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Stress training for the surgical resident

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Abstract

BACKGROUND: Much effort in surgical education is placed on the development of clinical judgment and technical proficiency. However, little focus is placed on the management of stress associated with surgical performance. The inability to manage stress may lead to poor patient care, attrition from residency, and surgeon burnout.

METHODS: A blinded, matched, comparison group study to evaluate the efficacy of an educational program designed to improve surgical resident performance during stressful scenarios was conducted. The experimental group (n = 11) participated in stress training sessions, whereas the control group (n = 15) did not. Both groups then completed a simulation during which stress was evaluated using objective and subjective measures, and resident performance was graded using a standardized checklist.

RESULTS: Performance checklist scores were 5% higher in the experimental group than the control group (P = .54). No change existed in anxiety state according to the State Trait Anxiety Inventory (P = .34) or in heart rate under stress (P = .17) between groups.

CONCLUSIONS: There was a trend toward improved performance scoring but no difference in anxiety levels after stress training. However, 91% of residents rated the stress training as valuable.

Surgical residency introduces the surgeon in training to many of the habits they will maintain for their career. Education in surgical residency has traditionally focused on the development of clinical judgment and technical skills. In its recent evolution, surgical education has directed attention to issues such as duty hour regulations, escalation of responsibility, and appropriate supervision.[1] However, little, if any, focus is placed on management of the inevitable stress associated with surgical performance.[2]

Although moderate stress has been associated with improvements in technical skill in the examination setting, the deleterious effects of excessive stress on surgical performance are well established.[3–5] Stress is also recognized as a factor affecting performance in other high-stress, high-stakes professions and has led to the development and implementation of successful stress management techniques in these fields.[6–9] Stress negatively impacts both technical and cognitive intraoperative performance, and recent literature has focused on the coping strategies developed by surgeons.[10,11] Data indicate that preparation for the unexpected along with the development and daily integration of stress management techniques leads to a more reliable performance in high-stress situations.[12]

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A reproducible educational strategy is needed to bridge the gap that exists between the expectation that residents and practicing surgeons will respond to stress-provoking situations in a calm, purposeful manner and the fact that there is no standardized method for training them to do so.[13] Based on programs successfully implemented in aviation, sport psychology, the military, and, more recently, in surgical training, we developed a stress training program for surgical residents at Temple University Hospital, Philadelphia, PA.[9,14–16] Mental practice as a strategy has been used with success in the training of novice surgeons in the laparoscopic setting.[17] In addition to mental practice, or visualization, our project focused on instruction and testing of the efficacy of stress management techniques including relaxation, focus, and positive self-talk. The aim of this study was to show that instruction in and the implementation of basic stress management techniques lead to a reduction of stress, which, in turn, leads to improved technical performance during peak stress scenarios for surgical residents.

Methods

Overview

A blinded, matched, comparison group study aimed to evaluate the efficacy of an educational program designed to improve surgical resident performance during stressful scenarios was conducted. Resident subjects were assigned to the experimental or control group and were then studied in a prospective, blinded fashion in which the treatment group first underwent stress management training education, whereas the control group did not. Both groups then completed a high-stress simulated patient care module during which subjective and objective measures of stress were obtained (Fig. 1).

