Mastering Stress: Mental Skills and Emotional Regulation for Surgical Performance and Life

Short Title: Mastering Stress

Nicholas E. Anton, MS[a], nanton@iu.edu, Carter C. Lebares, MD, FACS[b], carter.lebares@ucsf.edu

Theoklitos Karipidis, MS[c], tkaripi@iu.edu

Dimitrios Stefanidis, Md, PhD, FACS, FASMBS, FSSH[a], dimstefa@iu.edu

a. Department of Surgery, Indiana University School of Medicine
545 Barnhill Dr., EH 125 Indianapolis, IN 46202 United States
b. Department of Surgery, University of California San Francisco
513 Parnassus Avenue, U-373, San Francisco, California 94143
c. Department of Counseling Psychology, Indiana University School of Education
201 N Rose Ave, ED 4000, Bloomington, IN 47405

Corresponding Author:

Nicholas E. Anton, MS
Surgical Skills Coach
Department of Surgery
Indiana University School of Medicine
702 Rotary Circle, R022b
Indianapolis, IN 46202

This invited white paper was written in conjunction with a Hot Topics symposium presented at the 15th annual meeting of the Academic Surgical Congress in Orlando, FL on 02/06/2020.

Mr. Nicholas Anton and Dr. Carter Lebares should be considered co-first authors, as they both equally wrote and edited a significant amount of this manuscript. Mr. Theoklitos Karipidis assisted in writing and editing this manuscript. The senior author for this manuscript, Dr. Dimitrios Stefanidis, provided oversight and edited the group's work on this manuscript throughout its development.

Keywords: Mental skills, emotional regulation, resilience, stress, performance, mindfulness

---

Introduction

Mental skills training (MST) and affective (or emotional) regulation are increasingly recognized as critical components of surgeon technical development,[1] well-being,[2] and professional longevity.[3] Evidence-based curricula now exist for both foundational skillsets and focused application. In this white paper, we will present the scientific background and evidence supporting MST, discuss theory and empirical work regarding underlying mechanisms, highlight existing evidence-based programs that provide basic and specialty-specific application of these skills, describe concrete steps for implementation of such programs, and propose a broader application to the field of surgery and healthcare in general. The purpose of this paper is to clearly define MST (a subject that remains unnecessarily misunderstood), draw attention to the substantial extant evidence supporting the value of MST, and orient surgeons to become leaders in promoting and resourcing these efforts locally and nationally.

What is Stress?

As surgeons we know the experience of stress well: the rapid heart rate and adrenaline rush of myriad things to do. Yet, while familiar, stress remains hard to define. In the modern conceptualization, stress is a comprehensive term that reflects increased arousal in response to both positive and negative stimuli. Reflecting its heterogeneous and dynamic nature, stress can be stimulating or toxic, and can be caused by different things for different people on different days.[4,5] In spite of its variable etiology, the initial effect of stress is universal and evolutionary: we physically prepare to fight or flee, we are compelled by a desire to react, and what we do next is mediated by feedback between the hypothalamic-pituitary-adrenal axis and the prefrontal cortex.[6] This last point is critical because it underscores the reciprocal communication that governs the human stress response, and clarifies how our experience of stress is related to

cognition. As such, there is growing awareness that stress can be mediated by cognitive skills, as first evidenced by studies of resilient individuals.[7-9] Resilient individuals, often concentrated in high stress, high-performance fields, share a common cognitive tendency to perceive stressors as surmountable rather than overwhelming events.[10] This kind of mental shift is familiar to surgeons, and is exemplified in the scenario of uncontrolled operative bleeding. As medical students, our natural reaction to a pumping artery is to flinch or freeze, but somewhere in the process of training we learn to subvert this reaction and replace it with controlled calm. This represents an adaptive response (a cognitive shift) that can be learned. With reinforcement and practice, such skills can be called on more readily and as needed.

Stress and Performance

Cultivating the ability to reframe stress has profound implications for performance. Decades of empirical work in both basic science and with top-performing athletes highlights how stress in the right circumstances can stimulate adaptation and mastery.[11-14] These observations exemplify the Yerkes-Dodson Law, often referred to as the "Inverted-U Phenomenon", which proposes that increasing stress is beneficial to achieve optimal performance,[15] but that beyond this point additional stress results in decline. In an attempt to clarify this further, Selye (1987) differentiated *distress* (i.e., that which negatively affects an individual's state) from *eustress* (i.e., that which positively affects an individual's state), noting that these states are largely dependent on an individual's interpretation and reaction to the stimuli at hand.[16] A key question is what determines this critical interpretation and reaction?

Indeed, Folkman et al. (1986) describe two primary processes, cognitive appraisal and coping, which mediate the individual-environment stress relationship.[17] Cognitive appraisal is a process whereby individuals evaluate interactions with the environment and assess their

relevance to well-being (i.e., potentially harmful versus beneficial). Subsequent appraisal determines if adequate abilities and resources exist to avoid harm, and this calculus determines an individual's perceived ability to cope. If a situation is appraised as threatening (or simply provocative), stress is heightened and a cascade of sympathetic-nervous system (SNS) activation is initiated. The body is mobilized to respond,[18,19] resulting in what we know as the 'fight or flight' response.[20] Evolutionarily, this reaction is essential to survival and in the short-term can stimulate adaptation and mastery of new skills. According to the 'broaden and build' paradigm,[21] this experience of stress increases an individual's sense of capability, enhances their perceived ability to cope, and increases their likelihood of facing future adversity in a similarly masterful fashion.[22] A key component of 'broaden and build' recognizes that one's perception of having adequate abilities is based on both past performance *and* one's sense of self. This latter point is the domain of mental training and emotional regulation, whereby ability can be dramatically influenced by positive versus negative self-talk, mental imagery of success versus failure, and a growth versus a fixed mindset.[13,23,24] These principles are foundational to high-performance sports psychology,[12,24] and supported by studies in elite women athletes,[13] military "soldier athletes",[25] and meta-analysis across sports fields.[26]

