Surgeons' Expertise During Laparoscopic Cholecystectomy:

An Expert-Novice Comparison

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THESIS

Submitted as partial fulfillment of the requirements
for the degree of Master of Health Professions Education
in the Graduate College of the
University of Illinois at Chicago, 2018

Chicago, Illinois

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Dedication

I would like to dedicate this thesis to my beloved parents, Zahra and Abdulkheir, my siblings, Ali, Amir and Sara, my uncle and aunt, Sam and Frances who have been my support and have encouraged me to pursue my passion in surgery and education.

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ACKNOWLEDGMENTS

I would like to thank all my mentors in MHPE program especially Dr. Ilene Harris, my thesis committee chair, who taught me the principles of educational research and guided me with her valuable suggestions and feedback. I would like to extend my most sincere thanks to Dr. Alan Schwartz who always challenged me with his thoughtful questions and helped me understand fundamental concepts. I am deeply grateful to Dr. Timothy Farrell, an outstanding surgeon, exemplary mentor and inspiring role model. Without his support and contribution, I could have not completed this work.

I would like to extend my appreciation to Dr. Lev Korovin, my research fellow, for his important contribution. He played an instrumental role in data analysis, interpretation and preparation of this manuscript. His curiosity and brilliance to understand complex aspects of surgeons' thought processes were key to successful completion of this project.

I would like to express my sincere gratitude to Dr. Andres Ericsson who inspired me with his lifelong commitment to learning and development of expertise. His influential and pioneering research in expertise has been the main source of this study. I am truly indebted to him and his critical review of my research from beginning to the end. His modesty and genuine interest in advancement of science is inspirational. I feel so fortunate to have met him and learned from him.

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I wish to extend my wholehearted thanks and gratitude to my first mentor in surgery, Dr. David Fleiszer. He introduced me to the concept of expertise and expert performance more than a decade ago and inspired me to find my passion in surgical education.

Finally, I would like to thank all the attending surgeons and residents from the University of North Carolina at Chapel Hill and the University of Arizona in Tucson who participated in this project.

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LIST OF ABBREVIATIONS

CI	Confidence interval
GEE	Generalized estimating equation
LC	Laparoscopic cholecystectomies
OR	Operating room
PGY	Postgraduate Year

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ABSTRACT

Introduction:

There are various methods to study expertise. In our preliminary study of Expert – Novice using think aloud method, we demonstrated the experts were notably different in their ability in cognition (comprehension of situation), mental image of future event and metacognition. In this follow-up study, we aimed to examine the differences between thought process of experts and novices surgeons while watching videos of intraoperative events during difficult laparoscopic cholecystectomies.

Methods and Materials:

A group of experienced and novice (general surgery residents Postgraduate Year 2) surgeons were individually shown a recording of two difficult laparoscopic cholecystectomies. A think-aloud method was used to capture their thought processes. Verbal reports were recorded during (concurrent) and after (retrospective reports) watching the video clips, transcribed verbatim and analyzed using the “protocol analysis” method. Ericsson and Simon’s model were used to develop coding schemes. The generalized estimating equation (GEE) model was used to analyze the verbalizations.

Results:

Twenty subjects (10 in each group) from two academic centers participated. The following coding schemes were developed from the verbal reports: perception, cognition (comprehension of the situation) and generated mental product (Ericsson and Simon); planning, metacognition, recall of previous experience/

knowledge and surgeon's technical preferences. Overall, surgeons allocated majority of their cognitive focus on perception, cognition and mental product and planning. Experienced surgeons showed a significantly higher level of ability to comprehend the situation (cognition) and create a mental product in anticipation of future events. They also referred to their previous experience and personal preferences more often. They were more aware of their own thought process (metacognition) in evaluating the situation. In the rest of categories such as perception and coordination with team, the quantity of verbalizations was not significantly different between two groups. None of the verbalizations were suggestive of intuition as a mechanism for decision-making. The analysis of retrospective verbal reports showed a very similar pattern.

Conclusions:

This study validates the results of our previous pilot study and demonstrated the differences and similarities between surgeons with different levels of experience. It provides an insight to the thought process of novice and experienced surgeons during challenging cases laparoscopic cholecystectomy. These findings can be used to develop a model for training of surgical residents.

