Residents Think in the "Now" and Supervisors Think Ahead in the Operating Room. A Survey Study About Task Perception of Residents and Supervising Surgeons

Nieboer, Patrick; Cnossen, Fokie; Stevens, Martin; Huiskes, Mike; Bulstra, Sjoerd K; Jaarsma, Debbie Adc

Published in:
Journal of Surgical Education

DOI:
10.1016/j.jsurg.2020.06.010

Residents Think in the "Now" and Supervisors Think Ahead in the Operating Room. A Survey Study About Task Perception of Residents and Supervising Surgeons

Patrick Nieboer, MD,[*] *Fokie Cnossen, PhD,*[†] *Martin Stevens, PhD,*[*] *Mike Huiskes, PhD,*[‡] *Sjoerd K Bulstra, MD, PhD,*[*] *and Debbie ADC Jaarsma, PhD*[§]

[*]Department of Orthopedic Surgery, University Medical Center Groningen, Groningen, the Netherlands; [†]Department of Artificial Intelligence, Bernouilli Institute of Mathematics, Computer Science and Artificial Intelligence, University of Groningen, Groningen, the Netherlands; [‡]Center for Language and Cognition, University of Groningen, Groningen, the Netherlands; and [§]Center for Research and Innovation in Medical Education, University Medical Center Groningen, Groningen, the Netherlands

OBJECTIVE: Progressive autonomous task performance is the cornerstone of teaching residents in the operating room, where they are entrusted with autonomy when they meet their supervisors' preferences. To optimize the teaching, supervisors need to be aware of how residents experience parts of the procedure. This study provides insight into how supervisors and residents perceive different tasks of a single surgical procedure.

DESIGN: In this qualitative survey study a cognitive task analysis (CTA) of supervisors and residents for the 47 tasks of an uncemented total hip arthroplasty was executed. Both groups rated the level of attention they would assign to each task and were asked to explain attention scores of 4 or 5.

SETTING: University Medical Centre Groningen (the Netherlands) and its 5 affiliated teaching hospitals.

PARTICIPANTS: Seventeen supervising surgeons and 21 residents.

RESULTS: Normal attention (median attention score 3) was assigned by supervisors to 34 tasks (72.3%) and by residents to 35 tasks (74.5 %). Supervisors rated 12 tasks (25.6%) and residents 9 tasks (19.1%) with a median attention score of 4. In general, supervisors associated high attention with patient outcome and prevention of complications, while residents associated high attention with "effort."

CONCLUSIONS: Supervisors and residents assigned attention to tasks for different reasons. Supervisors think ahead and emphasize patient outcome and prevention of complications when they indicate high attention, while residents think in the "now" and raise attention to execute the tasks themselves. The results of this study allow residents and supervisors to anticipate preferences: residents are able to appreciate why supervisors increase attention to specific tasks, and supervisors obtain information on which tasks require individual guidance of residents. This information can contribute to improve the learning climate in the operating room and task-specific procedural training. (J Surg Ed 78:104–112. © 2020 Published by Elsevier Inc. on behalf of Association of Program Directors in Surgery.)

KEY WORDS: Surgical education, Intraprocedural variation, Workplace-based learning and teaching, Faculty development

COMPETENCIES: Practice-Based Learning and Improvement, Medical Knowledge, Interpersonal and Communication Skills

INTRODUCTION

The operating room (OR) is a complex workplace in which time is limited and optimal patient outcome is required. It is also the most important learning

Correspondence: Inquiries to Patrick Nieboer, MD, Department of Orthopedic Surgery, University Medical Center Groningen, PO Box 30001, Groningen 9700RB, the Netherlands; e-mail: p.nieboer01@umcg.nl

  1931-7204/$30.00 https://doi.org/10.1016/j.jsurg.2020.06.010

environment for surgical residents to master the technical and nontechnical skills of a surgical procedure.[1] To prepare residents for independent practice, supervisors progressively entrust residents to "handle the scalpel."[2] However, at the end of surgical training gaps in independent task performance for even basic surgical procedures are not uncommon, suggesting that residents' autonomous task performance in training programs needs attention.[3]

Residents' insufficient autonomous task performance has several causes. It is generally known that restrictions in working hours have decreased exposure of residents to the OR.[4,5] In addition, research in the field of OR training demonstrates that different expectations of supervisors and residents on how to prepare, guide, and teach affect residents' autonomous task performance.[6-10] Once in the OR, a supervisor seems more willing to "hand over the scalpel" when residents acknowledge their own limitations and recognize critical clues.[11-13] Insight into the individual preferences of a supervisor will also increase levels of entrusted autonomy.[12-14] On the other hand, the supervisor needs information about the resident's specific expertise gaps to guarantee effective learning in the OR.

Insights into each other's perceptions of a procedure's specific tasks could be beneficial to autonomous task performance and effective learning. However, it is unclear whether and to what degree supervisors and residents demonstrate similar understandings for the specific tasks of a procedure. To explore this, we conducted a cognitive task analysis of both supervisors and residents, and surveyed their perceptions for each task of an uncemented total hip arthroplasty.

