we decided to merge those concepts into the process of transforming, which we have defined as “working with information for a purpose.”

The cyclical process that characterizes the transforming process was particularly important to surgeons to achieve goals, such as projecting the final outcome, maintaining the principle of progress, or reassuring focus on the big picture. It was suggested that “although we know this to be true, experts and novices perform this transformation differently: novices generally interpret information at the level of pathology and physiology while experts perceive with ‘new meaning’ that is, what the situation in front of them means for the patient’s immediate and long-term future.” The following is an illustration from an experienced surgeon reflecting on a very difficult case: “One of the things that was very challenging was that the tumour itself seemed to be fixed to part of the stomach or at least it seemed to be in the beginning. The second thing was to figure out how aggressive we should be with this woman because she has metastatic disease inside her abdomen and her prognosis is quite poor long-term. And so if removing the tumour required doing heroic or very extensive surgery is that

really in her best interest to do some huge operation? Or would it be better to just not remove the tumour and make her comfortable and palliate her and let her die in comfort? And then the third level of uncertainty was trying to weight the practical decision of avoiding complications in the future versus ‘providing her with the best possible quality of life, knowing that she’s not going to live all that long’.”

This transformation process—as described by our key informants—may be a key process in the development of expertise in surgery. According to them “this is the step before the decision ... the surgeons seem to transform the information into a higher order of understanding [big picture] ‘and the result is a better understanding of the problem which then enables the surgeon to make the decision’.” In this way, our participating surgeons suggested that gaining surgical expertise is a continual process of consideration and refinement and that refinement contributes to the creation of new meaning. Not only are surgeons refining their technique but they are also refining their thinking, so that, for example, when they unexpectedly interpret that someone is going to die nonetheless aside from the purpose of the operation (eg, operating a perforation of the stomach on a terminal cancer patient) they see the anatomical data differently (they call it “fine knowledge”) and, more importantly, they see the “big picture” (ie, the new meaning in perceiving the goal) differently, such as providing better quality of life rather than solving the patient’s overall situation.

Surgeons in our study suggested that there are “layers” of thinking that are developed and that progressively evolve as surgical experience is extended. For instance, a trainee can move from a focus on “contextual factors of the case” (as a novice), to a focus on “refining objectives” to make the right decision at the right time in the right circumstances (as a mid-level trainee), “to interpreting new meaning” such as seeing, reflecting, and informing patient and family of short, intermediate, and long-term implications (as an experienced surgeon). As one of our key informants commented in a return of findings meeting, “expertise is contingent on learning to interpret new meaning and reflect on it, and residents often get lost in the contextual factors”.

While gaining information precedes transforming information, new understandings or meanings emerging from the transformation process lead back to gaining more information, suggesting a cyclical relationship among the 2 process. The “Reconciliation Cycle” is therefore our representation and interpretation of those 2 information-related activities—gaining and transforming information—that occur throughout the course of a surgery as a dynamic and intertwined process of reflective awareness. Whether the emphasis is on being aware of a current state in the surgery or of future states will determine the types of interactions between the components of the Reconciliation Cycle.

Comments

The Reconciliation Cycle constitutes the core element of a decision-making model we have previously proposed in the context of surgery.⁵ In this study, we further investigated the intricate nature of the Reconciliation Cycle as a process that experienced surgeons engage with while making challenging intraoperative decisions. Given the similarities with the

notion of situation awareness, in this section, we consider the implications of our results for an improved understanding of how situation awareness applies to the domain of surgery, specifically how it is used by experts as they encounter challenging situations. We anticipate that this theoretical elaboration offers a language to facilitate teaching during unforeseen complications; teaching that currently happens tacitly.²²

Much of the medical education literature has focused on the situation awareness model proposed by Endsley as the precursor to the act of clinical decision making.²¹ Endsley defines situation awareness as “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.”²¹ In this model, individuals proceed linearly from “perception” (Level 1) to “comprehension” (Level 2) to “projection” (Level 3). Incorrect decisions are a result of failing to progress from one level to another. This linear definition of situation awareness and the possibility of translating it into a measurement tool have contributed to the popularity of Endsley’s model.^{23–27} In relation to our decision-making model (Fig. 1), the premises of Endsley’s situation awareness process are captured in the gaining information stage of the Reconciliation Cycle. The intertwining nature of the methods used by our participating surgeons (active seeking and perceiving) encapsulates the same activities proposed by Endsley: perceiving, comprehending, and projecting. However, the transforming information stage in our results that is not explicitly present in Endsley’s model suggests that experts’ situation awareness encompasses a high-order cognitive process. Our participating surgeons reinforced this notion by referring to the transformation activity as a key process in the development of expertise in surgery. We found that during challenging events, situation awareness in experts is a cyclical rather than a linear activity that the “process” is more important than the “outcome” in how surgeons go about understanding the overall situation, and that it involves a higher degree of awareness. For instance, in a case where one surgeon was operating on a perforation of the stomach on a terminal cancer patient, he commented: “And, so it was a very difficult case, because most of the normal ways in which we would treat a perforation of the stomach were not available to us, either because of the anatomy or the fact that he had tumour, the fact that he was on chemotherapy or his overall condition at the time. Plus, in the background, the idea being that he’s undergoing palliation, so we were continuously thinking how to limit the risks and maximize the benefits.”

