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Observational Teamwork Assessment for Surgery (OTAS): Refinement and Application in Urological Surgery

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Abstract
Background Teamwork in surgical teams is at the forefront of good practice guidelines and empirical research as an important aspect of safe surgery. We have developed a comprehensive assessment for teamwork in surgery—the Observational Teamwork Assessment for Surgery (OTAS)—and we have tested it for general surgical procedures. The aim of the research reported here was to extend the assessment to urology procedures.
Methods After refining the original assessment, we used it to observe 50 urology procedures. The OTAS comprises a procedural task checklist that assesses patient, equipment/provisions, and communication tasks as well as ratings on five team behavior constructs (communication, cooperation, coordination, leadership, and monitoring). Teamwork was assessed separately in the surgical, anesthesia, and nursing subteams in the operating theater. We also assessed the reliability of the behavioral scoring.
Results Regarding task completion, a number of communication and equipment/provisions tasks were not routinely performed during the operations we observed. Regarding teamwork-related behaviors, adequate reliability was obtained in the scoring of behaviors. Anesthetists and nurses obtained their lowest scores on communication. Surgeons' scores revealed a more complex pattern. In addition to low scores on communication, surgeons' teamwork behaviors appeared to deteriorate as the procedures were finishing.
Conclusions Our findings suggest that OTAS is applicable to various branches of surgery. Separate assessment of the subteams in the operating theater provides useful information that can be used to build targeted teamwork training aiming to improve surgical patients' safety and outcomes.

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In recent years, there have been major changes in the way surgical outcomes are understood and analyzed. Traditionally, surgical outcomes have been perceived as a function of the operating surgeon's skill: the more skilled the surgeon, the better the postoperative outcome for the patient. Recent empirical and conceptual work on the assessment of surgical skills suggests that the surgeon's manual and perceptual dexterity (i.e., the main components of skill in the traditional view) may not be the only factor mediating the relation between patient risk factors and postoperative outcomes [1, 2]. Features of the operative environment [3], the quality of the communication among operating theater professionals [4–7], and the quality of the teamwork of the operating theater team determine, jointly with the surgeon's technical dexterity, postoperative outcomes.

Teamwork between clinicians appears to be at the forefront of the relevant good-practice guidelines and empirical research. The Institute of Medicine has recommended team training to improve teamwork [8]. Teamwork and attitudes toward it have been investigated in a number of specialist clinical domains, such as neonatal and perinatal care [9, 10], accident and emergency departments [11, 12], and critical care medicine [13]. In relation to operating theaters, recent studies suggest that different professionals hold different views on the quality of the teamwork in their teams [14, 15]. Moreover, although operating theater professionals have positive attitudes toward the cognitive and interpersonal skills that are necessary inputs to high level teamwork in their teams, they are often unconvinced regarding the input of such skills to their performance [16, 17].

If teamwork is indeed an important aspect of safe and effective surgery, an assessment that captures teamwork in operating theaters successfully and comprehensively is needed to assess it. Such an assessment should include a number of dimensions that contribute to effective teamwork in surgical teams, and it should be reliable (i.e., it should measure teamwork in a consistent fashion) and valid (i.e., it should be able to predict surgical processes and outcomes).

The Observational Teamwork Assessment for Surgery (OTAS) that we have been developing aims to be such a comprehensive measure of operating theater teamwork. In contrast to existing measures that tend to focus on a single professional discipline, OTAS has been designed to capture the way surgical teams function in their entirety; in other words, OTAS assesses teamwork-related behaviors for all the members of a surgical team concurrently. (The assessment is described in detail in the Methods section.) To date, we have collected data using OTAS on 50 general surgery procedures [18–20].