MATERIALS AND METHODS

Survey Study

A qualitative survey was conducted among the faculty and residents of the orthopedic surgery department of University Medical Center Groningen and 5 affiliated teaching hospitals in the Netherlands; 21 residents and 17 orthopedic surgeons (supervisors) participated in the study. The program for orthopedic surgery residents in the Netherlands lasts 6 years, and they receive training in general surgery in the first 18 months. The supervisors in this study had practiced between 5 and 35 years as licensed orthopedic surgeons and were all capable of supervising total hip arthroplasties. All participants were recruited during regular formal training courses for residents and supervisors of University Medical Center Groningen and its affiliated hospitals (convenience sample). Such training courses are obligatory for residents. All participants were informed about the study before giving consent.

Cognitive Task Analysis of an Uncemented Total Hip Arthroplasty

We used the technique of cognitive tasks analysis (CTA) to extract relevant information about task execution from the participants.[15,16] The first step of a cognitive task analysis is breaking down a task—in this case, an uncemented total hip arthroplasty (posterior approach)—into relevant separate tasks. We invited 2 expert orthopedic surgeons to define relevant tasks and discussed discrepancies among them until they reached consensus. In the end, 47 tasks were identified.

Data Collection and Analysis

For each of the 47 tasks of the procedure we asked the participating supervisors and residents to rate their "required amount of attention to execute the task successfully" on a Likert scale from 1 to 5. We clarified addressing low and high attention to specific tasks using 2 examples. In 1 example, we explained low attention to a task as the level of attention they would normally assign to traveling in a familiar environment, like commuting from home to their usual workplace. Conversely, we used the level of attention someone assigns to traveling to a hospital in an unfamiliar environment as an example of high attention.

The participants were informed that a score of 3 on the Likert scale was defined as normal attention, 5 as maximum attention, and 1 minimum attention. For tasks that participants rated as more than normal attention (scores 4 and 5) we asked them to provide arguments for the scores. We calculated the median attention scores of all the different tasks for both groups (supervisors and residents) separately and calculated the distribution of attention scores for each task and each group.

RESULTS

An uncemented total hip replacement procedure has 11 major steps and 47 tasks. Normal attention (median attention score 3) was assigned by supervisors to 34 tasks (72.3%) and by residents to 35 tasks (74.5 %). Supervisors rated 12 tasks (25.6%) and residents 9 tasks (19.1%) with more-than-normal attention (median attention score 4), and supervisors rated one task (2.1%) and residents 3 tasks (6.4%) with less-than-normal attention (median attention score 2-2.5; Table 1).

Attention scores differed between tasks and within groups. In Table 2, the tasks are specified for each of the 11 steps. The median scores are presented, followed by the distribution of scores within the groups. Median

TABLE 1. Overall Attention Scores of Supervisors and Residents

	Less Than Normal Median Attention Scores 2-2.5	Normal Median Attention Scores = 3	More Than Normal Median Attention Scores 4
Supervisors	1 (2.1%)	34 (72.3%)	12 (25.6%)
Residents	3 (6.4%)	35 (74.5%)	9 (19.1%)

TABLE 2. Median Attention Scores and Distribution of Attention Scores for Each Task