On the contrary, if stressors are prolonged or overwhelming, an individual's sense of capability can become overtaxed and they can be pushed to the "Threat" side of the "Inverted-U" curve. This decline can be promoted or exacerbated by individual factors, such as poor self-perception,[27] habituated negative self-talk,[13] or simply a lack of coping skills.[28] Systems factors in the form of external resources play an equally critical role, as evidenced by the deleterious effect of poor social support in studies of job strain and workplace satisfaction.[29] An increasing body of evidence underscores the impact of chronic psychosocial stress and describes the

adverse physiologic, cognitive, and affective impact of this "allostatic load", particularly when it is prolonged.[30-32]

Stress and Well-being

The field of social genomics provides insight into the mechanism by which chronic or overwhelming stress drives physiologic deterioration by identifying specific types of human gene-activation patterns associated with adverse social conditions.[31,33] The "conserved transcriptional response to adversity" (CTRA),[34] characterized by increased activity of pro-inflammatory gene transcription pathways (i.e., NFkB and AP-1) and decreased activity of the innate antiviral response (e.g., Type I interferons), is a common pattern of gene transcriptional alterations that occur with chronic low-grade sympathetic nervous system stimulation such as that found in populations experiencing socioeconomic stress, social isolation, or sleep deprivation.[30] This state has been linked to the development of cardiovascular disease,[35] Alzheimer's dementia, and cancer.[36,37]

Cognitively, profound or chronic SNS activation can decrease working memory capacity (i.e., the system responsible for temporary storage and manipulation of information), promote hypervigilance (i.e., inappropriate attention to task-irrelevant stimuli), and impair decision making (i.e., decreased executive function, cognitive control and intentionality in decisions).[18,32,38,39] Psychologically, chronic distress dramatically increases the odds of disorders such as burnout, anxiety, suicidality and depression,[40] and the odds of concomitant negative coping behaviors such as alcohol abuse.[41,42] Interpersonally, burnout (i.e., defined as a sustained response to overwhelming work-related stress) is further associated with strained and dysfunctional relationships including decreased patient satisfaction and impaired professionalism.

Impact of Stress on Surgeon Performance

Surgery is among the most stressful and demanding professions one can enter. Surgeons are faced with cognitive, physical and emotional demands, some of which are inherent (stemming from the life and death nature of our work), and some of which are unnecessary (stemming from system-level inefficiencies and institutional-level inequities).[43] Nevertheless, individuals accumulate the effect of negative stressors regardless of the source, as described above. For surgeons, the sequelae of high stress titers are profound: overwhelming stress is associated with higher prevalence of burnout, anxiety, depression, suicidality and alcohol abuse.[42] Moreover, surgeons suffering from high levels of burnout are at higher risk for reduced work capacity and increased attrition from the field,[44] with a recent estimated healthcare expense of $900 million attributed to attrition of surgeons under the age of 55 years old.[13] Ultimately, heightened stress can impair surgeons' performance, which can increase intraoperative errors and compromise patient safety.[45,46]

Nevertheless, surgery is also profoundly gratifying and comes with substantial social capital. Surgery residency remains highly competitive, drawing prospective applicants from the upper echelons of top institutions and producing individuals who are thought-leaders in ethics and humanism, pioneers in equality and innovation, and champions in global health. In spite of these achievements, we know that burnout is real, attrition and suicide are unacceptably high, and there is a loss of potential and a diminishment of joy that deserve redress. Growing international consensus recognizes that this situation and its remedy involve three reciprocal domains,[47] necessitating intervention on the level of individuals, systems *and* culture.[48-51] The critical point is that changes among all three are necessary for us fix our situation.

Surgeons are rightly characterized as highly individualistic, disciplined, oriented towards skills acquisition, and inspired by the desire to fix what's broken.[52] These tendencies, in concert with our persistent role as thought- and opinion-leaders, place us in a unique position to affect change in this arena. Below we will present evidence and argument that the incorporation of mental skills training in Surgery as a means for us to intervene on a pressing issue in our midst (i.e., overwhelming stress), re-inspire a deserved sense of joy in our work, and galvanize us to identify and direct changes to the obsolete systems and organizational elements that contribute to this problem.

Definition of Mental Skills

Mental skills refer to a set of psychological techniques designed to support individuals and teams to achieve optimal levels of performance through skilled management of stressors inherent to high-stakes endeavors.[53] Those skills have been applied widely in sport psychology and among other high-performance populations such as musicians, performing artists, business professionals, military personnel, and police special forces.[53-57] Mental skills training is fundamentally divided in two categories: somatic and cognitive interventions. The somatic domain involves the use of mindfulness-based interventions (MBIs) to develop situational awareness (of internal and external stimuli), emotional response regulation (to provocative stimuli) and meta-cognition (the ability to purposefully call on these skills as needed). The cognitive domain involves, but is not limited to, mental imagery, mental rehearsal, refocusing strategies, goal setting, and performance mental routines.[58] Although the somatic and cognitive interventions are presented as separate, they are interrelated components of human psycho-somatic function and reflect the feedback process between the hypothalamic-pituitary-adrenal axis and the prefrontal cortex, which governs the human stress response.