In the present article, we report data from an additional set of 50 cases following extensive refinement and modification of the original assessment. We chose to collect the additional 50 cases in urology operating theaters. For urology procedures, poor teamwork has been implicated as a potent source of errors and adverse outcomes for patients, such as wrong-side surgery on the kidney or testis. Such scenarios carry devastating consequences and require interventions to ensure that they do not occur [21]. Effective teamwork has the potential to prevent such errors through mutual cross checking and monitoring of procedures by team members. Moreover, there have been recent calls from urologists that urge improved teamwork in urologic procedures. For instance, Coxon et al. suggested that training similar to that used for aviation teams could improve the performance of urology teams [22]. Furthermore, in addition to the usual interactions among surgeons, nurses, and anesthetists, urologic procedures often require input from radiologists, radiographers, and other specialists. Thus, urology surgical teams tend to be fluid, encompassing various members and different inputs from them over time. This adds a layer of complexity to the task of coordinating the team, leading it effectively and efficiently during the various phases of the procedure and communicating adequately with other team members. For these reasons, urology seemed to be the ideal specialty on which to test the modified OTAS assessment.

Aims

Our aims in this research project were to: (1) refine the assessment in the light of the initial general surgery findings; (2) examine the reliability of the assessment; and (3) replicate the teamwork assessment in a different surgical specialty (i.e., urology).

Methods

Study design

This work was an observational study of urology procedures in real time.

The sample

We collected observations from 50 urology procedures in two operating theaters: one in a teaching hospital and the other in a specially designed treatment center. In total, 20 operations were the first surgery of the day, and the remaining 30 were the second or subsequent operation of the day. The mix of operations contained cystoscopy, ureteroscopy, ureterorenoscopy, transurethral resection of the prostate (TURP), and other procedures such as orchidectomy, vasectomy, and circumcision. In six additional procedures, we assessed interobserver reliability. There was relative consistency of the teams being observed across the two sites. Attending surgeons and senior nursing teams tended to be more consistent than the residents and junior nurses. Anesthesia teams, both seniors and residents as well as their assistants (Operating Department Practitioner (ODP)/anesthetic nurses), tended to be much less consistent. For the purposes of the present research, we collected data from procedures that lasted 30 to 240 minutes.

Materials and measures

The OTAS assessment consists of two distinct but interrelated features. The first is a teamwork-related task checklist, and the second comprises five observable behaviors rated on seven-point scales. In what follows, we provide brief descriptions of the original development of the task checklist and the behaviors (for additional reporting of the development of OTAS, see [19, 20]).

Task checklist

The task checklist consists of a number of teamwork-related tasks. The initial task list was compiled for use in routine general surgery procedures. The tasks were chosen on the basis of their inclusion in operating theater protocols, good practice guidelines, and input from expert surgeons. This list was used to collect data on 50 general surgery procedures [18], and it was subsequently revised for use in urology theaters. During the process of revising the task list, a panel of operating theater experts (surgeons, anesthetists, nurses) rated the appropriateness of each task and its contribution to surgical teamwork and outcome. Tasks that were deemed inappropriate or that overlapped considerably with other tasks were excluded. The shorter task list that we used in the present study comprised tasks falling into one of three categories.

- Patient tasks—related to actions or information associated directly with the patient
- Equipment and provisions tasks—included items such as checking and counting surgical instruments
- Communication tasks—included confirming consent, patient details, and operative site

A surgeon observer equipped with a personal digital assistant (PDA) that contained the task checklist checks whether each task had been performed during the course of the procedure. For instance, the diathermy machine (an equipment/provisions task) is marked as '''checked'' if the machine is switched on and tested before the procedure. Likewise, the anesthesia machine is marked as ''checked'' if the anesthetist on duty checks the equipment according to recommended protocol before the procedure. For all equipment checks, if the check is observed for the first procedure of the daily operating list the observer marks the equipment as ''checked'' for all subsequent procedures.

Teamwork-related behaviors

In addition to the task checklist, OTAS comprises five teamwork-related behaviors that are rated on seven-point scales. The following behaviors are assessed [20].

- Communication—refers to the quality and the quantity of the information exchanged among members of the team
- Coordination—refers to the management and to the timing of activities and tasks
- Cooperation/backup behavior—refers to assistance provided among members of the team, supporting others, and correcting errors
- Leadership—refers to the provision of directions, assertiveness, and support among members of the team
- Monitoring/awareness—refers to team observation and awareness of ongoing processes

These behaviors are assessed by a psychologist or human factors expert who is present in theater alongside the surgeon observer. The assessment is done on a seven-point scale: 0 = the lowest teamwork behavior score, and 6 = the highest teamwork behavior score. The intermediate levels of the scales are all based on observable behavior as well. (See Appendix for the full communication rating scale, as an example.)