I. INTRODUCTION

Patient outcomes are directly related to the performance of clinicians.[1,2,3,4] Therefore, understanding the knowledge and skills associated with superior clinician performance has become a focus of surgical education research. Ward et al. stated, “Only by eliciting the true properties of expertise and considering how the mechanics of the underlying representation bring about superior performance will we increase our understanding of expertise and move beyond simple descriptions of experts as superior recognizers or intuitive decision makers.”[5] Yet, few studies have been conducted to characterize the surgeon’s superior performance, i.e., surgical expertise. [6,7,8] Although extensive experience is an important element of expertise, it has been shown that experience alone cannot exclusively explain expertise in medicine. It is believed that “the cognitive process and the knowledge on which they are based emerge as central to expertise in medicine”. [9]

Many authors have developed models to conceptualize expertise to determine its components and the methods of skill acquisition. The Dreyfus brothers described a five-stage model of skills acquisition.[10] In their model, which was based on their study of pilots during pilot training, they proposed development of expertise associated with increased experience in a specific domain. This model consists of five stages: novice, advanced beginner, competent, proficient and expert. The central determinant of moving from one stage to another is the evolution of one’s perceptions of the task environment. The

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learner moves through these stages of competence. In the first stage, the novice learns the rules and concepts of the domain and tries to apply them in a deliberate sequential, even mechanistic manner. As experience increases, the learner progresses through the various stages, and perceives actions within the domain more holistically. The expert can effortlessly generate thoughts and actions, based on an intuitive repertoire of knowledge.[11] The assessment of learners, from novice to expert, is a "gradual transition from a rigid adherence to taught rules and procedures through to a largely intuitive mode of operation that relies heavily on deep, implicit knowledge". In this model, when the intuitive approach to performance fails at the expert level, analytical approaches might be used.[10]

One characteristic that sets the expert apart from the novice is the expert's superior ability to perceive and monitor critical aspects of situations during performance.[12] Ericsson and Simon's information-processing model separates the human cognitive process into three categories: "Perception", " Cognition" and " Mental products". [13] Likewise, Endsley refers to the concept of 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". [14] According to both models, "perception" means identifying an element in the environment; "cognition" relates to appraising the significance of this element in relation to one's goals, and "mental products" project how this element will impact future performance, including whether or not the operator will need to change his plan in response to predicted consequences.[14, 15,16]

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The existing body of research on surgical expertise is largely retrospective in nature, with various forms of structured interviews, and their subsequent interpretation, playing a major role.[9, 17] These retrospective and introspective study designs, though valuable in providing knowledge about how expertise is developed, do little to identify the underlying cognitive mechanisms of expert performance, which was the goal of this study. In the study of expertise in other domains, such as among chess masters, math prodigies, [18] and clinical diagnosticians, [9] the use of protocol analysis and the "think aloud" method, in which the subject must continuously verbalize what he or she is thinking, with the verbalizations later broken up into individual thoughts for analysis, has allowed investigators to capture thought content and to gain insight into the cognitive approaches of expert decision-making. The purpose of this study was to examine differences in thought processes between novice and experienced surgeons when they were presented with videos of difficult case of laparoscopic cholecystectomy.

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II. MATERIALS AND METHODS

The study was conducted at two centers: the University of North Carolina, Chapel Hill and the University of Arizona. Two groups of volunteer subjects were recruited: Experienced surgeons were attending surgeons who had performed more than 150 laparoscopic cholecystectomies (LC). We used 150 LC as the cut off point for the experienced group, based on the criteria Sarker and colleagues used for expert surgeons when examining their rates of generic, minor and major errors.[19] Novice surgeons were defined as general surgery residents in their PGY-2 year who were familiar with all steps of laparoscopic cholecystectomy, but had performed less than 20 laparoscopic cholecystectomies.