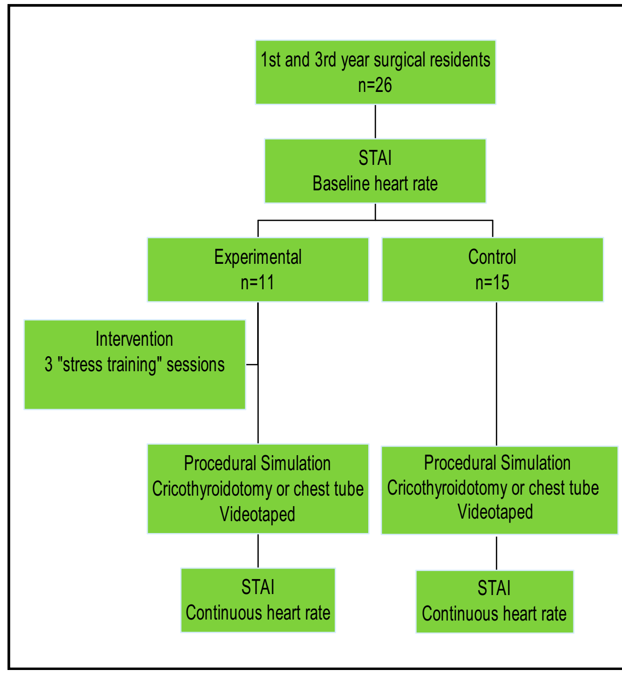

Figure 1 A graphic representation of the study design.

Subjects

Between January 2011 and May 2011, 20 first- and 6 third-year surgical residents were assigned to the experimental or control group. Resident service obligations and demographic information informed the selection. The groups were matched for post-graduate year, sex, and designation as preliminary or categoric residents. The exclusion criterion was participation in the study design (Fig. 2).

After institutional review board approval and informed consent from subjects were obtained, the State Trait Anxiety Inventory (STAI), a 40-item, validated measure of generalized and procedural stress requiring less than 5 minutes for completion and used widely in educational research, was administered to all 1st- and 3rd-year surgical residents to assess baseline stress level.[18]

Intervention

A recent article by Arora et al[4] identified stress recognition, understanding the impact of stress on performance, the development of coping strategies, feedback, and a safe simulated practice environment as the key components to stress reduction intervention. The group, based at the Department of Surgery at Imperial College London, London, UK, acknowledged the lack of a current model for such training.

In collaboration with a sport psychologist specializing in the psychology of peak performance, we developed a combined didactic and experiential curriculum to fill this gap. The program took place over 3 consecutive Wednesdays with 3 hours per session. Nine total hours of stress training were conducted during protected, predesignated educational conference time and had a 3-part focus: (1) the identification of individual stress triggers; (2) the identification of individual stress management techniques used before stress training sessions and instruction in 4 specific skills; and (3) the application of these techniques to surgical situations.

	Experimental	Control	p value
Demographics			
Post graduate year	Junior: 3 Intern: 8	Junior: 3 Intern: 12	n/a
Gender	M: 8, F: 3	M: 9, F: 6	n/a
Designation	Categorical: 6 Preliminary: 6	Categorical: 7 Preliminary: 8	n/a
Prior exposure to procedure tested Mean (range)	4.75 (1-12)	3.41 (0-7)	0.47
Post-simulation stress score Mean (range)	17.6 (10-23)	18.5 (11-25)	0.85
Baseline STAI Mean (range)	39.27 (27-53)	44.6 (25-68)	n/a
Post-simulation STAI Mean (range)	45.27 (25-66)	45.2 (28-73)	n/a
Change in STAI over baseline			0.34
Baseline heart rate, BPM Mean (range)	73.2 (49-91)	74.7 (54-94)	n/a
Peak heart rate, BPM Mean (range)	123 (90-158)	117 (92-162)	n/a
Change in heart rate over baseline			0.17
Blinded OSATS checklist score Mean (range)	8.55 (7-10)	8.14 (5-10)	0.54
ANOVA (heart rate, STAI, stress score, OSATS scores)			0.15

Figure 2 The endpoint results summary table.

Week 1: identification of stress triggers

Residents were asked to identify situational, procedural, and interpersonal stressors in the workplace drawing from both personal experience and situations generated by more experienced surgeons. Discussion about both real and anticipated stressors was encouraged. Residents were guided through this didactic component in an effort to normalize the experience of stress in surgical residency.

Week 2: identification and instruction in stress management strategy

The 4 skills focused on during the stress training sessions were relaxation, focus, visualization, and positive self-talk, all of which have been described previously as skills used in high-performance fields including surgery.[19] Residents were introduced to the skills, coached in their application, and then instructed to integrate the techniques into stressors occurring in the coming week.