Initially, the psychologist observer allocated a rating to each of these behaviors across all members of the surgical team. This rating scheme, however, was revised after the initial sample of 50 general surgery cases was analyzed. It was noted that discrepancies existed at times between the subteams that make up the operating theater team—namely, the nursing, surgical, and anesthesia subteams. The rating scheme was therefore revised prior to use in urology theaters to provide separate ratings for each of the five behaviors to each of the three theater subteams (nurses, surgeons, anesthetists). The scoring was further aided by the use of specifically designed demonstrative scenarios and exemplar behaviors, which were constructed by experts.

Procedure

A urological surgeon of registrar level (S.U.) and a psychologist of postdoctoral level (N.S. or A.N.H.) were present in the operating theater before the patient arrived. The surgeon completed the task checklist, and the psychologist focused on the behavioral ratings.

The OTAS assessment uses a timeline for the procedures under observation. Observations are grouped into three distinct phases: preoperative, intraoperative, and postoperative. During the preoperative phase, the patient is sent for, being anesthetized, transferred to the operating theater, and set up for surgery. The intraoperative phase starts from the point of the incision and finishes when the procedure has been completed (e.g., the operating surgeon has finished suturing). The postoperative phase starts when the anesthesia is being reversed and covers the time when the patient regains consciousness and is being transferred to the recovery room. (For detailed definitions and contents of each phase, see [18–20].)

Because the observations follow this timeline, the surgeon observer checked the various patient, equipment/provisions, and communication tasks across the three operative phases. Likewise, the psychologist observer rated the observed behaviors three times: once preoperatively, once again intraoperatively, and finally postoperatively. This resulted in 45 behavioral ratings per observed procedure (5 behaviors $\times$ 3 subteams $\times$ 3 operative phases). For the purposes of the present study, we also recorded whether the condition of the patient was monitored throughout the procedure and any critical incidents. In the six cases in which we assessed the reliability of the behavioral ratings, only two psychologist observers were present. In these cases we did not use the task checklist.

Data analyses

The OTAS provides task completion rates for three types of task checked across three operative phases. It also provides ratings for five teamwork-related behaviors rated across three subteams and three operative phases. We used a mix of parametric and nonparametric tests to analyze the data. Differences in percent task completion across phases were assessed via chi-squared tests. Analyses of variance (ANOVAs) were carried out to examine the differences in behavior ratings across operative stages and operating theater subteams. Finally, Pearson's correlation coefficient (r) was computed to assess the interobserver reliability of the behavioral ratings.

Results

We first report our findings regarding task completion rates, followed by the findings on behavioral ratings. For both areas, we compare the pattern of findings we obtained for urology to those we obtained for general surgery. We then present evidence on the reliability of the behavioral ratings.

Task checklist: levels of observed teamwork-related task completion Table 1 summarizes our findings from the task checklist and presents data on monitoring the patient's condition. The average level of task completion across the three categories of tasks that we observed (patient, equipment/provisions, communication) was relatively high: 83% of the tasks were completed. However, we obtained large differences across the different types of tasks and phases of the procedure. A chi-squared (χ^2) test revealed significant differences in rates of task completion across the types of task [χ^2 (2) = 267.66, $p < 0.001$]. The observed rates of task completion were 93% for patient tasks, 80% for equipment/provisions tasks, and 71% for communication tasks. Moreover, for equipment/provisions tasks as well as communication tasks, we observed variations in task completion across operative phases. Specifically, significantly fewer equipment/provisions tasks were completed during the preoperative phase (61%) than during the intraoperative phase (91%) or the postoperative phase (95%) [χ^2 (2) = 204.20, $p < 0.001$]. The opposite was found for communication tasks, with significantly more of them completed during the preoperative phase (71%) and postoperative phase (84%) and fewer during the intraoperative phase (57%) [χ^2 (2) = 81.61, $p < 0.001$]. We did not observe differences in task completion across the three phases in the patient tasks [χ^2 (2) = 5.51, $p > 0.05$] or monitoring of the patient's condition [χ^2 (2) = 1.84, $p > 0.05$].