In this study we used the “relative approach to the study of expertise”.[8] This approach is the study of experts in comparison with novices. It assumes that expertise is a level of proficiency that novices can achieve. As Chi comments, “Because of this assumption, the definition of expertise for this contrastive approach can be more relative, in the sense that the more knowledgeable group can be considered the “experts” and the less knowledgeable group the “novices”.[8] Junior residents would technically be “advanced beginners”, under the Dreyfus model, since they are familiar with the steps of the operation. The differences in thought processes between junior residents and attendings, however, was seen as more informative than comparing experienced surgeons with medical students, who would have been true “novices” according to this model.[10] Subjects from each of the two groups were shown video recordings of two difficult laparoscopic cholecystectomies. During one of the operations, there was an unexpected

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bleeding event, caused by the operating surgeon not recognizing aberrant anatomy and avulsing the cystic artery. The second patient had a severely inflamed gallbladder, which made the dissection very challenging.

Each video was divided into multiple clips in various lengths. The temporal occlusion paradigm was used to assess anticipatory ability of the surgeons.[20] The clips were paused just before the surgeon in the video took important actions, at fixed points determined by the researchers. Three external experts reviewed the videos and were asked to determine appropriate alternative next steps (task analysis).

Using video recordings, instead of having the subjects “think aloud” during a case actively in progress, allowed for a controlled and reproducible situation, free of any distracting factors inherent to working in the operating room.

Verbalization during and after watching a video

The video clips were played and the subjects were asked to think aloud while the video was running. The subjects were asked to verbalize their thoughts at the end of each clip and to describe the situation, what future events he or she could anticipate and how he or she would hypothetically proceed with the case and make a decision about next course of action. The goal was to obtain plans and strategies generated from the verbal reports of participating surgeons after watching video clips. Obviously, the subjects had no control over the course of the operation they were watching, but they had an opportunity to express their thoughts and decisions regarding both “the situational probabilities”[21] (when identifying what the operating surgeon in the video might do next) and what their

own hypothetical plans would be, such as continuing dissection, clipping structures, and/or cleaning the operative field. Study subjects were asked to commit to one particular course of action before proceeding with the next clip.

The subjects were instructed to verbalize their thoughts as long as they were thinking, and to avoid attempting to explain or provide rationalization for their thoughts. These verbal reports were recorded, and they were transcribed verbatim. Transcripts were analyzed using the protocol analysis method, separating the subjects' narrations into individual verbalizations pertaining to separate thoughts. In this study, a single knowledgeable coder (LK) coded all the verbalizations once the coding schemes were initially established by LK and IG.[22] In addition, the principal investigator (IG) independently reviewed 10 percent of verbalizations to assure the accuracy of protocol analysis.[23] Intercoder agreement was 95%.

Each verbalization was categorized according to Ericsson and Simon's information processing model[13] and Endsley's situational awareness model.[14] The categorized verbalizations were tallied. The time each subject spent engaged in each type of thinking was represented as the number of all of the verbalization counts that the subject had generated. We fitted log-linear models, using generalized estimating equations and adjustment for total numbers of verbalizations, to calculate the relative risk and associated 95% CI for differences between the two groups in terms of thought content types while controlling for clustering of verbalizations within participants. Statistical significance was based on a familywise alpha of 0.05.[24]

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III. RESULTS

Twenty (20) subjects (10 experienced and 10 novice surgeons) from 2 institutions participated in this study. Because none of the PGY2 surgery residents had performed fewer than 20 LC, this criterion was ignored. (Table 1) The experienced surgeons reported that they had performed more than 200 laparoscopic cholecystectomies.

We separated the verbalizations during and after each video clip (concurrent and retrospective verbalizations), as they were qualitatively different. Eight different categorizations were identified (Table 2,3), which included: A. Notification, B. Cognition (comprehension), C. Mental image (projection), D. Plan of action, E. Reference to experience, F. Statement of preference, G. Coordination with the rest of the operating room (OR) team, and M. Metacognition. Cognition (comprehension) and mental image (projection) were each subdivided into 1. verbalizations of *critical* significance, relating to an element or mental image with potential significant consequences to the course of the operation 2. verbalizations of local significance, which could not have a significant effect on the course of the operation, but could influence the immediate situation, and 3. verbalizations which were clearly wrong, leading to dangerous consequences.