Task	Description	Sup/ Res	Median score	1 (low)	2	3 (normal)	4	5 (high)
Step 1 Prepping and draping								
1-A	Prep the skin	Sup	3.0	1: 5.9%	1: 5.9%	7: 41.2%	5: 29.4%	3: 17.6%
		Res	2.5	4: 20.0%	6: 30.0%	9: 45.0%	1: 5.0%	0: 0%
1-B	Drape the patient	Sup	3.0	1: 6.2%	0: 0%	9: 56.3%	5: 31.3%	1: 6.2%
		Res	3.0	1: 5.0%	6: 30.0%	12: 60.0%	1: 5.0%	0: 0%
Step 2 Expose rotator muscles								
2-A	Assess location of skin incision	Sup	3.0	1: 5.9%	1: 5.9%	8: 47.1%	5: 29.4%	2: 11.8%
		Res	3.0	0: 0%	5: 23.8%	9: 42.9%	4: 19.0%	3: 14.3%
2-B	Incise skin and subcutaneous tissues	Sup	3.0	1: 5.9%	5: 29.4%	9: 52.9%	2: 11.8%	0: 0%
		Res	2.5	3: 14.3%	9: 42.9%	8: 38.1%	1: 4.8%	0: 0%
2-C	Control bleeding tissues	Sup	3.0	1: 5.9%	8: 47.1%	7: 41.2%	1: 5.9%	0: 0%
		Res	2.0	2: 9.5%	8: 38.1%	9: 57.1%	2: 9.5%	0: 0%
2-D	Assess fascia lata location and incision	Sup	3.0	1: 5.9%	0: 0%	14: 82.4%	2: 11.8%	0: 0%
		Res	3.0	0: 0%	7: 33.3%	12: 57.1%	2: 9.5%	0: 0%
2-E	Incise gluteal maximus muscle	Sup	3.0	1: 5.9%	1: 5.9%	11: 64.7%	4: 23.5%	0: 0%
		Res	2.5	1: 4.8%	9: 42.9%	9: 42.9%	1: 4.8%	0: 0%
Step 3 Expose hip joint								
3-A	Identify exorotator muscles	Sup	3.0	1: 6.2%	1: 6.2%	9: 56.3%	4: 25.0%	1: 6.2%
		Res	3.0	0: 0%	3: 14.3%	10: 47.6%	7: 33.3%	1: 4.8%
3-B	Incise exorotator muscles	Sup	3.0	1: 6.2%	1: 6.2%	10: 62.5%	4: 25.0%	0: 0%
		Res	3.0	1: 4.8%	3: 14.3%	13: 61.9%	3: 14.3%	1: 4.8%
3-C	Incise and suture piriformis muscle	Sup	3.0	1: 6.2%	1: 6.2%	9: 56.3%	4: 25.0%	0: 0%
		Res	3.0	0: 0%	3: 14.3%	12: 57.1%	4: 19.0%	2: 9.5%
3-D	Expose hip capsule	Sup	3.0	1: 5.9%	2: 11.8%	12: 70.6%	2: 11.8%	0: 0%
		Res	3.0	1: 4.8%	4: 19.0%	14: 66.7%	1: 4.8%	1: 4.8%
3-E	Place retractors behind m. gluteus medius	Sup	3.0	1: 6.2%	1: 6.2%	10: 62.5%	3: 18.8%	1: 6.2%
		Res	3.0	0: 0%	2: 9.5%	13: 61.9%	5: 23.8%	1: 4.8%
3-F	Incise joint capsule	Sup	3.0	0: 0%	2: 11.8%	9: 52.9%	5: 29.4%	1: 5.9%
		Res	3.0	0: 0%	1: 4.8%	10: 47.6%	9: 42.9%	1: 4.8%
3-G	Luxate hip joint	Sup	3.0	0: 0%	1: 5.9%	11: 64.7%	5: 29.4%	0: 0%
		Res	3.0	0: 0%	4: 19.0%	9: 42.9%	6: 28.6%	2: 9.5%
Step 4 Remove femoral head								
4-A	Expose collum femoris	Sup	3.0	0: 0%	2: 11.8%	13: 76.5%	2: 11.8%	0: 0%
		Res	3.0	0: 0%	5: 23.8%	2: 9.5%	13: 61.9%	1: 4.8%
4-B	Insert Hohmann retractors	Sup	3.0	0: 0%	3: 18.8%	10: 62.5%	3: 18.8%	0: 0%
		Res	3.0	0: 0%	5: 23.8%	13: 61.9%	2: 9.5%	1: 4.8%
4-C	Expose osteotomy location of collum	Sup	3.0	0: 0%	4: 25.0%	11: 68.8%	1: 6.2%	0: 0%
		Res	3.0	0: 0%	4: 19.0%	14: 66.7%	2: 9.5%	1: 4.8%
4-D	Assess angle and height of osteotomy	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***5: 29.4%***	***9: 52.9%***	***3: 17.6%***
		RES	***4.0***	***0: 0%***	***1: 4.8%***	***4: 19.0%***	***13: 61.9%***	***3: 14.3%***
4-E	Perform collum osteotomy	Sup	3.0	0: 0%	0: 0%	12: 70.6%	5: 29.4%	0: 0%
		Res	3.0	0: 0%	1: 4.8%	14: 66.7%	4: 19.0%	2: 9.5%
4-F	Evaluate and assess collum osteotomy	Sup	3.0	1: 5.9%	1: 5.9%	13: 76.5%	2: 11.8%	0: 0%
		Res	3.0	0: 0%	5: 23.8%	11: 52.4%	4: 19.0%	1: 4.8%
4-G	Remove caput femoris from acetabulum	Sup	3.0	2: 11.8%	5: 29.4%	9: 52.9%	1: 5.9%	0: 0%
		Res	3.0	1: 4.8%	5: 23.8%	13: 61.9%	1: 4.8%	1: 4.8%

(continued)

TABLE 2 (*continued*)

