Quantifying surgeon’s contribution to team effectiveness on a mixed team with a junior surgeon

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Background. A surgical team often consists of an experienced surgeon and surgeons in training. This project quantified the contribution of the experienced surgeon to the teamwork in a team comprised of 1 experienced and 1 novice surgeon (Mixed Team).

Methods. An experienced and a novice surgeon in a Mixed Team were required to complete a peg transportation task and an intracorporeal suture task collaboratively. Tasks were evaluated by a summative score (up to 100 points) that was calculated on task speed and accuracy. Performances of 24 Mixed Teams were compared to 24 Novice Teams (each composed of 2 novices) and 8 Expert Teams (each composed of 2 experienced surgeons).

Results. The Mixed Teams performed better (67.6 points) than the Novice Teams (51.3; P < .001) but worse than the Expert Teams (88.3; P < .001). When examining individual performance in the Mixed Teams, we observed that experienced surgeons maintained their superior performance like they did in the Expert Teams (P = .153). Novices in the Mixed Teams, however, showed markedly better performances than they did in the Novice Teams (P = .024).

Conclusion. Instant guidance and instruction from experienced surgeons inspire novices’ performance, providing a foundation for surgical teamwork effectiveness. (Surgery 2011;149:761-5.)

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In the operating room (OR), a surgical team often includes an experienced surgeon and an assistant surgeon who is completing his or her fellowship or residency training. We recently published a survey demonstrating that 1 surgeon/1 assistant teams comprise 60% of surgical teams that perform laparoscopic procedures. This type of team composition also is commonly found in other surgical specialties.

Obviously, surgeons’ responsibilities in such mixed teams are not equally distributed. The primary surgeon in the team has the responsibility to generate a clear surgical goal and develop a realistic strategy to ensure the goal is achieved without jeopardizing patient safety. When working with a surgeon-in-training, the primary surgeons also must provide sufficient learning opportunities for the junior surgeons to improve their surgical skills.

In addition, when the assistants are practicing tasks, the primary surgeons needs to maintain vigilance, preparing for any unexpected events that might occur in the OR and assuring the safety of the patient. Although such team support activities are carried out in the OR on a daily basis, the contribution of the experienced surgeon to the effectiveness of the teamwork is seldom quantified.

In this study, we deliberately created a number of Mixed Teams. Each mixed team was composed of an experienced surgeon and a novice with minimal surgical experience. The performances of Mixed Teams were compared to Novice Teams (composed of 2 members with minimal surgical experience) and Expert Teams (composed of 2 surgeons who had performed numerous laparoscopic procedures) in a simulated environment. In addition to the overall teamwork performance, we also examined the individual performances of members in each type of team.

Explicitly, the novices’ performance in Mixed Teams and Novice Teams were compared, and
the experts’ performance in Mixed Teams and Expert Teams was analyzed in a similar fashion. In this way, we could scrutinize the contribution of leadership brought by the experienced surgeon to the teamwork effectiveness and examine the impact of teaching on individual performance.

We undertook this study to prove 2 hypotheses. First, the mean team performance score earned by the Mixed Teams will be greater than the Novice Teams but lesser than the Expert Teams. Second, the individual performances of novices when participating in Mixed Teams will be better than their performances when they are members of Novice Teams and, in the same way, the individual performances of experts in Mixed Teams will be worse than their performances in Expert Teams.

METHODS

Participants and teams. We assembled 2-member surgical teams using participants with variable surgical and laparoscopic experiences that ranged from attending surgeons, laparoscopic fellows, surgical residents, medical students, and nursing students to surgical researchers and office staff. Surgical and laparoscopic experience, level of training, and demographics were obtained from a pretest questionnaire. Ethics approval was obtained from the Legacy Health System Institutional Review Board, where the study was conducted.