A. Concurrent verbalization

A statistically significant difference between the experienced and novice group of surgeons was identified in five domains. Experienced surgeons spent more time verbalizing cognition and mental images of *critical* significance,

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referring to previous experience, stating preferences, and being engaged in metacognition. Novice surgeons spent more time verbalizing cognition of local significance. (Table 4)

B. Retrospective verbalization

The findings with retrospective verbalization were mostly similar with a few key differences. There were statistically significant differences between the experienced and novice group in four domains. Similarly, experienced surgeons spent more time verbalizing cognition of *critical* significance, stating preferences, and being engaged in metacognition. In retrospective verbalization, the experienced surgeons verbalized their cognition of local significance and planning more often. Novice surgeons spent more time verbalizing mental images of local significance. (Table 5)

Compared to novice surgeons, experienced surgeons consistently demonstrated cognition and decision-making patterns directed at the operation progressing safely and efficiently, such as suggesting actions to minimize the risk of liver or common bile duct injury. Verbalizations labeled “reference to experience” and “statement of preference” were largely directed at safety. Experienced surgeons also provided significantly more verbalizations indicating metacognitive activity, trying to understand what the operating surgeon in the video was thinking about, and thus trying to identify any cognitive pitfalls the operating surgeon was heading towards. A select few experienced surgeons, and none of the novice surgeons, verbalized an intent to say something to other people in the OR, such as the anesthesiologist or the circulating nurse, while watching the video recording.

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Conversely, some representatives of the novice group verbalized clearly poor judgment, oftentimes as a result of incorrectly assessing the situation. (Table 4) Notably, none of the verbalizations from either group were suggestive of *intuition* as a mechanism for decision-making. Only members of the novice group verbalized clearly incorrect and dangerous cognition and mental images on a few occasions.

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IV. DISCUSSION

To our knowledge, this is the first study of surgical expertise to use protocol analysis with the “think aloud” method, and to place subjects in a standardized and reproducible environment. The value of these data was that they were collected from subjects placed in an unfamiliar situation and responding to stimuli in real time. The “think aloud” methodology allowed for the examination of the participants’ “online” verbalized thought content, as distinguished from how participants remembered their thinking.

The definition of intraoperative expertise is multifaceted. Experience alone is clearly not synonymous with expertise. In fact, Gostlow and colleagues found, unexpectedly, that the experienced surgeons in their study cohort did worse in a set of simulations assessing non-technical (cognitive) skills than senior trainees.[25] Cristancho and colleagues assign great value to situational awareness as the key to expert judgment.[26] Moulton et al, in their analysis of semi-structured interviews using grounded theory, focus on the “slowing down phenomenon”, when expert surgeons realize that they are being faced with an unusual situation, requiring them to leave their mode of automatic function and to move toward a more effortful state. They identified “drifting”, or the inability to recognize such a situation, as a source of errors and near misses.[27]The findings of this study fall within the same conceptual framework, showing superior awareness of the operative environment as a hallmark trait of a safe surgeon. On a related note, engaging in meta-cognition as a way to “put one’s self in another’s shoes”, being aware of what is happening in the mind of one’s trainee can be seen as a vital

behavior of a safe and effective teacher in the operating room.

Inherent limitations of this study include its small sample size and the fact that the two groups being compared were differentiated by relative expertise. Ideally, surgical experts could be identified based on superior clinical outcomes; however, the same selection criteria cannot be used with residents, because they work under supervision. The data presented here come from the analysis of verbalizations during a critical portions of the cases, including immediately leading up to a bleeding event, as well as in regaining control of the situation as well as difficult dissection of a very inflamed gallbladder in the second case.

The other limitation of the study is that the subjects watched video recordings of another surgeon. One can argue that the subjects' thought processes and decision making could have been different if they were performing the operations themselves. The study was designed to provide similar scenarios to different subjects in a simulated setting without distracting elements in the operating room. Moreover, junior surgical residents usually do not perform the operations without supervision and direct instruction and decision making of their attending surgeons. Therefore, such comparisons between experts and novices may not be feasible in the operating room.