Task	Description	Sup/ Res	Median score	1 (low)	2	3 (normal)	4	5 (high)
Step 5 Prepare the acetabulum								
5-A	Expose acetabulum with retractors/pins	***SUP***	***4.0***	***0: 0%***	***3: 17.6%***	***5: 29.4%***	***8: 47.1%***	***1: 5.9%***
		Res	3.0	0: 0%	0: 0%	11: 52.4%	7: 33.3%	3: 14.3%
5-B	Excise labrum, remove tissue fovea	Sup	3.0	0: 0%	4: (23.5%)	11: (64.7%)	2: (11.8%)	0: 0%
		Res	3.0	0: 0%	2: 9.5%	14: 66.7%	4: 19.0%	1: 4.8%
5-C	Ream acetabulum in correct angle, depth, width	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***7: 41.2%***	***9: 52.9%***	***1: 5.9%***
		RES	***4.0***	***0: 0%***	***0: 0%***	***5: 23.8%***	***10: 47.6%***	***6: 23.8%***
5-D	Insert trial acetabular component and assess definitive size	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***7: 41.2%***	***9: 52.9%***	***1: 5.9%***
		RES	***4.0***	***0: 0%***	***0: 0%***	***7: 33.3%***	***8: 38.1%***	***4: 19.0%***
Step 6 Insert definitive acetabular components and assess definitive position								
6-A	Insert definitive acetabular component	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***3: 17.6%***	***6: 35.3%***	***8: 47.1%***
		RES	***4.0***	***0: 0%***	***0: 0%***	***6: 23.8%***	***6: 23.8%***	***9: 38.1%***
6-B	Assess definitive acetabular component position	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***2: 11.8%***	***8: 47.1%***	***7: 41.2%***
		RES	***4.0***	***0: 0%***	***0: 0%***	***3: 14.3%***	***8: 38.1%***	***10: 47.6%***
Step 7 Prepare the femur								
7-A	Insert Hohmann retractors	Sup	3.0	1: 5.9%	3: 17.6%	9: 52.9%	4: 11.8%	0: 0%
		Res	3.0	0: 0%	6: 23.8%	14: 66.7%	0: 38.0%	1: 4.8%
7-B	Prepare proximal femoral canal before inserting canal reamers	Sup	3.0	1: 5.9%	1: 5.9%	13: 76.5%	2: 11.8%	0: 0%
		Res	3.0	1: 4.8%	4: 19.0%	9: 42.9%	6: 23.8%	1: 4.8%
7-C	Insert straight canal reamers in ascending order	Sup	3.0	1: 5.9%	1: 5.9%	12: 70.6%	2: 11.8%	1: 5.9%
		Res	3.0	1: 4.8%	3: 14.3%	13: 61.9%	3: 14.3%	1: 4.8%
7-D	Assess femoral component anteversion angle	***SUP***	***4.0***	***0: 0%***	***1: 5.9%***	***4: 23.5%***	***10 58.5%***	***2: 11.8%***
		Res	3.0	0: 0%	2: 9.5%	10: 47.6%	7: 33.3%	2: 9.5%
7-E	Broach proximal femur in ascending order	Sup	3.0	0: 0%	1: 5.9%	10: 58.5%	5: 29.4%	1: 5.9%
		Res	3.0	0: 0%	3: 14.3%	13: 61.9%	4: 19.0%	1: 4.8%
7-F	Insert trial femoral component and assess position offset	***SUP***	***4.0***	***0: 0%***	***1: 5.9%***	***3: 17.6%***	***11 64.7%***	***2: 11.8%***
		RES	***4.0***	***0: 0%***	***2: 9.5%***	***5: 23.8%***	***10: 47.6%***	***4: 19.0%***
7-G	Assess definitive femoral component size	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***8: 47.1%***	***7: 41.2%***	***2: 11.8%***
		Res	3.0	0: 0%	3: 14.3%	11: 52.4%	4: 19.0%	3: 14.3%
Step 8 Insert definitive femoral components and assess definitive position								
8-A	Insert definitive femoral component	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***6: 35.3%***	***4: 23.5%***	***7: 41.2%***
		Res	3.0	0: 0%	1: 4.8%	10: 47.6%	4: 19.0%	6: 23.8%
8-B	Assess femoral component position, anteversion angle and depth	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***4: 23.5%***	***7: 41.2%***	***6: 35.3%***
		RES	***4.0***	***0: 0%***	***1: 4.8%***	***7: 33.3%***	***8: 38.1%***	***5: 23.8%***
Step 9 Combine femoral and acetabular component, assess stability								
9-A	Insert trial head	Sup	3.0	0: 0%	2: 9.5%	12: 57.1%	0: 0%	2: 9.5%
		Res	3.0	1: 4.8%	3: 14.3%	16: 76.2%	0: 0%	1: 4.8%
9-B	Reduce femur with trial head	Sup	3.0	0: 0%	1: 5.9%	10: 58.5%	3: 17.6%	3: 17.6%
		Res	3.0	0: 0%	6: 23.8%	12: 57.1%	2: 9.5%	1: 4.8%
9-C	Insert trial head, combine components, assess position	***SUP***	***4.0***	***0: 0%***	***0: 0%***	***4: 23.5%***	***5: 29.4%***	***7: 41.2%***
		RES	***4.0***	***0: 0%***	***0: 0%***	***5: 23.8%***	***11: 52.4%***	***5: 23.8%***
9-D	Insert definitive head	Sup	3.0	0: 0%	0: 0%	15: 82.4%	2: 11.8%	0: 0%
		Res	3.0	1: 4.8%	4: 19.0%	12: 57.1%	3: 14.2%	1: 4.8%
9-E	Reduce femur definitively	Sup	3.0	0: 0%	1: 5.9%	11: 64.7%	2: 11.8%	3: 17.6%
		RES	***4.0***	***0: 0%***	***1: 4.8%***	***8: 38.1%***	***9: 42.9%***	***3: 14.3%***

(*continued*)

TABLE 2 (*continued*)

Task	Description	Sup/ Res	Median score	1 (low)	2	3 (normal)	4	5 (high)
9-F	Assess stability	Sup	3.0	0: 0%	1: 5.9%	14: 82.4%	2: 11.8%	0: 0%
		Res	3.0	1: 4.8%	5: 23.8%	14: 66.7%	1: 4.8%	0: 0%
Step 10 Reconstruct joint capsule and muscle insertions								
10-A	Reconstruct joint capsule	Sup	3.0	0: 0%	2: 12.5%	9: 56.3.%	5: 31.3%	0: 0%
		Res	3.0	0: 0%	5: 23.8%	14: 66.7%	1: 4.8%	1: 4.8%
10-B	Reconstruct pirifor-mis/exorotator muscles	Sup	3.0	0: 0%	2: 9.5%	10: 47.6%	4: 19.0%	0: 0%
		Res	3.0	0: 0%	3: 14.3%	16: 76.2%	1: 4.8%	1: 4.8%
10-C (was D)	Reconstruct m. gluteus maximous/fascia lata	Sup	3.0	1: 5.9%	0: 0%	14: 82.4%	2: 11.8%	0: 0%
		Res	3.0	2: 9.5%	6: 23.8%	11: 52.4%	1: 4.8%	0: 0%
Step 11 Close wound								
11-A	Reconstruct subcuta-neous tissues	Sup	3.0	1: 5.9%	4: 11.8%	10: 58.5%	2: 11.8%	0: 0%
		Res	3.0	2: 9.5%	8: 38.1%	9: 42.9%	2: 9.5%	0: 0%
11-B	Close skin	Sup	3.0	1: 5.9%	1: 5.9%	11: 64.7%	4: 23.5%	0: 0%
		Res	3.0	3: 14.3%	7: 33.3%	7: 33.3%	4: 19.0%	0: 0%