Week 3: application of stress management techniques

Discussion regarding the application of these 4 stress management techniques in the context of the preceding week was carried out. Residents were asked to discuss stress triggers, the technique applied to the stressor, and the challenges in application.

Simulated evaluation of stress training efficacy

After completion of the stress training sessions, residents from both the experimental and control groups were required to complete a high-stress simulation, which was chosen based on survey data revealing the most stressful clinical and procedural settings for our residents. Residents in the experimental group participated in this simulation between 2 and 4 weeks after the completion of the stress training program. All residents were required to view educational videos of 3 procedures (ie, chest tube placement, central line placement and cricothyroidotomy) before completion of the simulation to ensure uniformity in baseline procedural knowledge.

Before instruction about the simulation, baseline heart rates were obtained. STAI baselines had been obtained within the month preceding the simulations. All residents then received a standardized introduction to the purpose of the simulation, including information about the use of continuous heart rate monitoring and the presence of attending observers during the simulation. Heart rate monitors were applied, and residents individually completed the simulation after a scenario introduction.

First-year residents participated in a surgical intensive care unit simulation requiring the diagnosis of tension pneumothorax and chest tube placement. Third-year residents participated in a trauma simulation requiring the identification of a difficult airway and the performance of a cricothyroidotomy. Residents were videotaped either placing a chest tube or performing a cricothyroidotomy on the TraumaMan simulator (Simulab, Seattle, WA, USA).

Residents were then asked to self-evaluate using an Objective Structured Assessment of Technical Skill (OSATS) procedural checklist, a post-simulation STAI, and a stress scale to capture subjective stress. Debriefs were conducted immediately after the simulation with the attending observer. Videotaped procedures were then sent to blinded expert reviewers at Thomas Jefferson University, Philadelphia, PA. Performance was assessed by using an 11-point OSATS checklist evaluating the technical accuracy of the procedure (Fig. 3).

Data analysis

Participant blinding was conducted by the research administrators who were not involved in the data analysis. All surveys, including the STAI, OSATS procedural checklist, and post-simulation self-evaluation, and heart rate readings were reassigned the blinded number before data analysis.

Resident participant stress and performance were evaluated in 3 ways. First, residents evaluated themselves using a subjective stress scale and OSATS procedural accuracy checklist after the simulation. Second, blinded expert faculty evaluated participant procedural accuracy using a procedure-specific OSATS checklist. Procedural checklists or OSATS tools have become a standard tool for performance evaluation of specific procedures.[20] Third, the resident physiologic stress level was measured by monitoring heart rate during the procedural performance.

Data were analyzed using the "intent-to-treat" principle. The checking and assessment of the data were performed in a blinded fashion. The code for the groups was not broken until the completion of the statistical analysis.

The continuous measurements of stress (physiologic variables, ie, heart rate) were tested for normality using the Shapiro-Wilk test. If continuous measurements failed the test for normality, the Wilcoxon rank sum test was used to assess between-group differences. If continuous measurements were normally distributed, an independent *t* test was used to compare group differences. Changes in heart rate before and after training were assessed using an independent *t* test. Multivariate analysis of variance was performed to detect group differences in a combined variable including changes in heart rate, state, stress scale, and 3 OSATS surveys (ie, self, blinded, and unblinded).

Outcomes measures

The primary dependent variables in the study are physiologic and survey measurements of stress. The primary endpoint was improved performance on the OSATS procedural checklist, and the secondary endpoint was a reduction

OSATS checklist

Chest Tube Insertion Checklist

Participant ID ____________

Date:__________

Evaluator Name
____

Start time
Diagnosis time
Procedure start time

	Correctly Performed	Incorrectly Performed
Sterile gown and gloves		
Identifies necessary materials for procedure		
Correctly identifies side for insertion		
Preps and drapes correctly		
Ant axillary line and nipple location used as landmarks		
Chest entered in a controlled way using hemostat or Kelly		
Pleural space swept for adhesions		
Chest tube mounted correctly on hemostat		
Chest tube directed apically		
Chest Tube sutured in place		
Chest tube connected to suction		

Correctly Performed 1 point
Incorrectly Performed 0 points

Total

Figure 3 The OSATS checklist used to evaluate the procedural performance of chest tube insertion.

in stress, which was objectively measured by heart rate variability and subjectively by the STAI state score.