Experience is much easier to quantify (by either years in practice or by number of cases performed) than expertise. The cognitive elements of expertise may become easier to quantify as more elegant methods of assessing cognition, including ones utilizing technology, become accepted. For example Harrington et al. and Lin et al. both describe using a virtual-reality simulator and a gaming

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platform, respectively, to assess surgical decision making.[28, 29] Simulated or virtual reality environments are controlled and reproducible; and furthermore, unlike watching a video recording, they allow for a subject to make decisions with immediate feedback. The use of such technology lends itself well to applying the "think aloud" method in further cognitive research as well as in the assessment of trainees.

As expertise, and its elements as related to surgery, becomes better defined, the next logical step for research would be to examine the thought processes of truly expert surgeons, whose expertise would be determined by superior clinical outcomes. Eventually, the findings of these studies would allow investigators to focus on how to most efficiently improve the cognitive domains relating to expertise in trainees, including advanced cognitive skills, allowing training programs to be more deliberate in structuring their curriculum.

From a practical standpoint, "think aloud" methods may have potential as a tool to improve safety in the operating room. Instead of having to engage in metacognition, a surgeon taking a resident or fellow through a procedure could ask him or her to "think aloud", thus giving the surgeon insight into the trainee's thought process, potentially uncovering errors in judgment and avoiding adverse consequences for the patient that could happen as a result of a lack of mutual understanding between the surgeon and the trainee. On the other hand, one can argue that asking the residents to split their attention between operation and verbalization could lead to more danger to patients. This idea is based on an assumption that think aloud does not cause significant cognitive load as the

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subjects do not try to explain their thought processes or justify their decisions. Further studies needed to test these hypotheses.

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V. CONCLUSIONS

Utilizing protocol analysis and the “think aloud” method provide insight into the thought processes of novice and experienced surgeons viewing a challenging intraoperative encounter, and it highlights the differences and similarities between surgeons with varying levels of experience. The domains of cognition, and mental image/ as well as metacognition appear to be key elements associated with surgical expertise.

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TABLE I

DEMOGRAPHICS (EXPERT VS. NOVICE SURGEONS)

	Expert (n=10)	Novice (n=10)
Gender		
Male	7	8
Female	3	2
Years in practice, y	9.7 (±10.5) (Range: 2-37)	PGY2*
Previous experience **	> 200	31±10.2 (Range: 20-40)

*PGY: postgraduate year

** Self- reported number of laparoscopic cholecystectomies

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TABLE II

VERBAL REPORTS: CODING

Item	Code
A	Notification
B	Cognition B1: Critical/strategic B2: Local significance B3: Error
C	Mental image C1: Critical/strategic C2: Local significance C3: Error
D	Plan of action
E	Reference to experience
F	Statement of preference
G	Coordination with the rest of the OR team
M	Metacognition

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TABLE III

EXAMPLES FROM CONCURRENT VERBALIZATIONS

Item	Code	Example
A	Notification	”We seem to be opening up anterior peritoneal attachments”; ES1-1,” So, you can see proximal portion of the artery is bleeding and really they are just trying to grasp it “ES1-56-57, “and has lost that again”, ES1-59, “so, he is using his right hand to brace”, “ and he has taken the left hand to grasp”,ES1-77-78.” Alright, so the suction has now come out”, ES1-96.
B1	Cognition: Critical/strategic	“very dangerous maneuver”, “ Digging with the electric cautery at the base “, ES1-9,10, “hopefully that is a band as opposed to some very Um...”, “So that band makes me concerned that it is a very short little cystic duct”, ES1- 24,26, “Um if that is a Um...if that is a short and sorry a very thin small cystic duct”, “then everything we have been working on posteriorly is likely the common bile duct”, ES1-30, 31. “the cystic structure that we thought were considering the possibility of a Um..a foreshortened anterior cystic duct”, “ and is likely an anterior branch of the cystic artery”, “ and in an apparent anterior position in front of our presumed structure.”, ES1- 38,40-41.
B2	Cognition: Local significance	“Um….in an effort to.. Well, I guess we are taking what is easy here unless..”, “that I don't necessarily believe was a helpful maneuver”, ES1,2,6, “Um.. where we've really not differentiated anything on the posterior aspect.” ES1-11, “So they were doing hydrostatic blunt dissection deep at the base”, Es1-16, “What I see is sort of a relatively small compared to a gallbladder”, ES2-44, “It doesn’t actually look like the gall bladder side is bleeding much”, “and it looks like they are having a fairly difficult time controlling the non gall bladder side “, ES2:95-96, “I see Um.. they have managed to control the bleeding by grabbing something”, ES2:114.” that looks like it is going up into what they probably thought was the gallbladder”, ES2:125
B3	Cognition: Error	“Uh I think that they are leaving some wall behind um.” UAN5-2NX-73, “Again I think they are leaving back, leaving some gallbladder wall behind.” UAN5-2NX-78.
C1	Mental image:	“You want to make sure that you just have vessel”,