Mental skills training is based on the premise that task mastery and performance can be enhanced by specifically addressing the psychological state of the individual,[56] improving self-knowledge and confidence, and providing discrete tools for the emotional and physical regulation of the stress response.[59] Hence, mental skills training involves mental and physical skills development that simultaneously enhance performance and psychological well-being.[58,60] Like all other forms of training, mental skills require initial teaching by experts, patient dedication by learners, and time to train and practice applied skills. A growing body of evidence demonstrates that this investment pays dividends, arguing that high-performance fields are remiss in *not* having an 'internal curriculum' of this sort to augment traditional intellectual and technical training. A seminal example is the United States military which, in response to a mandate by 2008 Chief of Staff General George W. Casey, Jr, and in collaboration with the University of Pennsylvania, created the Comprehensive Soldier Fitness (CSF) program, a pre-emptive intervention aimed at increasing resilience, psychological well-being, and mental toughness in soldiers, their families, and civilian personnel.[56] This unprecedented move was motivated by General Casey's recognition of increased psychological and behavioral issues among soldiers returning from repeated deployment to Iraq and Afghanistan. He declared that the United States Army was charged with comprehensively preparing its soldiers for success yet had historically lacked any formal training for managing the profound inherent stress of active military duty.[61-63] Since then, similar training has been integrated in the recruiting process of Special Forces, such as the U.S. Navy Seals,[64] and other high-stress, high-stakes fields such as policing and politics.[65,66]

In spite of more than a decade of data supporting the benefit of this approach, Surgery has been slow to incorporate such practices. Nevertheless, the growing body of evidence

regarding both the need for and efficacy of mental skills training for surgeons confirms the feasibility and value of adopting an 'internal surgical curriculum' to augment traditional intellectual and technical training.[1,2,3,67,68]

Mental Skills Interventions in Surgery and Evidence of Effectiveness

There have been substantial efforts made to develop mental skills and emotional regulation training programs with surgeons. Since our groups (Departments of Surgery at University of California, San Francisco (UCSF) and Indiana University (IU) have published a significant amount of research on the efficacy of our programs, we will highlight these programs first. We will then briefly highlight other programs designed to implement mental skills and emotional regulation skills in surgery.

At UCSF, our group has developed Enhanced Stress Resilience Training (ESRT) which is a streamlined and tailored mindfulness-based intervention (MBI) loosely based on John Kabat-Zinn's Mindfulness-Based Stress Reduction (MBSR), the most scientifically-vetted MBI to date.[69] The core components of ESRT focus on the development of 3 key cognitive skills: interoception (i.e., moment-to-moment situational awareness of thoughts, emotions, and sensations),[70] emotional regulation (i.e., development of nonreactivity in response to internal and external stimuli),[71] and meta-cognition (i.e., conscious awareness of one's cognitive control processes).[72] These skills are taught through experiential training in various mindfulness practices (focused breathing, body-scan, qi gong), and scaffolded onto a conceptual framework explaining their relationship to cognitive training, emotional regulation, and behavior change for the purpose of enhancing stress resilience in physicians. Critically, there is an emphasis on bringing these skills into surgeons' daily lives through informal (i.e., ''throughout the day'')

practice and explicit contextualization of skills to the personal and professional circumstances of surgeons.[2]

For example, using emotion regulation techniques in difficult communication with other healthcare workers, mindful walking during rounds, breathing techniques to dispel stress and reclaim attention in the operating room (OR), and using meta-cognitive skills to transition out of work and enjoy personal time more fully. The goal of this applied practice is to explicitly mitigate the most common and recurring sources of surgeons' stress, and emphasize the pragmatic importance of integrating mindfulness practices within daily life. The course is comprised of 5, 1-hour classes with a focus on experiential practice, not intellectual content (Table 1). A progressive amount of daily home practice is assigned, and a voluntary group meditative hike (2-3 hours outdoors) is held after Week 3 or 4. The ESRT curriculum bundle involves an online platform of short videos which deliver the conceptual framework, an app-based platform of guided meditation recordings to support daily home practice, and a facilitators guide (detailed manual) to support implementation.

Since its inception, in 2016, ESRT has been studied in two single-institution randomized controlled trials, of a total of 65 first-year surgery trainees, and several cohort studies of non-surgical trainees and faculty/practicing surgeons. Early studies of ESRT among surgery trainees demonstrated feasibility and acceptability as evidenced by the reasonable implementation cost, low attrition, and high rate of home practice. Furthermore, ESRT was perceived as credible and satisfying, in spite of the untraditional content and the need for in-person class attendance. Skills were readily integrated into participants' everyday lives.[69] Early studies also showed ESRT participants to have reduced stress, increased working memory capacity, increased activation of

neural substrates associated with executive cognitive function, emotional-regulation, and complex bimanual coordination,[73] and better performance on laparoscopic simulator tasks. More recent work has demonstrated statistically-significant benefits to ESRT participants in terms of lower emotional exhaustion, lower depersonalization, higher mindfulness, and higher global executive cognitive function both post-intervention and at long-term follow-up. Moreover, ESRT participants showed statistically significant mitigation of a stress-activated pro-inflammatory gene expression profile (Conserved Transcriptional Response to Adversity), as compared to controls.[2] With the on-set of the COVID-19 pandemic, ESRT was modified for remote delivery and was successfully provided to practicing surgeons at 10 academic sites, across all four US time zones, and to individual surgeons in the military. In 2020, for the first time, ESRT is part of the mandatory educational curriculum for in-coming UCSF residents in Surgery and Obstetrics and Gynecology.