In the situation awareness literature, the cyclical nature of situation awareness is in line with theoretical conceptualizations that incorporate reflection as a way of interpreting information.^{16,21} Under these alternative conceptualizations of situations awareness, “reflection” refers to the need to move from a product-oriented to a process-oriented focus in the decision-making activity.¹⁶ As elaborated by Bedny and Meister¹⁶ and Smith and Hancock,¹⁷ product-based conceptualizations of situation awareness do not pay sufficient heed to the process of being aware. According to these authors, situation awareness models that acknowledge the process of “being aware” recognize how internal goals and external factors such as doctrine, rules, and politics fundamentally change how individuals perceive their environments and that the same individual may be “reflectively” aware of those changes.^{16,17} In surgery, for example, we know that trainees must learn to act according to different “best practices” depending on which staff surgeon is supervising them; therefore,

from an educational perspective, it is critical that we better understand the process of being aware and how it informs decision making as it is exercised by experts.²⁸

Our model argues for a process-oriented approach to situation awareness. Rather than focusing on a single individual acquiring the skills of an expert, such as the Dreyfus & Dreyfus model²⁹ and other models based on cognitive psychology, this model relies on a different logic. It focuses on the relationship between multiple agents and suggests that work is completed through interaction. Integrating these alternative notions of situation awareness into our model has produced a more refined language for describing how experienced surgeons perceive and respond to challenging situations. We suggest that in the absence of such a language, trainees may misinterpret critical components of the decision-making activity that are required to effectively perform during unusual situations. Furthermore, the notion of the Reconciliation Cycle, as a potential key process in the development of expertise, may provoke important discussions in relation to how to best tailor the teaching moments of a clinical situation to help trainees to further develop their ability to transform information. We suggest that future research on the influence of the Reconciliation Cycle in the acquisition of expertise will benefit from including the “voice” of the trainees.

Conclusion

Gaining and transforming information from the environment might seem intuitive, but both are purposeful and active processes that were used and shared by experts in our study when facing a challenging situation. In the face of an unusual finding, experts set high-level goals such as projecting the final outcome, maintaining the “principle of progress” or reassuring focus “on the big picture.” In the quest to achieving these goals, experts engage in a thinking process that is cyclical and that demands a high degree of situational awareness as a way of interpreting information. Our work advances the notion of situation awareness as experienced by experts through the identification of the “cyclical”, process-based and “reflective” nature of how experienced surgeons perceive and interact with the environment. We suggest that such understanding will also be useful as a language that can assist teaching around complex decision making and judgment, particularly in moments when trainers and trainees gain the same information but transform it differently.

Acknowledgments

Supported by the Canadian Institutes of Health Research (123239) through an Open Operating Grant and by the Royal College of Physicians and Surgeons of Canada (12/MERG-15) through a Medical Education Grant to conduct this research.

We would like to thank Dr Mark Goldszmidt, Associate Professor, Department of Medicine, Schulich School of Medicine & Dentistry, The University of Western Ontario, for his feedback on manuscript revisions.

References

1. Mylopoulos M, Regehr G. Cognitive metaphors of expertise and knowledge: prospects and limitations for medical education. *Med Educ.* 2007; 41:1159–65. [PubMed: 17986193]
2. Schraagen, JM., Ormerod, T., Militello, L., et al. *Naturalistic Decision Making and Macrocognition.* Aldershot: Ashgate Publishing, Ltd; 2012.