We also compared the levels of task completion we observed during urology procedures with those that we observed during the general surgical procedures. Table 2 juxtaposes the checklist results across the two types of surgery. Although the rates of task completion that we observed were somewhat higher for urology, the overall pattern of task completion was strikingly similar.

In summary, task completion was highest for patient tasks and lowest for communication tasks, with equipment/

Table 1 Rates of task completion across phases and task types

	Task type and task completion (yes/no)									
	Patient		Equipment and provisions		Communication		Patient condition		Total	
Phase	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Preop	667	44	329	213	377	156	183	14	1556	427
Intraop	389	29	458	43	266	199	270	29	1383	300
Postop	554	51	269	14	386	72	94	6	1303	143
Total	1610	124	1056	270	1029	427	547	49	4242	870

Table 2 Comparison of task completion in general surgery versus urology

Task type	Preoperative Phase (%)		Intraoperative Phase (%)		Postoperative Phase (%)	
	Gen. Surg	Urology	Gen. Surg	Urology	Gen. Surg	Urology
Equipment/provisions	56	61	82	91	89	95
Communication	61	71	55	57	90	84
Patient	90	94	93	93	97	92
Overall	69	77	77	80	92	90

provisions tasks somewhere in between. In addition, although we obtained higher rates of task completion for the urology procedures than for the general surgical procedures, the pattern of task completion across task types was similar across the two specialties. Communication tasks were the least likely to be completed, whereas patient tasks were the most likely to be completed.

Behavioral ratings across professional subteams and operative phases Table 3 summarizes the behavioral ratings across behaviors (communication, coordination, leadership, monitoring, cooperation), subteams (anesthetic, nursing, surgical), and operative phases (pre-, intra-, and postoperative). Inspection of Table 3 suggests that communication and leadership were scored lower than the other three behaviors. As with the task completion rates, this pattern is similar to the one we obtained for general surgical procedures, in which communication and leadership received the lowest scores, followed by monitoring, coordination, and cooperation [18].

We submitted these scores to a 3 × 3 × 5 mixed model ANOVA, with subteam (anesthetists vs. nurses vs. surgeons) as a between-subjects factor and phase (preop vs. intraop vs. postop) and behavior (communication vs. coordination vs. leadership vs. monitoring vs. cooperation) as within-subjects factors. The analysis yielded main effects for phase [$F(2, 256) = 3.37$, $p < 0.05$]; behavior [$F(4, 512) = 110.41$, $p < 0.001$]; and interactions between behavior and subteam [$F(8, 536) = 2.13$, $p < 0.05$] and between behavior, subteam, and phase [$F(16, 1072) = 1.94$, $p < 0.05$]. In the presence of these interactions, we further analyzed the data within each subteam.

In anesthetists, the analysis revealed an effect of behavior [$F(4, 160) = 32.35$, $p < 0.001$]. Post hoc pairwise comparisons of the five behaviors in this group revealed, most notably, that anesthetists scored highest on cooperation and lowest on communication. In nurses, the analysis revealed a similar pattern. In this group, too, we obtained a significant effect of behavior [$F(4, 176) = 56.55$, $p < 0.001$]. The nurses' scores were highest on cooperation, followed by monitoring and coordination. Finally, the nurses scored lowest on communication (as did the anesthetists) and on leadership.

In the surgical group the results were somewhat more complex. We did obtain an effect of behavior [$F(4, 176) = 28.87$, $p < 0.001$], such that communication scores were the lowest and cooperation scores were consistently high. These findings replicate those in the anesthetist and nursing groups. However, we also found an effect of phase [$F(2, 92) = 8.54$, $p < 0.001$], such that surgeons' scores were significantly lower in the postoperative phase than in the preoperative phase ($p < 0.01$) or in the intraoperative phase ($p < 0.001$). In addition to these two main effects, we obtained an interaction between behavior and phase [$F(8, 368) = 3.31$, $p < 0.01$]. Further analyses of this interaction (one-way ANOVAs for each of the behaviors with phase as a within-subjects factor) revealed that surgeons' communication, monitoring and leadership were rated higher in the preoperative and intraoperative phases than in the postoperative phase. Cooperation scores in this group also dropped significantly from the intraoperative phase to the postoperative phase. Coordination was not significantly different across phases.

