Expert Intraoperative Judgment and Decision-Making: Defining the Cognitive Competencies for Safe Laparoscopic Cholecystectomy

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BACKGROUND: Bile duct injuries from laparoscopic cholecystectomy remain a significant source of morbidity and are often the result of intraoperative errors in perception, judgment, and decision-making. This qualitative study aimed to define and characterize higher-order cognitive competencies required to safely perform a laparoscopic cholecystectomy.

STUDY DESIGN: Hierarchical and cognitive task analyses for establishing a critical view of safety during laparoscopic cholecystectomy were performed using qualitative methods to map the thoughts and practices that characterize expert performance. Experts with more than 5 years of experience, and who have performed at least 100 laparoscopic cholecystectomies, participated in semi-structured interviews and field observations. Verbal data were transcribed verbatim, supplemented with content from published literature, coded, thematically analyzed using grounded-theory by 2 independent reviewers, and synthesized into a list of items.

RESULTS: A conceptual framework was created based on 10 interviews with experts, 9 procedures, and 18 literary sources. Experts included 6 minimally invasive surgeons, 2 hepato-pancreatico-biliary surgeons, and 2 acute care general surgeons (median years in practice, 11 [range 8 to 14]). One hundred eight cognitive elements (35 [32%] related to situation awareness, 47 [44%] involving decision-making, and 26 [24%] action-oriented subtasks) and 75 potential errors were identified and categorized into 6 general themes and 14 procedural tasks. Of the 75 potential errors, root causes were mapped to errors in situation awareness (24 [32%]), decision-making (49 [65%]), or either one (61 [81%]).

CONCLUSIONS: This study defines the competencies that are essential to establishing a critical view of safety and avoiding bile duct injuries during laparoscopic cholecystectomy. This framework may serve as the basis for instructional design, assessment tools, and quality-control metrics to prevent injuries and promote a culture of patient safety. (J Am Coll Surg 2015;221:931–940. © 2015 by the American College of Surgeons)

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The advent of laparoscopy has revolutionized the management of benign gallbladder disease, resulting in faster recovery, decreased hospitalization, lower costs, and superior cosmesis for cholecystectomy compared with the open approach.[1,2] Yet, bile duct injuries remain a significant source of morbidity, resulting in a 3-fold greater risk of short-term mortality and markedly reduced long-term quality of life.[3,4] Recent studies reported a rate of injury ranging from 0.2% to 1.5%[5-8] compared with the 0.1% to 0.2% rate of injury reported in the era of open cholecystectomy.[9,10] Given that more than 700,000 cholecystectomies are performed annually in the US,[11] and that bile duct injuries are associated with significant consequences and medico-legal costs,[12] there is a need for

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Abbreviations and Acronyms
CTA = cognitive task analysis
CVS = critical view of safety
HTA = hierarchical task analysis
IQR = interquartile range
SME = subject-matter expert

quality-improvement initiatives to address this safety issue.

There have been many efforts aimed at diminishing the risk of bile duct injuries,[7,13-16] including the "critical view of safety" (CVS), an intraoperative technique suggested by Strasberg and Brunt,[17] which relies on a method of ductal identification before dividing the presumed cystic structures. Attaining the CVS requires that the triangle of Calot be cleared of fatty and fibrous tissue, the lowest part of the gallbladder be separated from the liver bed, and that only 2 structures be seen entering into the gallbladder. Several case series have suggested that the CVS technique can reduce major bile duct injuries considerably, even in cases of acute cholecystitis.[18,19] Also, a recent modified Delphi consensus of laparoscopic cholecystectomy experts, led by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Safety in Cholecystectomy Task Force, identified the CVS technique as the most important intervention for overall safety and the highest priority for training and assessment.[20]

Technical mishaps are often blamed for intraoperative complications, but most major bile duct injuries occur due to errors in judgment, leading to the misinterpretation of a major duct for the cystic duct, often caused by significant anatomic distortion from inflammation or aberrant anatomy.[21] Expert intraoperative performance that allows a surgeon to arrive at a CVS requires significant dissection and effective application of a complex body of knowledge and skills that are integrated and adapted to various operative and patient-specific scenarios. Yet our current understanding of how surgeons acquire these higher-order cognitive skills is limited. Despite their importance in avoiding pitfalls that can lead to bile duct injuries, current methods to teach and assess these skills tend to be subjective, biased, instructor- and rater-dependent, and are not standardized.[22]

Understanding the qualities, behaviors, and mental models of experts is at the crux of this problem, and there is a need for these complex and sometimes abstract concepts to be organized into a conceptual framework in order to better understand the construct of surgical expertise. This framework can be used to develop effective training programs, performance metrics that promote safer performance of laparoscopic cholecystectomy, and quality-control interventions for error avoidance when establishing the CVS. The purpose of this qualitative study was to define the complex and higher-order cognitive competencies required to safely perform a laparoscopic cholecystectomy.

METHODS

In order to map out the thoughts and practices that characterize effective intraoperative decision-making and judgment when attempting to establish a CVS during a laparoscopic cholecystectomy, qualitative methodologies were used, followed by grounded theory data analysis. The study protocol was approved by the institutional review board and conforms to the Canadian Tri-Council Policy Statement of Ethical Conduct.

Task analysis

Task analyses include a number of different techniques used to systematically decompose the performance of complex tasks into constituent elements and to define the content that needs to be taught in order to perform the tasks.[23] Instructional designers and other behavioral scientists also use task analyses to identify potential human errors that can occur during a procedure, ascertain pre-conditions that can give rise to those errors, and suggest possible methods to reduce errors in order to perform the procedure successfully. For this study, 2 different forms of task analysis were used in conjunction: an action-oriented approach (hierarchical task analysis; HTA) and a cognitive approach (cognitive task analysis; CTA). An HTA systematically describes, in a top-down manner, all major tasks and their associated sub-tasks to achieve a particular goal, including all conditions that must be met for their completion. The level of detail is task-dependent and varies according to the level of granularity required to achieve the purpose of the analysis and understand how errors occur. Once the information was organized and depicted according to the hierarchy of tasks required to achieve a CVS, this framework was used to perform a CTA in order to develop a cognitive model. Contrary to an HTA, which is more focused on delineating observable actions, a CTA attempts to characterize the underlying mental processes that contribute to pattern recognition and decision-making.[23] This approach is particularly suited for complex and dynamic tasks that depend heavily on higher-order cognitive functions.

Data collection

A combination of qualitative methods was used to perform the task analysis and to explore the competencies