At IU, a novel Mental Skills Curriculum (MSC) designed to reduce stress and enhance the performance of surgery residents has been developed and implemented. This MSC consists of 8 modules (outlined in Table 2) and was developed by a multidisciplinary team of a surgeon educator, a PhD educator with industrial design expertise, and a performance psychologist with expertise in mental skills training.[74] The modules are implemented with residents in weekly sessions and feature video education and didactics with a trained mental skills coach, workbook exercises for immediate practice of learned skills, and applied practice of surgical skills during simulation training. We have accumulated evidence of effectiveness for this curriculum through the conduct of numerous studies. We have shown that novices significantly improved their laparoscopic surgical skills and mental skills use,[74] and experienced significantly lower stress during two validated stress tests after training with this curriculum.[75] We have also shown that

this curriculum enhances skill transfer from the simulated environment to the clinical environment[76] by minimizing the typical skill deterioration that is observed during this transition.[77] In a randomized-controlled trial with surgical novices, we found that MSC-trained novices demonstrated higher laparoscopic skill retention 2 months after training compared to controls. [78] Importantly, our group implemented our MSC with surgery residents in a multi-site, randomized-controlled trial of its effectiveness.[1] Following stratification of residents into training conditions (i.e., MSC and controls), both groups were trained in laparoscopic skills and asked to participate in a transfer test on a porcine Nissen model. Residents were asked to perform under normal and stressful conditions where stressors (e.g., interruptions, technical challenges, poor assistance, etc.) were introduced by the study team. We found that in spite of both groups performing comparably under normal conditions, MSC-trained residents were able to preserve their surgical skill significantly better than controls under stressful conditions.

Thus, our studies demonstrate that the IU MSC is effective in increasing mental skills of participants, enhance their surgical skill acquisition and retention, and minimize performance deterioration under stressful conditions in the OR. Given these findings this curriculum has been incorporated into our surgery residency curriculum to benefit all our trainees.

There have been efforts beyond our groups to implement MBSR and mental skills interventions in surgical education that warrant mention as well. In a recent review of mental skills interventions in surgery, we found that prior to 2017, 19 studies had been conducted to assess the benefit of mental skills (i.e., primarily mental imagery) for surgical novices and trainees.[79] Results indicate that these interventions are highly effective for enhancing skill acquisition and surgical performance, increasing confidence, knowledge, teamwork, and reducing stress. There have also been efforts in surgical education to implement stress-resilience

training to improve surgeon well-being. Riall et al. (2017) have developed the "Energy Leadership Well-Being and Resiliency Program" for surgeons, which is a curriculum designed to address the mental, social, and physical elements of surgery residents' well-being.[3] During monthly sessions, residents are taught skills related to goal setting, mindfulness, team building, communication, work-life balance, empathy, diet and exercise strategies, mindfulness of ergonomics, and stress management techniques. The authors found that their program improved residents' exhaustion, life satisfaction, perceived stress, emotional intelligence, and overall perception of the residency program. Residents reported that they were able to incorporate these skills into their daily work and personal lives, which provides further evidence that regular practice of mindfulness and mental skills provides beneficial downstream effects.

Common Characteristics of Existing Programs

A number of common elements are found in available mental skill and mindfulness/emotional regulation training programs that are worth exploring. First, is the use of cognitive training to notice stress and address it through learned skills. Across interventions, we see effectively lowered stress and anxiety and (where assayed) improved performance in challenging situations. In some instances these benefits are operative, but in others instances benefits are seen in challenging interpersonal, or even intrapersonal situations. Additionally, both MSC and ESRT have shown benefits to executive function, which suggests that the performance benefits we see are not one-offs, but rather the result of more central cognitive changes. Finally, across interventions we see benefits to well-being in the form of greater self-confidence intraoperatively, less vulnerability to burnout, and/or a stronger sense of being balanced in one's life. These findings support the assertion that mental skills/emotional regulation training yields tangible benefits that can been seen and applied in multiple contexts. This speaks to the

longitudinal relevance and versatility of such skills, that can be applied across the breadth and trajectory of a surgeon's life. While mental skills training is not meant to replace technical and didactic surgical training, it can effectively be used as a synergistic adjunct. Nevertheless, similar to technical and cognitive skills, all versions of mental skills training require dedicated practice time outside the OR.

Second, evidence suggests that deliberate practice of mental skills is needed to obtain maximal benefits. In those programs that feature comprehensive skills training over time and assimilation into daily habits with in-class and outside practice, there are clear longitudinal benefits. Thus, educators seeking to implement mental skills training with trainees should view mental skills much like technical skills, deliberate practice can facilitate mastery and "muscle memory" during stressful situations that impair one's ability to make conscious decisions, as practice will enable trainees to automatically utilize stress coping skills to manage their activation and focus on the task at hand.

The third common component of these programs is that they have all focused on training residents in the context and constraints of real life, clearly showing that implementation of formal mental skills and ESRT programs is feasible and effective despite the limitations on resident duty hours. Educators interested in applying mental skills training with residents should not be deterred by the time required to learn these skills. Trainees perceive these programs as valuable to their performance and well-being,[69,74] when they are framed as skills with evidence-based roots. The question becomes, how can leaders implement similar programs in their own residency programs?