Taken together, these results suggest that all three subteams of the operating theaters that we observed scored lowest on communication and highest on cooperation. Whereas in anesthetists and nurses this pattern can be generalized across operative phases, surgeons showed more

Table 3 Mean ratings of teamwork-related behaviors across phases and staff specialties

Phase	Communication	Coordination	Leadership	Monitoring	Cooperation
Anesthetists					
Preop	$4.73^a \pm 0.81$	$5.42^b \pm 0.87$	$4.93^a \pm 0.79$	$5.42^b \pm 0.92$	$5.76^c \pm 0.54$
Intraop	$4.81^a \pm 0.84$	$5.49^b \pm 0.84$	$4.95^a \pm 0.95$	$5.15^b \pm 1.11$	$5.76^c \pm 0.49$
Postop	$4.76^a \pm 0.94$	$5.29^b \pm 1.21$	$4.89^a \pm 1.00$	$5.32^b \pm 1.19$	$5.59^c \pm 0.77$
Nurses					
Preop	$4.73^a \pm 0.81$	$5.22^b \pm 1.06$	$4.69^a \pm 0.90$	$5.29^b \pm 1.14$	$5.60^c \pm 0.78$
Intraop	$4.40^a \pm 0.94$	$4.86^b \pm 1.28$	$4.47^a \pm 1.06$	$4.91^b \pm 1.22$	$5.49^c \pm 0.90$
Postop	$4.56^a \pm 0.94$	$5.07^b \pm 1.37$	$4.57^a \pm 1.14$	$5.09^b \pm 1.33$	$5.47^c \pm 0.87$
Surgeons					
Preop	$4.89^a \pm 0.94$	$5.42^b \pm 1.01$	$5.18^c \pm 0.81$	$5.51^b \pm 0.92$	$5.53^d \pm 0.89$
Intraop	$4.87^a \pm 0.92$	$5.58^b \pm 0.78$	$5.16^c \pm 0.71$	$5.58^b \pm 0.69$	$5.71^d \pm 0.63$
Postop	$4.58^a \pm 0.92$	$5.22^b \pm 1.22$	$4.61^c \pm 1.05$	$4.96^b \pm 1.33$	$5.36^d \pm 1.03$

Note: means not sharing the same superscript *within a row* differ at $p < 0.05$. For Anaesthetists and Nurses, the table summarises all the significant differences across behaviours and phases. For Surgeons, these findings are supplemented by those described on section 2 of the results complex behaviors. With the exception of coordination, surgeons tended to obtain higher scores in the beginning stages than in the ending stages of the observed procedures.

Interobserver reliability in the rating of behaviors Two of the authors (N.S., A.N.H.) with backgrounds in behavioral research and with adequate exposure to the operating theater environment (N.S. > 40 procedures; A.H. > 80 procedures at the time of the study) observed jointly six urology operations and provided a total of 45 ratings each per procedure (5 behaviors × 3 specialties × 3 operating phases). Table 4 presents Pearson correlation coefficients (r) between the behavior ratings of the two observers. The meaningful correlations for our purposes here are the ones on the main diagonal of Table 4 (in boldface). We obtained significant and sizeable correlations (i.e., $r > 0.50$) for all behaviors except communication, for which the obtained correlation was positive but lower ($r = 0.35$). These findings indicate overall adequate agreement between the two observers in the assessment of the behaviors.

Discussion

The research we report here aimed to accomplish three goals. We set out to refine the OTAS, to assess its reliability, and to replicate the observational assessment that we developed in general surgery procedures and apply it to another specialty. These aims were accomplished. We replicated the assessment in a different surgical specialty and using a refined version of the OTAS. Urology was chosen because it is a specialty that poses a number of challenges to operating theater professionals' team-working skills. In addition to the usual interactions, urologic procedures often require input from other members. This adds a layer of complexity to the task of coordinating, leading, and communicating adequately in urology operating theater teams. Our observational assessment showed that, overall, team-working in the urology teams that we observed was of adequate standards. Most of the teamwork-related tasks were performed. Likewise, the behaviors were scored relatively high.