Tasks that received a median score of 4 are bolded and italicized.

attention scores ranged from 2 to 4. Tasks with a median attention score of 4 are bolded and italicized.

Supervisors rated 12 tasks with a median score of 4 (Table 3). They generally used arguments such as "crucial to end result," "essential to outcome," and "prevention of luxation or complications."

Residents rated 9 tasks with a median score of 4. The specific tasks are shown in Table 4. The residents used arguments such as "little room for error," "being inexperienced," "not too deep and the right amount of pressure," "is difficult," and "must be perfect" to clarify their high attention scores.

Comparable Attention Scores, Differences in Distribution

Some tasks received comparable overall median attention scores but supervisors and residents demonstrated differences in the distribution of attention

TABLE 3. Type of Tasks That Received More-Than-Normal Attention From Supervisors

Task	Description	Median Score	1 (Low)	2	3 (Normal)	4	5 (High)
4-D	Assess angle and height of osteotomy	4.0	0 (0%)	0 (0%)	5 (29.4%)	9 (52.9%)	3 (17.6%)
5-A	Expose acetabulum with retractors/pins	4.0	0 (0%)	3 (17.6%)	5 (29.4%)	8 (47.1%)	1 (5.9%)
5-C	Ream acetabulum in correct angle, depth, width	4.0	0 (0%)	0 (0%)	7 (41.2%)	9 (52.9%)	1 (5.9%)
5-D	Insert trial acetabular component and assess definitive size	4.0	0 (0%)	0 (0%)	7 (41.2%)	9 (52.9%)	1 (5.9%)
6-A	Insert definitive acetabular component	4.0	0 (0%)	0 (0%)	3 (17.6%)	6 (35.3%)	8 (47.1%)
6-B	Assess definitive acetabular component position	4.0	0 (0%)	0 (0%)	2 (11.8%)	8 (47.1%)	7 (41.2%)
7-D	Assess femoral component anteversion angle	4.0	0 (0%)	1 (5.9%)	4 (23.5%)	10 58.5%)	2 (11.8%)
7-F	Insert trial femoral component and assess position offset	4.0	0 (0%)	1 (5.9%)	3 (17.6%)	11 64.7%)	2 (11.8%)
7-G	Assess definitive femoral component size	4.0	0 (0%)	0 (0%)	8 (47.1%)	7 (41.2%)	2 (11.8%)
8-A	Insert definitive femoral component	4.0	0 (0%)	0 (0%)	6 (35.3%)	4 (23.5%)	7 (41.2%)
8-B	Assess femoral component position, ante-version angle, depth	4.0	0 (0%)	0 (0%)	4 (23.5%)	7 (41.2%)	6 (35.3%)
9-C	Insert trial head, combine components, assess position	4.0	0 (0%)	0 (0%)	4 (23.5%)	5 (29.4%)	7 (41.2%)

TABLE 4. Type of Tasks That Received More-Than-Normal Attention From Residents

Task	Description	Median Score	1 (Low)	2	3 (Normal)	4	5 (High)
4-D	Assess angle and height of osteotomy	4.0	0 (0%)	1 (4.8%)	4 (19.0%)	13 (61.9%)	3 (14.3%)
5-C	Ream acetabulum in correct angle, depth, width	4.0	0 (0%)	0 (0%)	5 (23.8%)	10 (47.6%)	6 (23.8%)
5-D	Insert trial acetabular component and assess definitive size	4.0	0 (0%)	0 (0%)	7 (33.3%)	8 (38.1%)	4 (19.0%)
6-A	Insert definitive acetabular component	4.0	0 (0%)	0 (0%)	6 (23.8%)	6 (23.8%)	9 (38.1%)
6-B	Assess definitive acetabular component position	4.0	0 (0%)	0 (0%)	3 (14.3%)	8 (38.1%)	10 (47.6%)
7-F	Insert trial femoral component and assess position offset	4.0	0 (0%)	2 (9.5%)	5 (23.8%)	10 (47.6%)	4 (19.0%)
8-B	Assess femoral component position, anteversion angle, depth	4.0	0 (0%)	1 (4.8%)	7 (33.3%)	8 (38.1%)	5 (23.8%)
9-C	Insert trial head, combine components, assess position	4.0	0 (0%)	0 (0%)	5 (23.8%)	11 (52.4%)	5 (23.8%)
9-E	Reduce femur	4.0	0 (0%)	1 (4.8%)	8 (38.1%)	9 (42.9%)	3 (14.3%)