Results

Performance

The blinded OSATS performance checklist score was 5% higher in the experimental group than in the control group ($P = .54$) (Fig. 2). Performance was evaluated on an 11-point checklist. The control group scored an average of 8.14 (range 5 to 10), whereas the experimental group scored an average of 8.54 (range 7 to 10). Interestingly, resident perception of performance was worse for the experimental group, with an average self-assessment score of 7.90 (range 6 to 10) versus a score of 8.53 (range 6 to 10) in the control group. Residents had equivalent prior exposure to the procedure (ie, chest tube placement or cricothyroidotomy) and identical presimulation education accomplished through the use of presimulation procedural video education modules (Fig. 2).

Stress

There was no change in anxiety state according to the STAI ($P = .34$) or in heart rate variability under stress ($P = .17$) between the groups (Fig. 4). In the control group, the STAI state anxiety scores were equivalent before and immediately after the simulation (44.6 vs 45.2). The scores for the experimental group increased after the training (39.3 vs 45.2). Heart rate increased significantly over baseline for both the control and experimental groups (average 45.8 beats/min), showing the physiologic stress of the simulation. However, heart rate variability was not significantly different between the 2 groups (control 42.5, experimental 50.3). Despite the absence of any statistically significant reduction in stress, 91% of residents who participated in the training sessions rated the sessions as valuable, and 100% rated the sessions as good, very good, or excellent.

Comments

Stress is inherent in surgical training and the practice of surgery. We developed a program designed to accelerate the learning curve for stress-reduction techniques in surgical residents. We then sought to prove that the implementation of these techniques would lead to improved technical performance in a novel clinical situation. We found that there was not a significant improvement in the technical performance score under stress for residents having

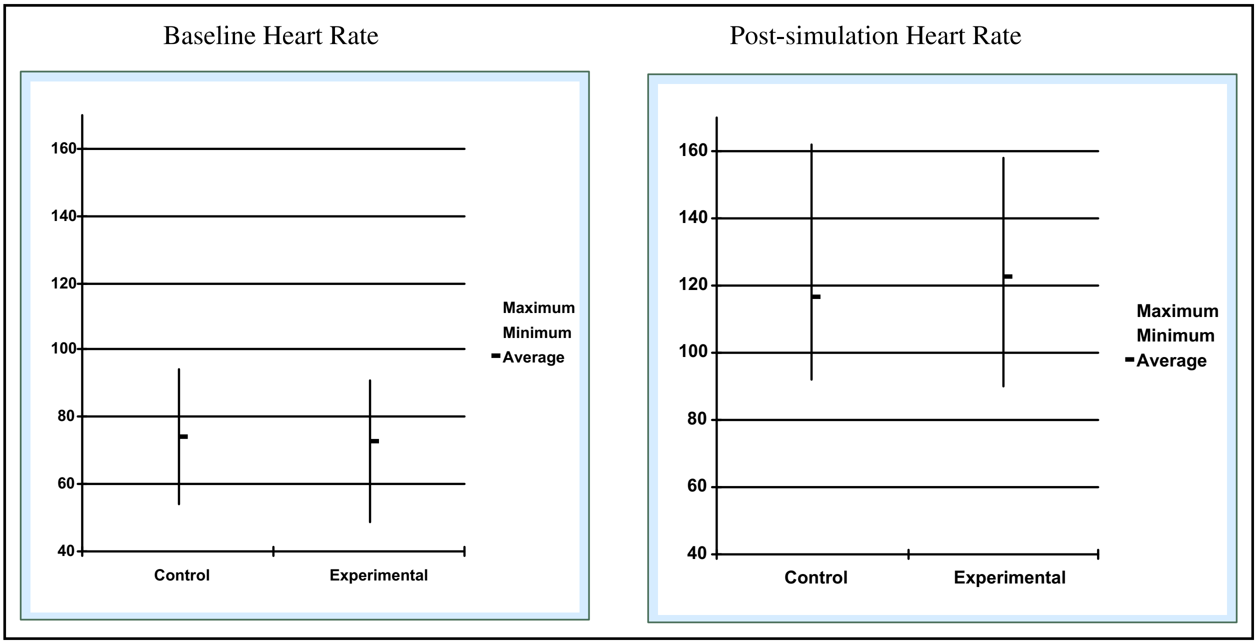

Figure 4 Heart rate comparison between the control and experimental groups showing physiologic stress of simulation.