More detailed examination of the findings, however, reveals some reasons for concern. A number of communication and equipment/provisions tasks were not routinely performed in the operations we observed. Simply put, this means that, at times, equipment was left unchecked or there was minimal communication between surgeons and anesthetists. These findings were complemented by our behavioral ratings. Anesthetists obtained their lowest scores on communication behaviors. Likewise, nurses scored low on both communication and leadership. Surgeons, as a group, demonstrated a more complex pattern in their behaviors. Although surgeons also obtained their lowest scores on communications (as did the other two subteams), their scores also deteriorated as the procedures were approaching their end. This pattern affected all of the surgeons' behaviors, except coordination with other team members.

These findings provide some insights in to how members of surgical teams work together. In the light of these findings, some would perhaps argue that little leadership or perhaps overt communication should be expected in routine procedures such as those that we observed. However, adequate communication and leadership behaviors are certainly needed when a crisis arises—although in current practice an expectation seems to exist that these behaviors will somehow ''occur'' when needed. These findings are exacerbated in the surgical subteam. Surgeons received lower scores toward the end of the procedures simply because they often left immediately after suturing the patient. More senior surgeons sometimes left the operating theater when a critical step in the procedure had been performed and their junior colleagues were left with the task of finishing off. As a result of this practice, the nurses were the

Table 4 Intercorrelation matrix of the psychologist observers' behaviour ratings

Observer 1	Observer 2				
	Communication	Coordination	Cooperation	Leadership	Monitoring
Communication	**0.35***	0.29*	0.43**	0.39**	0.42**
Coordination	0.72***	**0.72*****	0.82***	0.75***	0.81***
Cooperation	0.57***	0.49***	**0.64*****	0.52***	0.55***
Leadership	0.59***	0.53***	0.69***	0.**62*****	0.58***
Monitoring	0.43**	0.42**	0.56***	0.46**	**0.53*****

Note: The significance levels for the tabulated correlations are as follows: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$. All numbers (N) = 51 (Observing three subteams in three stages in six procedures gives $N = 54$. However, one procedure was done with local anesthesia; hence there was no anesthesia team to observe in any of the three stages.).

The relevant correlations are those in the main diagonal (in **boldface**). The remaining indices represent correlations between different behaviors as rated by the two observers (e.g., observer 1's rating of communication correlated with observer 2's ratings of Leadership and so on). These indices are not relevant to this study sole group coordinating the flow of cases during the day and, to both the surgeon and the psychologist observer's eyes, operating theaters often appeared chaotic. It is not unreasonable to explain the nurses' comparatively low leadership scores as a result of their increased preoccupation with the state of the operating theater.

A clear purpose of a teamwork assessment in operating theaters is to identify possible areas of concern and then implement changes to address the problems. In terms of implementation of interventions to improve teamwork, several possibilities arise from our findings. We found that during the preoperative phase equipment often goes unchecked, although there is time to do the checks. Introducing clear guidelines and protocols similar to those mandating the checking of name bands could address this problem. Checking practices could also be improved via the introduction of aviation-type equipment checklists and operating theater team briefings at the beginning of the daily operating list. A preoperative checklist has already been suggested by Lingard et al. [23] that aims to systematize preoperative communication among operating theater staff. After implementation, such interventions should be closely monitored to ensure that they enhance teamwork and surgical processes. Moreover, possible resistance to the introduction of checklists and briefings should be assessed. It may be awhile until a culture shift occurs in surgery and these interventions are seen as a routine part of the day-to-day teamwork and training of junior staff.

Finally, having established the reliability of the behavioral assessment, we are now in the process of designing a series of studies to follow up our existing work. This is the first reliability analysis of OTAS; and although communication achieved a relatively lower reliability score, more studies are needed to evaluate the reasons for this. First, the communication scale is currently being revisited and revised, especially because communication tasks in the checklist were consistently less likely to be carried out than other types of task by theater staff. Less clear anchors and exemplars in communication than in the other behaviors may have caused this greater discrepancy—hence the revision. Moreover, we aim to assess the usefulness and acceptability of using video recordings instead of human observers in the OTAS assessment.