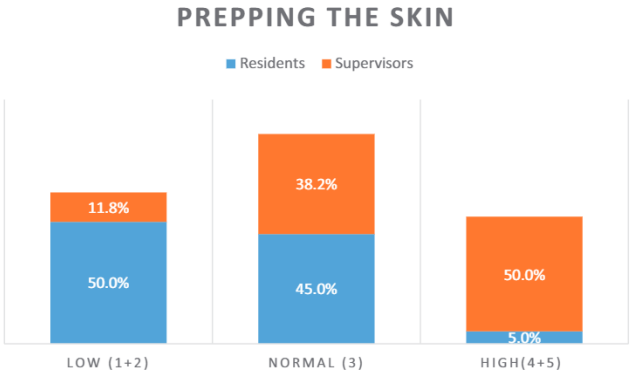

FIGURE 1. Contrasts in attention scores between supervisors and residents within a task.

scores. The most notable example is prepping the skin (Fig. 1). Eight supervisors marked this task with attention scores higher than 3 (47.0%) versus only 1 resident (5.0%). Supervisors stated arguments such as "keeping the team alert" or "preventing infection." Moreover, 10 residents (50.0%) rated this task with attention scores lower than 3 compared to just 2 supervisors (11.8%).

Similar patterns of high attention scores of supervisors versus low attention scores of residents were identified in 9 tasks (19.1%) of the procedure (Table 5, see bolded and italicized text).

The majority of these tasks do not involve critical decision-making but do involve steps to expose the joint (steps 1-3) and the soft-tissue reconstruction (steps 10-11). The opposite—tasks with comparable median attention scores in which a large proportion of residents rated high attention and a large proportion of supervisors rated low attention—could not be recognized in this study.

DISCUSSION

This qualitative survey study explored the preferences of supervisors and residents for the different tasks of an uncemented total hip arthroplasty. We used cognitive task analysis, a technique that has been effective in understanding and teaching-specific procedures in the military, government, and healthcare.[15-18] In this study, we asked supervisors and residents to assess how much attention they would commonly invest in the different tasks of the procedure. Interestingly, supervisors and residents demonstrated comparable attention scores overall. They both rated normal attention for the majority of tasks. Supervisors upgraded their attention in 12 tasks and residents in 9 tasks.

To us this was a surprising finding. From the literature on expertise it is known that as surgeons become experts, they automate their performance for the majority of the tasks of a common surgical procedure.[19-21] Decision-making and motor actions are swift and efficient because experts do not require much attention or mental effort for task execution. When a surgeon is executing a surgical task that is unfamiliar, there are no previous experiences to rely on. New information needs to be assessed and processed, and conscious, deliberate decision-making strategies become necessary.[19,22,23] As a result, both decision-making and motor actions take more time and cognitive effort.[19,22,23] It is therefore more likely that inexperienced residents will rate more tasks with high attention than supervisors.

TABLE 5. Contrasts Within Tasks: Supervisors' High Attention Versus Residents' Low Attention Scores (Bolded and Italicized)

Task	Description	Sup/Res	Median Score	1 (Low)	2	3 (Normal)	4	5 (High)
1-A	Prep the skin	Sup	3.0	1: 5.9%	1: 5.9%	7: 41.2%	***5: 29.4%***	***3: 17.6%***
		Res	2.5	***4: 20.0%***	***6: 30.0%***	9: 45.0%	1: 5.0%	0: 0%
1-B	Drape the patient	Sup	3.0	1: 6.2%	0: 0%	9: 56.3%	***5: 31.3%***	***1: 6.2%***
		Res	3.0	***1: 5.0%***	***6: 30.0%***	12: 60.0%	1: 5.0%	0: 0%
2-A	Assess location of skin incision	Sup	3.0	1: 5.9%	1: 5.9%	8: 47.1%	***5: 29.4%***	***2: 11.8%***
		Res	3.0	***0: 0%***	***5: 23.8%***	9: 42.9%	4: 19.0%	3: 14.3%
2-E	Incise gluteal maximus muscle	Sup	3.0	1: 5.9%	1: 5.9%	11: 64.7%	***4: 23.5%***	***0: 0%***
		Res	2.5	***1: 4.8%***	***9: 42.9%***	9: 42.9%	1: 4.8%	0: 0%
3-B	Incise exorotator muscles	Sup	3.0	1: 6.2%	1: 6.2%	10: 62.5%	***4: 25.0%***	***0: 0%***
		Res	3.0	***1: 4.8%***	***3: 14.3%***	13: 61.9%	3: 14.3%	1: 4.8%
3-G	Luxate hip joint	Sup	3.0	0: 0%	1: 5.9%	11: 64.7%	***5: 29.4%***	***0: 0%***
		Res	3.0	***0: 0%***	***4: 19.0%***	9: 42.9%	6: 28.6%	2: 9.5%
9-B	Reduce femur with trial head	Sup	3.0	0: 0%	1: 5.9%	10: 58.5%	***3: 17.6%***	***3: 17.6%***
		Res	3.0	***0: 0%***	***6: 23.8%***	12: 57.1%	2: 9.5%	1: 4.8%
10-A	Reconstruct joint capsule	Sup	3.0	0: 0%	2: 12.5%	9: 56.3.%	***5: 31.3%***	***0: 0%***
		Res	3.0	***0: 0%***	***5: 23.8%***	14: 66.7%	1: 4.8%	1: 4.8%
11-B	Close skin	Sup	3.0	1: 5.9%	1: 5.9%	11: 64.7%	***4: 23.5%***	***0: 0%***
		Res	3.0	***3: 14.3%***	***7: 33.3%***	7: 33.3%	4: 19.0%	0: 0%