3. Jacklin R, Sevdalis N, Darzi A, et al. Mapping surgical practice decision making: an interview study to evaluate decisions in surgical care. *Am J Surg.* 2008; 195:689–96. [PubMed: 18424290]
4. Sarker SK, Chang A, Vincent C. Decision making in laparoscopic surgery: a prospective, independent and blinded analysis. *Int J Surg.* 2008; 6:98–105. [PubMed: 17869199]
5. Cristancho SM, Vanstone M, Lingard L, et al. When surgeons face intraoperative challenges: a naturalistic model of surgical decision making. *Am J Surg.* 2013; 205:156–62. [PubMed: 23331980]
6. Durning S, Artino AR, Pangaro L, et al. Context and clinical reasoning: understanding the perspective of the expert's voice. *Med Educ.* 2011; 45:927–38. [PubMed: 21848721]
7. Lingard L. Productive complications: emergent ideas in team communication and patient safety. *Healthc Q.* 2012; 15(Special Issue):18–23.
8. Gordon M, Darbyshire D, Baker P. Non-technical skills training to enhance patient safety: a systematic review. *Med Educ.* 2012; 46:1042–54. [PubMed: 23078681]
9. Mylopoulos M, Regehr G. Putting the expert together again. *Med Educ.* 2011; 45:920–6. [PubMed: 21848720]
10. Hazlehurst B, McMullen CK, Gorman PN. Distributed cognition in the heart room: how situation awareness arises from coordinated communications during cardiac surgery. *J Biomed Inform.* 2007; 40:539–51. [PubMed: 17368112]
11. Yule S, Flin R, Paterson-Brown S, et al. Non-technical skills for surgeons in the operating room: a review of the literature. *Surgery.* 2006; 139:140–9. [PubMed: 16455321]
12. Flin R, Youngson G, Yule S. How do surgeons make intraoperative decisions? *Qual Saf Health Care.* 2007; 16:235–9. [PubMed: 17545353]
13. Fioratou E, Flin R, Glavin R, et al. Beyond monitoring: distributed situation awareness in anaesthesia. *Br J Anaesth.* 2010; 105:83–90. [PubMed: 20551029]
14. Pauley K, Flin R, Yule S, et al. Surgeons' intraoperative decision making and risk management. *Am J Surg.* 2011; 202:375–81. [PubMed: 21477792]
15. Salmon PM, Stanton NA, Walker GH, et al. What really is going on? Review of situation awareness models for individuals and teams. *Theor Issues Ergon Sci.* 2008; 9:297–323.
16. Bedny G, Meister D. Theory of activity and situation awareness. *Int J Cogn Ergon.* 1999; 3:63–72.
17. Smith K, Hancock PA. Situation awareness is adaptive, externally directed consciousness. *Hum Factors.* 1995; 37:137–48.
18. Novick RJ, Lingard L, Cristancho SM. The call, the save and the threat: understanding expert help-seeking behavior during non-routine operative scenarios. *J Surg Educ.* 2015; 72:302–9. [PubMed: 25451719]
19. Watling CJ, Lingard L. Grounded theory in medical education research: AMEE Guide No. 70. *Med Teach.* 2012; 34:850–61. [PubMed: 22913519]
20. Charmaz, K. *Constructing Grounded Theory: A Practical Guide through Qualitative Research.* Thousand Oaks, CA: Sage; 2006.
21. Endsley MR. Toward a theory of situation awareness in dynamic systems. *Hum Factors.* 1995; 37:32–64.
22. Sadideen H, Kneebone R. Practical skills teaching in contemporary surgical education: how can educational theory be applied to promote effective learning? *Am J Surg.* 2012; 204:396–401. [PubMed: 22688108]
23. Hogan MP, Pace DE, Hapgood J, et al. Use of human patient simulation and the situation awareness global assessment technique in practical trauma skills assessment. *J Trauma.* 2006; 61:1047–52. [PubMed: 17099507]
24. Fletcher G, Flin R, McGeorge P, et al. Anaesthetists' Non-Technical Skills (ANTS): evaluation of a behavioural marker system. *Br J Anaesth.* 2003; 90:580–8. [PubMed: 12697584]
25. Sevdalis N, Davis R, Koutantji M, et al. Reliability of a revised NOTECHS scale for use in surgical teams. *Am J Surg.* 2008; 196:184–90. [PubMed: 18558392]
26. Catchpole K, Mishra A, Handa A, et al. Teamwork and error in the operating room: analysis of skills and roles. *Ann Surg.* 2008; 247:699–706. [PubMed: 18362635]

27. Manzey D, Luz M, Mueller S, et al. Automation in surgery: the impact of navigated-control assistance on performance, workload, situation awareness, and acquisition of surgical skills. *Hum Factors*. 2011; 53:584–99. [PubMed: 22235522]
28. Mamede S, van Gog T, Moura AS, et al. Reflection as a strategy to foster medical students' acquisition of diagnostic competence. *Med Educ*. 2012; 46:464–72. [PubMed: 22515754]
29. Dreyfus, SE., Dreyfus, HL. *A Five-stage Model of the Mental Activities Involved in Directed Skill Acquisition* (No. ORC-80-2). Berkely, USA: California Univ Berkeley Operations Research Center; 1980.

Figure 1.
Revised version of our intraoperative decision-making model during challenging situations.