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	Critical/strategic	“because we still have not delineated our major structures”, “ but in this instance I would not do that”, ES1: 80-82, “tenting up infundibulum in an effort to see if we can see any other source of bleeding”, ES1-102, “Could be the cystic artery close by”, UAE5: 20, “you kind of arrange your hand position and have to clip in your dominant hand”, UAE5: 51, “it might make the bleeding worse like that because you tear”, “ or clip something you don't want to clip”, UAE5:73-74.” because I’d be worried about um getting what was behind it pretty much”, ES3:26, “because I will have my right arm available”, UAE1:63
C2	Mental image: Local significance	“So, now he kind of like to switch to the on the other side again”, “kind of may be hoping to develop some plane there as well”, “to try to do it kind of like a top-down fashion from kind of how high the dissection went”, UAE1: 1,2,4 “Kind of this oozing makes the operation now quite tricky”, UAE1: 10, “So basically again it is kind of trying to identify the structure”, “ and kind of the move to try to identify the inferior part”UAE1: 54-55, “and using the clip applier to potentially stop the bleeding”, UAE1: 113, “I think they are trying to accomplish to mobilize more of the Gallbladder off the liver”, UAE5:9,” Might be able to get across here through to the other side”, UAE2:7
C3	Mental image: Error	“I'm afraid that in order to get control of this bleeding we really have no choice but to come around this supposed cystic duct and fire staple to get both the cystic duct and to get proximal control of this exsanguinating cystic artery”, UAN1-50, “I was expecting the duct to be thicker given the dimensions on the ultrasound”, NS2-30
D	Plan of action	“using the Maryland to kind of try to separate the, dissect the duct from the surrounding tissue”, UAE1:18” try to change my approach may be to take it from the other side”, UAE1:62, “So you have to regrab and try to put a clip the right way”, UAE1:73, “So trying to gain hemostasis”, UAE1:74,” and now try to kind of dissect the other structure”, UAE1:81, “So, it is helpful but I would have put a clip on”, UAE2:52, “I might get a 5mm clipper and put it on there”, UAE2:56, “Try to put pressure and see where the stump of the vessel is and put a clip on the stump that is kind of blindly...”, UAE5:75-76. “I think at this point, I would wash copiously as much of the blood out as I can”, “ and perhaps switch to the Kittner”, “ and just do some