Challenges and Recommendations for Implementation

In a study on the barriers and enablers to adoption of ESRT and factors contributing to sustainability, the group at UCSF performed a thematic analysis of interview data with departmental leadership and administrators across multiple disciplines.[80] The researchers found several key factors contributed to adoption and sustainability of ESRT, including culture (i.e., establishing value, knowledge of evidence, and personal experience), infrastructure to mitigate barriers (i.e., time barriers, service coverage, and allowance), and adaptability in the training program to suit the need of individuals (i.e., aligning with local culture, ensuring the content is practical, and tailoring the program to be relevant for individual needs).

In an effort to determine how these influential themes could be generalized to support sustained program implementation, themes were compared to the Consolidated Framework for Implementation Research (CFIR) (Table 3). The CFIR can be utilized to clarify factors that impact what aspects of an intervention work, why they work, and how to guide implementation efforts based on this data.[81] Below we outline a few key factors that are universally valuable to advancing the up-take of mental skills training, institutionally.

First, we acknowledge that all educators involved in improving the training and experience of surgical trainees are ultimately targeting the same outcome. We all aim to equip learners with the skills necessary to be the most effective surgeons possible in spite of variable conditions inside and outside of the OR, to achieve and maintain fulfillment and joy in their work, and to maintain and possibly enhance well-being throughout their careers. These goals are not exclusive to the select mental skills and ESRT programs outlined previously, rather, there are similar local efforts in residency programs across the world. The local champions of these efforts should be lauded for their often pioneering and under-appreciated work to disseminate these needed skills to their resident charges. However, we contend that our field should transition to a

more comprehensive and systematic approach to mental skills training, much like the use of TeamSTEPPS to disseminate skills to enhance teamwork with medical professionals.[82]

A conceptual framework for mental skills training in surgery

We propose the following framework to conceptualize the evolution and applicability of mental skills in surgical training and beyond (Figure 1).

Figure 1. Conceptualization of Mental Skills in Surgical Training

Basic Training

The implementation of mental skills and ESRT should ideally begin with an introduction of concepts, and education about the mind-body connection that defines performance and well-being. Specifically, it is important to clearly delineate the impact of positive and negative thinking on psychophysiological functioning. It is also important to help learners define their ideal performance state (IPS) (i.e., psychological and physiological) in various performance contexts before they move into learning specific skills. As described in previous sections, eustress can be beneficial to performance if it promotes an individual's IPS, so helping learners identify the boundaries of their own IPS can enable them to realize when activation management is necessary. Moreover, during basic training, individuals should be exposed to fundamental techniques (e.g., breathing relaxation, mindfulness) to familiarize themselves with the process.

Embodied Learning

The concepts and skills taught during basic training should be embodied by residents as habits for surgical performance. Much like technical skills, deliberate practice of mental skills is necessary for the maturation of those skills. For example, residents might use mental imagery to

improve their laparoscopic suturing ability, which would require them to engage in an iterative process of practicing imagery, then physically suturing in the low-pressure environment of simulation, then refining their imagery experience by including newly learned suturing techniques. Through deliberate practice, residents would be able to develop more vivid and accurate mental representation of suturing, while simultaneously enhancing their technical skills. Once skills and confidence in their use is developed in the low-pressure simulation environment, residents should then seek opportunities to transfer these techniques clinically.

Our suggested application of mental skills is based on Fredrickson's (2004) broaden and build theory which states that positive emotions "broaden peoples' momentary thought–action repertoires and build their enduring personal resources".[83] We contend that the positive experiences and emotions derived from mental skill development in low-stakes environments could promote joy and interest for residents to continue to practice these skills on their own time, which could further develop their mental skills repertoires to manage unforeseen challenges in the future. Ultimately, we believe this approach will allow residents to build their skill set effectively and work towards independence, growth, and improved well-being.

Preparing for Independence

Throughout their advancement in residency training, surgery residents are afforded greater autonomy in training that allows them to perform surgical procedures and manage patient care with more passive supervision from faculty.[84] However, increased autonomy exposes surgery residents to numerous challenges that attendings face on a regular basis (e.g., technical complications, aberrant anatomy, frustration and doubt about skill, managing difficult patients or families) that require robust mental abilities to overcome. While residents are expected to learn these skills serendipitously, we believe mental skills that are developed through basic training

and embodied learning can better prepare senior residents to face this transition to independent surgical practice including after they leave residency. Through the adaptation and refinement of learned mental skills throughout training, residents can learn to apply these techniques to manage their psychological response to complications or extremely difficult procedures, and maintain appropriate confidence in their abilities.

Systems Improvement

Ultimately, the expected downstream effects of residents' learning mental skills and ESRT will be their adaptability to varying clinical situations that help them mitigate errors, ensure patient safety, and maintain their personal well-being when they enter practice. Estimates of costs incurred to hospital systems as a result of surgical complications indicate that costs increase by up to 5 times when complications occur after surgery.[85] Through the use of mental skills to help mitigate preventable intraoperative errors, surgeons can avoid significant costs being incurred on hospital systems. Furthermore, a recent cost-consequence analysis of physician burnout in the United States revealed that physician turnover and reduced clinical hours cost approximately $4.6 billion each year. Given the evidence of ESRT to increase physician well-being,[2] physicians trained in ESRT may experience lower burnout, and as a result, stave off career change or a reduction in clinical hours. Thus, mental skills and ESRT programs could save hospital systems significant costs over time.