We assembled 24 Novice Teams and 8 Expert Teams. Novice Teams included medical students, nursing students, research and office staff, and junior residents (postgraduate year [PGY] 1 and 2). Junior residents had been involved with less than 20 laparoscopic surgeries and the remaining novices had not performed or assisted in any laparoscopic surgery. Expert Teams included attending surgeons, laparoscopic fellows, and PGY4 and PGY5 surgical residents. As a prerequisite, a surgeon placed in an Expert Team must have performed more than 100 laparoscopic procedures. When forming a Mixed Team, 1 participant from the novice group was selected to work with an expert to perform the same task. A total of 24 Mixed Teams were formed.

Surgical experience score of a team. The surgical experience score was calculated for each team by averaging the surgical and laparoscopic training experiences of 2 team members in each team as follows:

\[
\text{Team score} = \frac{(\text{individual score A} + \text{individual score B})}{2}.
\]

For each team member, the individual laparoscopic experience score was calculated based on years of surgical training and the number of laparoscopic cases performed. To help gauge individual experience, a list of 12 surgical procedures was created that included both surgeries that the individual had performed and surgeries in which the individual had assisted. The frequency for performing each procedure was rated on a 5-point scale.

In some cases, a single expert might have been assigned to different surgical teams, and so performed the simulation task more than once. The repeated use of experts in different teams was necessary because a relatively small number of experienced surgeons could be recruited. When an expert was assigned to a new team, 1 point was added to their experience score to reflect the experience gained by working with a previous team. Whether the expert performed first in a Mixed Team or an Expert Team was counterbalanced to avoid possible bias in task performance between the 2 groups.

The calculation used to score individuals was as follows:

\[
\text{Individual score} = \frac{[(\text{Sum of laparoscopic procedure performed} + \text{year of surgery} + \text{trials in team simulator})/150]}{100}.
\]

A denominator of 150 was chosen to normalize the individual score to a scale of 100. Basically, the surgical experience scores for each team were calculated by adding team members’ individual experiences in performing laparoscopic procedures, their years of working on both general and laparoscopic surgery, and the number of team simulation trials they performed in this study.

Apparatus. A benchtop simulator was built to allow 2 surgeons to work together as a laparoscopic team. The training box used in this study was modified from an old laparoscopic training box (LapTrainer; Ethicon Endo-Surgery Inc, Cincinnati, OH). The rigid, plastic cover of the training box was replaced with a piece of soft, synthetic fabric (Tissue Model; Simulab Corp, Seattle, WA), so that its appearance looked more like real human skin. Through this soft skin, 4 trocars were placed to providing entry ports for the insertion of 1 laparoscope and 3 laparoscopic instruments into the training box.

Tasks. A team of 2 surgeons were required to perform 2 laparoscopic team exercises. The exercises carried out by the surgeons using the same training box have been described previously in our validity study for LISETT, the Legacy Inanimate Surgery June 2011
The accuracy of a team’s performance was evaluated with penalty scores, which were calculated differently for each of the 2 exercises. For the peg transportation exercise, the penalty score was calculated by adding the number of times that the object fell off the instruments and the number of times the object went outside of the field of laparoscope’s view.

The penalty score for the suturing exercise was measured with the following criteria: (1) the number of times that the suturing site went outside of the view of the laparoscope, (2) the deviation (measured in millimeters) of the suture from the pre-marked dots, and (3) the security of the knot that was tied. A secure knot meant zero penalties, a slipping knot meant the team received a 10-second penalty, and a lost knot netted the team a 20-second penalty. This system for scoring knot security is similar to the McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS) scoring system for suture quality described by Derossis and colleagues.