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		brushing of the fibers Um...structures anteriorly." ES1:12-14.
E	Reference to experience	"and this is something I have done only a few times", UAE-2:2, "So holding the distal portion does not help", ES4:36, "but then again I have taken one or 2 patients back for bleeding…", UAE2: NX2:174, "Surgicell is unfriendly to a CT scan or ultrasound I think" UAE2:NX2: 195
F	Statement of preference	"we don't put a massive clip ligation like that because we don't know the anatomy" UAE5:72, "this stuff I don't like too much", UAE2:12, "Again I would have gone, I would get the other end first.", UAE2:71, "so I would have rather used a pair of Marylands with fine tips", ES4:57, "I think Maryland dissection is more delicate.", UAE5:24, "I think Maryland dissection is more delicate." UAE5: 72
G	Coordination with the rest of the OR team	"so this is where as an assistant but senior surgeon I can hand the resident the grasper, they can hold the infundibulum of gallbladder up" UAE2-NX:11-12, "Push the camera in further so that we can see.", UAE2-NX:124.
M	Metacognition	"again buying some time doing some hydrostatic sweeping on the posterior side", ES1:7, "uh again it is where opportunistic part of the operation", UAE1NX:82, "Ok so uh seems like he was not happy with the, with the hemostasis in window view." UAE1NX: 116, "to uh seems like uh he is kind of still not really happy with the hemostasis", UAE1NX: 165, "Think how you're going to approach then try to make it stop." UAE1: 54, "The dissection of unknown tissues here with a cautery would have made me nervous." UAE2: 14 , "If this turns into blind clipping, I'm going to be unhappy" UAE2:74, "I think the thought process once you get a cystic duct control, then the rest is slam dunk", UAE3:15, "I think what I can see is some frustration in the operator that doesn't want to waste any more time.", UAE3:27

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TABLE IV

CONCURRENT VERBALIZATION COUNTS BY EXPERIENCE

Item	Expert (n=10)	Novice (n=10)	RR (N vs. E)[b]	p-value
A	4.75±4.42[a]	8.60±6.99	1.55 (0.78, 3.08)	0.21
B1	15.45±9.71	7.70±2.95	0.56 (0.40, 0.77)	<0.001
B2	29.80±11.00	50.60±19.73	1.74 (1.48, 2.03)	<0.0001
B3	0.00±0.00	0.35±0.82	NA	NA
C1	10.15±5.01	3.00±1.51	0.31 (0.21, 0.47)	<0.0001
C2	13.10±7.31	14.20±6.63	1.19 (0.85, 1.67)	0.30
C3	0.00±0.00	0.20±0.48	NA	NA
D	9.15±7.13	5.40±4.02	0.71 (0.41, 1.23)	0.22
E	2.65±1.16	0.65±0.85	0.28 (0.14, 0.59)	<0.001
F	6.35±3.92	1.20±1.18	0.22 (0.11, 0.42)	<0.0001
G	0.70±0.86	0.35±0.58	0.52 (0.14, 1.89)	0.32
M	6.20±4.56	1.95±1.48	0.33 (0.17, 0.63)	<0.001
Total	98.30±29.09	94.20±28.27	0.96 (0.79, 1.16)	0.65

[a]mean±standrad deviation based on the aggregated data

[b]relative risk and the associated 95% CI derived from a generalized estimating equation (GEE) model with the adjustment of total counts for verbalization A-M.

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TABLE V

RETROSPECTIVE VERBALIZATION COUNTS BY EXPERIENCE

Item	Expert (n=10)	Novice (n=10)	RR (N vs. E)[b]	p-value
A	0.75±1.09[a]	0.25±0.79	0.56 (0.07, 4.24)	0.57
B1	7.60±4.14	2.75±1.30	0.54 (0.40, 0.74)	<0.0001
B2	5.65±3.28	5.15±2.12	1.40 (0.99, 1.96)	0.05
B3	0.15±0.47	0.20±0.48	1.94 (0.18, 20.79)	0.58
C1	10.20±5.58	5.15±3.27	0.71 (0.51, 0.98)	0.04
C2	8.25±3.34	12.25±9.07	1.98 (1.41, 2.79)	<0.0001
C3	0.00±0.00	0.25±0.49	NA	NA
D	10.70±2.75	10.30±4.66	1.40 (1.01, 1.94)	0.04
E	1.80±2.25	0.50±0.75	0.42 (0.14, 1.20)	0.10
F	4.30±2.93	0.45±0.72	0.14 (0.05, 0.36)	<0.0001
G	0.70±0.63	0.15±0.34	0.36 (0.09, 1.52)	0.17
M	5.65±3.27	1.60±1.05	0.41 (0.26, 0.65)	0.0001
Total	55.75±18.06	39.00±14.06	0.69 (0.53, 0.89)	<0.01

[a]mean±standrad deviation based on the aggregated data

[b]relative risk and the associated 95% CI derived from a generalized estimating equation (GEE) model with the adjustment of total counts for verbalization A-M.

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