On an individual level, surgeons trained in these techniques may be able to apply them to other important aspects of surgery practice including leading others effectively (e.g., colleagues, trainees, and staff), demonstrating enhanced teamwork, and contributing to system level process improvements. Recent research in the effect of mindfulness training on interpersonal relationships and leader-follower relationships at work found that leaders' mindfulness use had a

positive relationship with followers' satisfaction, particularly leaders' communication with their followers.[86] Thus, it is possible that surgeons trained in mindfulness techniques could enhance the satisfaction of colleagues and patients at their institution, which could further benefit hospital systems.

Moving Forward

Research priorities

Ongoing rigorous scientific study of mental skills and ESRT programs is paramount to define the most important components and combination of training approaches. We propose that the Kirkpatrick's four-level model of training evaluation should be used to for the effectiveness of mental skills training programs moving forward.[87] The four levels of this program include evaluation of learner reactions (Level One), evaluation of learning outcomes (Level Two), evaluation of occupational performance changes due to the intervention (Level Three), and evaluation of the larger benefits of interventions on organizational goals and objectives (Level Four). To this point, research efforts in our field have primarily studied the effects of mental skills and ESRT programs on the first three levels of the Kirkpatrick scale albeit with few level three studies having been performed. Moving forward, research should expand on the impact of mental skills interventions on learner clinical performance (Level 3 outcomes), and establish the broader systems-level impact of mental skills interventions such as physician retention and burn out rates, patient complication rates, and follower and patient satisfaction (Level 4 outcomes). Research efforts should also focus on studying the longitudinal effects of these programs on learners' performance and well-being. We hypothesize that there is a dose-response effect of mental skills training on these outcomes, but as of now, the available evidence is limited. Lastly, to ensure that the benefits of mental skills and ESRT programs are replicable, there is a need for

multi-institutional projects to study the generalizability of these programs on a larger scale. While these research priorities may appear daunting, concerted efforts by surgical education leaders to develop a national mental skills/ESRT training curriculum may allow for more robust research efforts to be undertaken.

Towards a national curriculum

Given the substantial evidence on the effectiveness of mental skills and ESRT with surgery residents, and the anticipated benefits this type of training can confer to surgeons and healthcare in general, we propose that our field should aspire to create a national mental skills training program that follows our proposed framework. This will require an organized approach that will consider the existing evidence of effectiveness of these programs and define an optimal program that draws knowledge from existing curricula and can be implemented widely across surgical training programs. Collaboration of groups that have developed substantial evidence of effectiveness for such interventions driven by national surgical organizations will be critical to the success of such a national curriculum.

Conclusions

In this paper we have reviewed the effects of stress on surgical performance and have provided the rationale for the implementation of mental skills training programs in surgery. We have reviewed the structure and content of available interventions and summarized the existing evidence of their effectiveness. Further, we have identified barriers and implementation strategies for these interventions and are proposing a conceptual framework for their structure. We advocate for the development of mental skills curricula on a national level and propose research priorities to advance the field. Ultimately, these programs are expected to enhance

surgeon skills, improve the outcomes of their patients, and promote their effective leadership in the healthcare system while preserving their well-being.

References

1. Anton NE, Mizota T, Whiteside JA, Myers EM, Bean EA, Stefanidis D. Mental skills training limits the decay in operative technical skill under stressful conditions: Results of a multisite, randomized controlled study. Surgery. 2019;165:1059-1064. DOI: 10.1016/j.surg.2019.01.011.
2. Lebares CC, Coaston TN, Delucchi KL, et al. Enhanced stress resilience training in surgeons: Iterative adaptation and biopsychosocial effects in 2 small randomized trials. Ann Surg. 2020. Online ahead of print. DOI: 10.1097/SLA.0000000000004145.
3. Riall TS, Teiman J, Chang M, et al. Maintaining the fire but avoiding burnout: implementation and evaluation of a resident well-being program. J Am Coll Surg. 2018;226:369-379. DOI: 10.1016/j.jamcollsurg.2017.12.017.
4. Karlamangla AS, Singer BH, McEwen BS, Rowe JW, Seeman TE. Allostatic load as a predictor of functional decline: MacArthur studies of successful aging. J Clin Epidemiol. 2002;55:696-710. DOI: 10.1016/s0895-4356(02)00399-2.
5. McEwen BS. In pursuit of resilience: stress, epigenetics, and brain plasticity. Ann N Y Acad Sci. 2016;1373:56-64. DOI: 10.1111/nyas.13020.
6. McEwen BS. Allostasis and the epigenetics of brain and body health over the life course: the brain on stress. JAMA psychiatry. 2017;74:551-552. DOI: 10.1001/jamapsychiatry.2017.0270.
7. Vythilingam M, Nelson EE, Scaramozza M, et al. Reward circuitry in resilience to severe trauma: an fMRI investigation of resilient special forces soldiers. Psychiatry Res. 2009;172:75-77. DOI: 10.1016/j.pscychresns.2008.06.00.
8. Lyons DM, Parker KJ, Katz M, Schatzberg AF. Developmental cascades linking stress inoculation, arousal regulation, and resilience. Front Behav Neurosci. 2009;3:32.