Once an exercise was completed, a raw exercise score was obtained by subtracting the penalty score from the timing score. The raw scores were then normalized into 100 by dividing the raw scores by the best scores. In this study, the best scores were defined as the scores obtained from the performance of 6 experienced surgeons, which were equal to the group mean plus 2 standard deviations. In other words, the best scores used to normalize the raw scores for the 2 tasks were 267 and 404 for the peg transportation and suturing, respectively, which were calculated as follows:

\[
(1) \text{Normalized peg transportation score} = \frac{\text{Raw peg transportation score}}{267} \times 100
\]

and

\[
(2) \text{Normalized suturing score} = \frac{\text{Raw suturing score}}{404} \times 100.
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The individual scores then were calculated by averaging the normalized peg transportation score and the normalized suturing score as follows:

\[
\text{Individual score} = \frac{(\text{Normalized peg transportation score} + \text{Normalized suturing score})}{2}.
\]

Once the individual scores of 2 team members on the same team were calculated, their team’s score was obtained by averaging the 2 individual scores as follows:
LISETT Team score = \left( \frac{\text{Normalized individual score } 1 + \text{Normalized individual score } 2}{2} \right)

As a result, the more accurately and quickly a task was completed by each team member, the greater were the individual and team scores.

A multivariance analysis (1-way analysis of variance [ANOVA]) on the individual scores and team scores was used to test the performance difference among different team compositions. A P value < .05 was considered significant. Results are reported as mean ± standard deviation unless otherwise stated.

RESULTS

The results revealed differences among team compositions (P < .001; Fig 1). Post hoc analysis revealed that group differences were notable between the Novice and the Mixed teams (Novice Team = 51.3 ± 16.0; Mixed Team = 67.6 ± 12.0; P < .001) and between the Mixed and the Expert teams (Mixed Team = 67.6 ± 12.0; Expert Team = 88.3 ± 4.5; P < .001).

The most interesting result came from analyzing the differences in individual performances that varied according to type of team (Fig 2). The Novices in Mixed teams performed significantly better than they did in Novice Teams (59.9 ± 20.4 vs 48.5 ± 19.3; P = .024). The improvement in performance was directly attributed to the guidance from the expert in the Mixed Team. A previous study showed that such instant feedback and coaching was nonexistent or insufficient when a novice was working with another inexperienced partner.

In contrast, experts working in Mixed teams showed decreased performances when working with an inexperienced partner compared to working with another expert. This decrease in task performance, however, was not statistically significant (87.4 ± 6.8 vs 83.2 ± 10.0; P = .153).

DISCUSSION

The results from the Mixed teams provide data that demonstrate the important contribution to teamwork efficiency made by experienced surgeons. In Mixed teams, novice team members had an invaluable opportunity to work with experienced surgeons who provided instant guidance to the junior surgeons. For example, an analysis of verbal communication during tasks performed by Mixed teams, we observed verbal communications between team members that consisted of short and direct instructions, instant correction of errors, positive encouragement, and constructive feedback. All of these efforts translate into better performance within and by a Mixed Team as opposed to a team comprised only of novices.

However, teaching a surgeon-in-training is not without its costs in regard to overall team performance. In this study, we observed that expert surgeons sacrificed their individual performance slightly to provide support to the novice in a team. The decrease in performance (5%) was not statistically significant, but it was observable. Our results echo the findings in clinical settings in which teaching residents during operative procedures markedly prolongs operative time in general, the duration of time a patient spends under anesthesia, and the duration of orthopedic operative procedures. If this is an inevitable cost for surgical education in the OR, we believe that simulations can be a useful tool for training surgical teams outside the OR and help minimize the cost for training in the OR.
Instead of using precious time in the OR to build basic team skills, working with simulators for a period of time can help team members overcome the barriers to effective team communication and cooperation. Simulation team training allows team members to construct common mental cognitive models and synchronize their movements. Team skills, such as interpersonal communication, cooperation, and decision-making skills, are transferable to the OR when practiced in a relevant simulation environment. In this sense, surgical training using simulation should have a direct impact by decreasing the OR times of surgical teams composed of expert and novice surgeons.

One of the limitations of this study was that the simulation model used could train only 2 surgeons at the same time. As such, the model and subsequent training could not represent a real surgical team in the OR, which includes nurses and anesthesiologists. In the future, we plan to build an entire surgical team in the simulation environment, and quantify the impact of team leadership on the team’s performance with more complex operative procedures.

REFERENCES