In this study most of the procedures were considered routine surgery, and there may be differences in team work in more complex procedures such as radical cystectomy and even robotic surgery. However, as with all scientific approaches, there is a need to clarify how a tool performs in a simpler environment before moving on to using it in a more complex one. Therefore, we aim to test the applicability of the OTAS assessment in complex surgery, crisis scenarios, and emergency surgery. It is likely that crisis situations require further refinement or a different version of the assessment to capture teamwork effectively. Even though the OTAS is still in development, the empirical findings suggest that it can provide useful guidance for the assessment of teamwork in surgical teams and for the implementation of team-training programs for surgery.

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Appendix

Communication in the OTAS Assessment. The behavior is assessed on the seven-point behaviorally anchored scale below. The attached exemplars and the demonstrative scenarios aid the observer in allocating a score to each subteam in the operating theater.

SUMMARY SCALE

6 The team exchanged information proactively and politely. Case-specific communication was clearly audible and well articulated. The team made a concerted and consistent effort to maintain open communication to fulfile teamwork.

Team communication was highly effective in enhancing teamwork.

5 High level of enhancement to teamwork through communication.

4 Moderate enhancement to teamwork through communication.

3 Case-specific communication was acceptable, although members did sometimes seek clarification. The manner and effort of communication was reasonable. Team communication neither hindered nor enhanced team work.

Team communication neither enhanced nor hindered teamwork.

2 Slight detriment to teamwork through communication.

1 Teamwork compromised through poor communication.

0 The team did not communicate appropriately. Case-specific communication was unclear, and members consistently sought clarification and repeats or did not ask for clarification. The manner of communication was negative and unacceptable. This team had a problem communicating openly. Overall, the function of this team was hindered by poor communication.

Team communication severely hindered teamwork.

EXEMPLAR BEHAVIORS

Anesthetists (A)	Nurses (N)	Surgeons (S)
Pre-operative Stage		
• Updates theater manager on any changes to case list	• Scrub nurse mediates progress of case through proactive communication	• Changes in the operation or case list communicated to all concerned
• Confirms patient details and condition with patient and informs N	• Confirms patient-specific requirements with A and S	• S talks to team and encourages communication from subteams
• Verbal communication to theater team on patient transfer and setup	• Communicate any problems regarding setup, provisions and staffing to team	• Verbal confirmation of procedure and intraop requirements
Intra-operative Stage		
• Asks surgeons if patient positioning is OK	• (SN) repeats surgeon's requests, confirming requirements	• Asks team if all are prepared to begin the operation
• Provides update on patient condition and anything administered to patient		• Asks A if ready to start the operation
• A inquires about operation and patient progress	• SN provides clear and audible requests for provisions to (CN)	• Requests and instructions to team communicated clearly and effectively
	• Swabs, needles, and instruments count confirmed verbally between CN and SN	• Provides information to whole team on progress
		• S informs the team of technical difficulties and/or changes of plan
		• S informs A of bleeding
Post-operative Stage		
• A instructs team on patient transfer to trolley	• Provides information concerning surgical procedure and patient condition to recovery nurses	• Informs and instructs team on any new patient requirements
• Asks team if ready to transfer patient and instructs on process		• Comments on work done in this case
• Information on patient condition and drugs provided to recovery nurse	• Recovery nurse confirms information transferred from theater team	
• A informs S about special needs for analgesia	• Ensures that patient documents are with patient in recovery	

DEMONSTRATIVE SCENARIOS RELATED TO SUMMARY SCALE

6 Surgeon explains clearly and audibly the steps of the operation to assistant and team throughout the procedure. Clear and audible instructions of Anaesthetist to the team regarding the latest blood gas report and that he/she will be giving the patient 2 units of blood. Scrub nurse is aware and informs the team that the circulating nurse is new and provides clear instructions about the location and type of instruments required.

3 Surgeon mostly busy operating but communicates effectively with scrub nurse when asked about progress explaining that he/she will be resecting the bowel and will need a staple gun. Anesthetist not volunteering patient management information but is polite and clear when asked by the surgeon and explains that she has given muscle relaxant that will last 20 minutes. When Anaesthetist reminds surgeon about requirements for local infiltration of anesthetic to the wound, scrub nurse communicates with anesthetist about amount of local anesthetic to be infiltrated before closure.