9. Masten AS. Ordinary magic: Resilience processes in development. Am Psychol. 2001;56:227-238. DOI: 10.1037//0003-066x.56.3.227.
10. Feder A, Nestler EJ, Charney DS. Psychobiology and molecular genetics of resilience. Nat Rev Neurosci. 2009;10:446-457. DOI: 10.1038/nrn2649.
11. Liston C, Cichon JM, Jeanneteau F, Jia Z, Chao MV, Gan WB. Circadian glucocorticoid oscillations promote learning-dependent synapse formation and maintenance. Nat Neurosci. 2013;16:698-705. DOI: 10.1038/nn.3387.
12. Brown JL. Cognitive–Behavioral Strategies. In: Luiselli J., Reed D., eds. Behavioral Sport Psychology. New York, NY; Springer. 2011. DOI: 10.1007/978-1-4614-0070-7_7.
13. Wilson D, Bennett EV, Mosewich AD, Faulkner GE, Crocker PR. "The zipper effect": Exploring the interrelationship of mental toughness and self-compassion among Canadian elite women athletes. Psychol Sport Exerc. 2019;40:61-70.
14. Thelwell RC, Greenlees IA. Developing competitive endurance performance using mental skills training. Sport Psychol. 2003;17:318-337.
15. Yerkes RM, Dodson JD. The relation of strength of stimulus to rapidity of habit-formation. Punishment: Issues and experiments. 1908:27-41. DOI: 10.1002/cne.920180503.
16. Selye H. Stress without Distress. 1987. London, UK: Transworld.
17. Folkman S, Lazarus RS, Dunkel-Schetter C, DeLongis A, Gruen RJ. Dynamics of a stressful encounter: cognitive appraisal, coping, and encounter outcomes. J Pers Soc Psychol. 1986;50:992-1003. DOI: 10.1037//0022-3514.50.5.992.
18. Goldstein DS. Stress-induced activation of the sympathetic nervous system. Baillieres Clin Endocrinol Metab. 1987;1:253-278. DOI: 10.1016/s0950-351x(87)80063-0.

19. Sherman DK, Bunyan DP, Creswell JD, Jaremka LM. Psychological vulnerability and stress: The effects of self-affirmation on sympathetic nervous system responses to naturalistic stressors. Health Psychol. 2009;28:554-562. DOI: 10.1037/a0014663.
20. Gordon M, Darbyshire D, Baker P. Non-technical skills training to enhance patient safety: a systematic review. Med Educ. 2012;46:1042–1054. DOI: 10.1111/j.1365-2923.2012.04343.x.
21. Fredrickson BL. What Good Are Positive Emotions? Rev Gen Psychol. 1998;2:300-319. DOI:10.1037/1089-2680.2.3.300.
22. Fredrickson BL. A functional genomic perspective on human well-being. Proc Natl Acad Sci USA. 2013;110:13684-13689. DOI: 10.1073/pnas.1305419110.
23. Bühlmayer L, Birrer D, Röthlin P, Faude O, Donath L. Effects of mindfulness practice on performance-relevant parameters and performance outcomes in sports: A meta-analytical review. Sports Medicine. 2017;47:2309-2321. DOI: 10.1007/s40279-017-0752-9.
24. Meijen C, Turner M, Jones MV, Sheffield D, McCarthy P. A theory of challenge and threat states in athletes: A revised conceptualization. Front Psychol. 2020;11:126. Published online 2020. DOI:10.3389/fpsyg.2020.00126.
25. Meyer VM. Sport psychology for the soldier athlete: A paradigm shift. Mil Med. 2018;183:e270-277. DOI: 10.1093/milmed/usx087.
26. Brown DJ, Fletcher D. Effects of psychological and psychosocial interventions on sport performance: A meta-analysis. Sports Med. 2017;47:77-99. DOI: 10.1007/s40279-016-0552-7.

27. Bynum WE, Artino AR, Jr., Uijtdehaage S, Webb AMB, Varpio L. Sentinel emotional events: the nature, triggers, and effects of shame experiences in medical residents. Acad Med. 2019;94:85-93. DOI: 10.1097/ACM.0000000000002479.
28. Cornum R, Matthews MD, Seligman ME. Comprehensive soldier fitness: building resilience in a challenging institutional context. Am Psychol. 2011;66:4-9. DOI: 10.1037/a0021420.
29. Sanne B, Mykletun A, Dahl AA, Moen BE, Tell GS. Testing the job demand–control–support model with anxiety and depression as outcomes: the hordaland health study. Occup Med (Lond). 2005;55:463-473. DOI:10.1093/occmed/kqi071.
30. Cole SW. Human social genomics. PLoS Genet. 2014;10:e1004601. DOI: 10.1371/journal.pgen.1004601.
31. Slavich GM, Cole SW. The emerging field of human social genomics. Clin Psychol Sci. 2013;1:331-348. DOI: 10.1177/2167702613478594.
32. Schoofs D, Preub D, Wolf OT. Psychosocial stress induces working memory impairments in an n-back paradigm. Psychoneuroendocrinology 2008;33:643-53. DOI: 10.1016/j.psyneuen.2008.02.004.
33. Cole SW. Social regulation of human gene expression: mechanisms and implications for public health. Am J Public Health. 2013;103:S84–S92.
34. Cole SW. The conserved transcriptional response to adversity. Curr Opin Behav Sci. 2019;28:31–37. DOI: 10.1016/j.cobeha.2019.01.008.
35. Chae DH, Lincoln KD, Adler NE, Syme SL. Do experiences of racial discrimination predict cardiovascular disease among African American men? The moderating role of internalized negative racial group attitudes. Soc Sci Med. 2010;71:1182-1188. DOI: 10.1016/j.socscimed.2010.05.045.