Still, the arguments supervisors and residents provided on why they scored high attention to a task differed, and may provide an explanation. In general, the supervisors in this study used arguments such as "safety" and "critical to optimal outcome" to give a high attention score. Interestingly, this pattern was also observed in the perceptions of some tasks like "prepping the skin," which 47% of supervisors rate as high attention. Experience with complications and adverse events might explain these phenomena. Our data therefore indicate that the supervisors raise their level of attention to tasks they perceive as important to the end result: optimal patient outcome and safety. Addressing deliberate attention to specific tasks is recognized in the literature of surgical decision-making as "slowing down when you should": experts learned from past experiences that they should shift out of automated decision-making mode during crucial tasks and make more effortful and conscious decisions to optimize team performance and patient outcome.[24] Supervisors demonstrated this phenomenon in the present study. They raise their attention, not because they perceive the task as technically demanding but because of the effect suboptimal task execution has on patient outcome and safety in the end: supervisors *think ahead*.

On the other hand, in this study, residents provided other arguments for high attention implying that attention relates to levels of difficulty or anxiety experienced while executing these tasks, and seeming to emphasize the technical challenges some tasks pose for them. Some evidence for these conclusions can be found in the type of tasks. Prepping the skin, draping, or closing the wound at the end of the procedure do not generally require a high level of technical skill. A relatively high percentage of residents assigned less-than-normal attention to these tasks. In contrast to supervisors, residents tend to think in the "now."

The CTA in this study provided detailed insights into the mental effort and arguments of supervisors and residents, information that could be used to develop procedure-specific training programs for residents. This study could additionally contribute to optimize levels of entrusted autonomy for individual residents.

In the daily practice of teaching surgical procedures, levels of entrusted autonomy depend on a number of elements related to the individual resident, the supervising surgeon, the complexity of the task, and other factors surrounding the procedure.[12-14,23-27] From Moulton's work on control dynamics in the OR, we know that supervisors emphasize the importance of residents working "in sync" with them lest they take residents' autonomy back.[12,13] In this context, our findings become very relevant: entrusted autonomy becomes at risk when, within a dyad, the resident invests less attention on a task than the supervisor expects for that task. In our study there are 9 tasks for which supervisors rated higher attention than residents. Our findings stress the importance for residents to explore and understand their supervisors' individual preferences before the procedure starts. On the other hand, the residents in this study raised attention when they needed to invest more effort to execute some of the tasks. Supervising surgeons can use these insights to customize teaching and thus optimize levels of entrusted autonomy.

The framework of this study, CTA of supervisors and residents, is a novelty in literature. It can be used to

explore individual preferences on procedures other than an uncemented total hip arthroplasty. Our study suggests that adding task- or procedure-specific preferences of supervisors and residents to preoperative preparation and briefings—instruments that have already proven their value in constructing an effective learning climate—could be an important further step in improving teaching and learning in the OR.[28-31]

Limitations of This Study

Perception studies are not without potential biases. Residents may have been taught by their supervisors that some tasks are more complex. There is also the matter of sample size and generalizability. Furthermore, the findings of this study represent the attention scores of participants for one procedure and one teaching region in the Netherlands. To what extent our findings represent OR teaching and learning in other locations, countries and cultures remains to be explored. Still, the framework of this study—extracting information from both supervisors and residents—can be used in other procedures and educational cultures to identify and analyze those local preferences of supervisors and residents.

CONCLUSIONS

Progressive entrustment of autonomy is the key didactic principle to master surgical procedures. Different insights and perceptions of supervisors and residents affect levels of entrusted autonomy. Our study focused on how supervisors and residents experience the different tasks of a surgical procedure. When both raise their levels of attention for a specific task they do this for different reasons: supervisors think ahead and focus on patient outcome and safety while residents invest attention on executing the task at hand itself (think "now"). This disparity is grounded in fundamental differences between experts and novices in decision-making and task execution. It is important to realize that the learning climate in the OR is shaped by individual preferences of a supervisor and a resident working together at a specific moment in time. Hence learning, teaching, and patient outcome will benefit when a resident can appreciate for which tasks and which reasons the supervisor increases attention, while the supervisor can adapt the level of guidance from the moment they understand the resident's individual learning needs for that specific task. As such, cognitive task analysis by both supervisors and residents can be a helpful tool in preparing and maintaining an effective learning climate in the OR.