completed the stress training program and no difference in stress level between the experimental and control groups.

Several studies looking at the use of stress management techniques in the context of specific surgical procedures have shown significant results.[17,23] We did not teach stress management techniques in the context of a single surgical procedure but rather as a skill set for broad application. Our stress training program was 9 hours of instruction and application, a significant educational time investment. However, the development of a global stress management skill set requires far more time. Integration of the stress management techniques introduced in this program into daily activity will be essential to resolve this issue. Evidence in sport psychology indicates that, for maximal benefit, techniques such as mental practice must be used 3 times per week.[21]

The increase in heart rate over baseline in both groups indicates the stress of the simulation. Failure to show any difference in either this outcome or that of subjective stress, as measured by the STAI, between the 2 groups could be a function of several factors. First, excessive stress of the scenario (ie, the simulation was so stressful that it overwhelmed the impact of the training) could explain the finding. Additionally, although the STAI is validated in the setting of education, it is not a tool specific to surgical education and therefore may not reflect the stress of the simulation.

There are a number of limitations to this study. First, the study design introduces allocation bias. Although resident cohorts were matched for training year, sex, and categoric or preliminary status and they were retrospectively found to be matched for prior experience and training with the tested technical skill, they were not randomized because of the time commitment of the training and conflict with service obligations, leading to allocation bias. Second, the pilot program revealed several flaws in the design of both the intervention and the testing. The curriculum is being revised to increase time allotted to experiential learning of the 4 stress management techniques. In order to maximize experimental group recall of the stress management techniques and their application, a brief stress training review will take place immediately before the simulation. Finally, our study is underpowered. In order to detect a 10% improvement in procedural performance in the experimental group, we need to accrue 127 residents per group. At our current accrual pace, this will occur at 5 years of data collection.

The measurements used to evaluate for stress are also imperfect. Although OSATS checklists are well-documented performance assessment tools, global ratings scales have superior concurrent validity, construct validity, and interstation reliability and will be used moving forward.[20] Heart rate has been validated as a physiologic measure of stress.[22] However, salivary cortisol will be added as a second and more specific physiologic measure of stress. The combination of the STAI, heart rate, and salivary cortisol has been documented as a validated stress measurement tool called the Imperial Stress Assessment Tool.[18]

Future research should focus on streamlining stress training curriculum including the development of curricular integration into everyday practice. Additionally, the study design should be modified to the randomization of subjects and include a manipulation check to reflect the effect of the stress training before completion of the program. Given the lack of a tool designed and validated for use in the detection of surgical stress, a modified STAI designed for this purpose must be developed. Finally, the accrual of additional subjects from collaborating residency programs is needed to appropriately power the data.

Conclusions

There was a trend toward improved performance scoring but no difference in anxiety levels after stress training in surgical residents. We think our detection of the impact of stress training will improve with adjustments in intervention and simulation design as described previously. Furthermore, the overwhelmingly positive resident response to the stress training sessions reinforces that there is a significant need in surgical training for this type of programming.

Effective management of the stress response leads to peak performance during surgical residency and beyond, whereas the inability to manage the stress associated with performance leads to poor patient care and outcomes, attrition from surgical residency programs, and surgeon burnout. In the era of "pay for performance" and in the face of a shrinking surgeon workforce, continued efforts to combat the untoward effects of excessive stress are necessary. In addition to other recently published and encouraging data by Wetzel et al,[23] we believe that stress training is a step in this direction.

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