0 Inquiry by surgeon about cardiovascular status of patient met with hostile comments from anesthetist about inadequacy of patient preparation. Surgeon entirely uncommunicative, simply holding out hand when instrument is required and dropping it if scrub nurse guesses incorrectly. Scrub nurse chatting loudly to circulating nurse about matters unrelated to the operation while surgeon and assistant request instruments from her.

References

1. Vincent C, Moorthy K, Sarker SK, et al. (2004) Systems approaches to surgical quality and safety: from concept to measurement. Ann Surg 239:475–482
2. Calland JF, Guerlain S, Adams RB, et al. (2002) A systems approach to surgical safety. Surg Endosc 16:1005–1014
3. Healey AN, Sevdalis N, Vincent C (2006) Measuring intra-operative interference from distraction and interruption observed in the operating theater. Ergonomics 49:589–604
4. Lingard L, Garwood S, Poenaru D (2004) Tensions influencing operating room team function: does institutional context make a difference. Med Educ 38:691–699
5. Lingard L, Reznick R, Espin S, et al. (2002) Team communications in the operating room: talk patterns, sites of tension, and implications for novices. Acad Med 77:232–237
6. Lingard L, Espin S, Whyte S, et al. (2004) Communication failures in the operating room: an observational classification of recurrent types and effects. Qual Saf Health Care 13:330–334

7. Sevdalis N, Healey AN, Vincent C (2007) Distracting communications in the operating theater. J Eval Clin Pract (in press)
8. Kohn LT, Corrigan JM, Donaldson MS (1999) To Err Is Human: Building a Safer Health System. Washington DC, Institute of Medicine, National Academies Press
9. Miller LA (2005) Patient safety and teamwork in perinatal care: resources for clinicians. J Perinat Neonat Nurs 19:46–51
10. Thomas EJ, Sexton JB, Lasky RE, et al. (2006) Teamwork and quality during neonatal care in the delivery room. J Perinatol 26:163–169
11. Morey JC, Simon R, Jay GD, et al. (2002) Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project. Health Serv Res 37:1553–1581
12. Risser DT, Rice MM, Salisbury ML, et al. (1999) The potential for improved teamwork to reduce medical errors in the emergency department: the MedTeams Research Consortium. Ann Emerg Med 34:373–383
13. Sherwood G, Thomas E, Bennett DS, et al. (2002) A teamwork model to promote patient safety in critical care. Crit Care Nurs Clin North Am 14:333–340
14. Undre S, Sevdalis N, Healey AN, et al. (2006) Teamwork in the operating theater: cohesion or confusion? J Eval Clin Pract 12:182–189
15. Makary MA, Sexton JB, Freischlag JA, et al. (2006) Operating room teamwork among physicians and nurses: teamwork in the eye of the beholder. J Am Coll Surg 202:746–752
16. Flin R, Yule S, McKenzie L, et al. (2006) Attitudes to teamwork and safety in the operating theater. Surgeon 4:145–151
17. Flin R, Fletcher G, McGeorge P, et al. (2003) Anesthetists' attitudes to teamwork and safety. Anesthesia 58:233–242
18. Undre S, Healey AN, Darzi A, et al. (2006) Observational assessment of surgical teamwork: a feasibility study. World J Surg 30:1774–1783
19. Healey AN, Undre S, Sevdalis N, et al. (2006) The complexity of measuring interprofessional teamwork in the operating theater. J Interprof Care 20:485–495
20. Healey AN, Undre S, Vincent CA (2004) Developing observational measures of performance in surgical teams. Qual Saf Health Care 13(Suppl 1):i33–i40
21. Rao AR, Hudd C, Laniado M, et al. (2005) Left or right, get it right! BJU Int 95(s5):95
22. Coxon JP, Pattison SH, Parks JW, et al. (2003) Reducing human error in urology: lessons from aviation. BJU Int 91:1–3
23. Lingard L, Espin S, Rubin B, et al. (2005) Getting teams to talk: development and pilot implementation of a checklist to promote interprofessional communication in the OR. Qual Saf Health Care 14:340–346