REFERENCES

1. Schaverien MV. Development of expertise in surgical training. *J Surg Educ*. 2010;67:37–43.
2. Halsted WS. The training of the surgeon. *Bull Johns Hopkins HospKerr*. 1904;15:267–275.
3. Meyerson SL, Teitelbaum EN, George BC, Schuller MC, DaRosa DA, Fryer JP. Defining the autonomy gap: when expectations do not meet reality in the operating room. *J Surg Educ*. 2014;71:64–72.
4. Kairys JC, McGuire K, Crawford AG, Yeo CJ. Cumulative operative experience is decreasing during general surgery residency: a worrisome trend for surgical trainees? *J Am Coll Surg*. 2008;206:804–811.
5. Mir HR, Cannada LK, Murray JN, Black KP, Wolf JM. Orthopaedic resident and program director opinions of resident duty hours: a national survey. *JBJS*. 2011;93:1421–1429.
6. Pugh CM, DaRosa DA, Glenn D, Bell RH. A comparison of faculty and resident perception of resident learning needs in the operating room. *J Surg Educ*. 2007;64:250–255.
7. Butvidas LD, Anderson CI, Balogh D, Basson MD. Disparities between resident and attending surgeon perceptions of intraoperative teaching. *Am J Surg*. 2011;201:385–389.
8. Chen X, Williams RG, Smink DS. Do residents receive the same OR guidance as surgeons report? Difference between residents' and surgeons' perceptions of OR guidance. *J Surg Educ*. 2014;71:79–82.
9. Ong CCP, Dodds A, Nestel D. Beliefs and values about intra-operative teaching and learning: a case study of surgical teachers and trainees. *Adv Health Sci Educ*. 2016;21:587–607.
10. Olmos Vega FM, Dolmans DHJM, Vargas Castro N, Stalmeijer RE. Dealing with the tension: how residents seek autonomy and participation in the workplace. Med Educ. 2017 51:699-707.
11. Sterkenburg A, Barach P, Kalkman C, Gielen M, ten Cate O. When do supervising physicians decide to entrust residents with unsupervised tasks? *Acad Med*. 2010;85:1408–1417.
12. Moulton C-A, Regehr G, Lingard L, Merritt C, MacRae H. Operating from the other side of the table: control dynamics and the surgeon educator. *J Am Coll Surg*. 2010;210:79–86.

13. Apramian T, Cristancho S, Watling C, Ott M, Lingard L. "They Have to Adapt to Learn": surgeons' perspectives on the role of procedural variation in surgical education. *J Surg Educ*. 2016;73:339–347.

14. Apramian T, Cristancho S, Sener A, Lingard L. How do thresholds of principle and preference influence surgeon assessments of learner performance? *Ann Surg*. 2018;268:385–390.

15. Tofel-Grehl C, Feldon DF. Cognitive task analysis-based training: a meta-analysis of studies. *J Cogn Eng Decis Mak*. 2013;7:293–304.

16. Wingfield LR, Kulendran M, Chow A, Nehme J, Purkayastha S. Cognitive task analysis: bringing Olympic athlete style training to surgical education. *Surg Innov*. 2015;22:406–417.

17. Sullivan ME, Brown CVR, Peyre SE, et al. The use of cognitive task analysis to improve the learning of percutaneous tracheostomy placement. *Am J Surg*. 2007;193:96–99.

18. Sullivan ME, Ortega A, Wasserberg N, Kaufman H, Nyquist J, Clark R. Assessing the teaching of procedural skills: can cognitive task analysis add to our traditional teaching methods? *Am J Surg*. 2008;195:20–23.

19. Cnossen F. Cognitive skill in medicine: an introduction. PanVascular Medicine. Berlin, Heidelberg: Springer; 2014. p. 1–41.

20. Dreyfus H, Dreyfus SE, Athanasiou T. Mind Over Machine. Simon and Schuster; 2000.

21. Schön DA. The Reflective Practitioner: How Professionals Think in Action. New York: Basic Books; 1983.

22. Schmidt H, Norman G, Boshuizen H. A cognitive perspective on medical expertise: theory and implications. *Acad Med*. 1990;65:611–621.

23. Norman GR, Eva KW. Diagnostic error and clinical reasoning. *Med Educ*. 2010;44:94–100.

24. Meyerson SL, Teitelbaum EN, George BC, Schuller MC, DaRosa DA, Fryer JP. Defining the autonomy gap: when expectations do not meet reality in the operating room. *J Surg Educ*. 2014;71:64–72.

25. Moulton C, Regehr G, Lingard L, Merritt C, MacRae H. 'Slowing Down When You Should': initiators and influences of the transition from the routine to the effortful. *J Gastrointest Surg*. 2010;14:1019–1026.

26. Sutzko DC, Boniakowski AE, Nikolian VC, Georgoff PE, Matusko N, Thompson-Burdine JA. Alignment of personality is associated with increased intraoperative entrustment. *Ann Surg*. 2019;270:1058–1064.

27. Bezemer J, Cope A, Faiz O, Kneebone R. Participation of surgical residents in operations: challenging a common classification. *World J Surg*. 2012;36:2011–2014.

28. DaRosa DA, Zwischenberger JB, Meyerson SL, et al. A theory-based model for teaching and assessing residents in the operating room. *J Surg Educ*. 2013;70:24–30.

29. Bohnen JD, George BC, Williams RG, et al. The feasibility of real-time intraoperative performance assessment with SIMPL (System for Improving and Measuring Procedural Learning): early experience from a multi-institutional trial. *J Surg Educ*. 2016;73:118–130.

30. Ahmed M, Arora S, Russ S, Darzi A, Vincent C, Sevdalis N. Operation debrief: a SHARP improvement in performance feedback in the operating room. *Ann Surg*. 2013;258:958–963.

31. Lyon P. A model of teaching and learning in the operating theatre. *Med Educ*. 2004;38:1278–1287.