36. Tian R, Hou G, Li D, Yuan TF. A possible change process of inflammatory cytokines in the prolonged chronic stress and its ultimate implications for health. ScientificWorldJournal. 2014;2014:780616. DOI: 10.1155/2014/780616.
37. Wang L, Liao WC, Tsai CJ, et al. The effects of perceived stress and life style leading to breast cancer. Women Health. 2013;53:20-40. DOI: 10.1080/03630242.2012.732680.
38. Sänger J, Bechtold L, Schoofs D, Blaszkewicz M, Wascher E. The influence of acute stress on attention mechanisms and its electrophysiological correlates. Front Behav Neurosci. 2014;8:1-13. DOI: 10.3389/fnbeh.2014.00353.
39. Starcke K, Brand M. Decision making under stress: a selective review. Neurosci Biobehav. Rev 2012;36:1228-1248. DOI: 10.1016/j.neubiorev.2012.02.003.
40. Sandström A, Rhodin IN, Lundberg M, Olsson T, Nyberg L. Impaired cognitive performance in patients with chronic burnout syndrome. Biol Psychol. 2005;69:271-279. DOI: 10.1016/j.biopsycho.2004.08.003.
41. Oreskovich MR, Kaups KL, Balch CM, et al. Prevalence of alcohol use disorders among American surgeons. Arch Surg. 2012;147:168-174. DOI: 10.1001/archsurg.2011.1481.
42. Lebares CC, Guvva EV, Ascher NL, O'Sullivan PS, Harris HW, Epel ES. Burnout and stress among us surgery residents: psychological distress and resilience. J Am Coll Surg. 2018;226(1):80-90. DOI: 10.1016/j.jamcollsurg.2017.10.010.
43. Arora S, Sevdalis N, Nestel D, Woloshynowych M, Darzi A, Kneebone R. The impact of stress on surgical performance: a systematic review of the literature. Surgery 2010;147:318-330. DOI: 10.1016/j.surg.2009.10.007.
44. Han S, Shanafelt TD, Sinsky CA, et al. Estimating the attributable cost of physician burnout in the United States. Ann Intern Med. 2019;170:784-790. DOI: 10.7326/M18-1422.

45. Panagioti M, Geraghty K, Johnson J, et al. Association between physician burnout and patient safety, professionalism, and patient satisfaction: A systematic review and meta-analysis. JAMA Intern Med. 2018;178:1317-1331. DOI: 10.1001/jamainternmed.2018.3713.
46. Anton NE, Montero PN, Howley LD, Brown C, Stefanidis D. What stress coping strategies are surgeons relying upon during surgery? Am J Surg. 2015;210:846-851. DOI: 10.1016/j.amjsurg.2015.04.002.
47. Bohman B, Dyrbye L, Sinsky C, et al. Physician well-being: the reciprocity of practice efficiency, culture of wellness, and personal resilience. NEMG Catalyst website. http://catalyst.nejm.org/physician-well-being-efficiency-wellness-resilience. Accessed: 8/18/2020.
48. Bodenheimer T, Sinsky C. From triple to quadruple aim: Care of the patient requires care of the provider. Ann Fam Med. 2014;12:573-576. DOI: 10.1370/afm.1713.
49. Brigham T, Barden C, Dopp AL, et al. A journey to construct an all-encompassing conceptual model of factors affecting clinician well-being and resilience. NAM Perspectives. Published online January 29, 2018. DOI: 10.31478/201801b.
50. Tawfik DS, Profit J, Webber S, Shanafelt TD. Organizational factors affecting physician well-being. Curr Treat Options Peds. 2019;5:11-25. DOI: 10.1007/s40746-019-00147-6.
51. Shanafelt TD, Noseworthy JH. Executive leadership and physician well-being: nine organizational strategies to promote engagement and reduce burnout. Mayo Clin Proc. 2017;92:129-146. DOI: 10.1016/j.mayocp.2016.10.004.
52. Foster KN, Neidert GP, Brubaker-Rimmer R, Artalejo D, Caruso DM. A psychological profile of surgeons and surgical residents. J Surg Educ. 2010;67:359-70. DOI: 10.1016/j.jsurg.2010.07.007.

53. Hoffman SL, Hanrahan SJ. Mental skills for musicians: Managing music performance anxiety and enhancing performance. Sport Exerc Perform Psychol. 2012;1:17-28. DOI: 10.1037/a0035409.
54. Hays KF. The enhancement of performance excellence among performing artists. J Appl Sport Psychol. 2002;14:299-312.
55. Jones G. Performance excellence: A personal perspective on the link between sport and business. J Appl Sport Psychol. 2002;14:268-281.
56. Fitzwater JP, Arthur CA, Hardy L. “The tough get tougher”: Mental skills training with elite military recruits. Sport Exerc Perform Psychol. 2018;7:93-107.
57. Le Scanff C, Taugis J. Stress management for police special forces. Journal of Applied Sport Psychology. 2002;14:330-343. DOI: 10.1080/10413200290103590.
58. Behncke L. Mental skills training for sports: A brief review. Online J Sport Psychol. 2004;6:1-19.
59. Adler AB, Bliese PD, Pickering MA, et al. Mental skills training with basic combat training soldiers: A group-randomized trial. Journal Appl Psychol. 2015;100:1752-1764. DOI: 10.1037/apl0000021.
60. Tenenbaum, G., & Eklund, R. C. (Eds.). Handbook of sport psychology. Hoboken, NJ: John Wiley & Sons. 2020.
61. Cornum R, Matthews MD, Seligman ME. Comprehensive soldier fitness: building resilience in a challenging institutional context. Am Psychol. 2011;66:4-9. DOI: 10.1037/a0021420.
62. Jarrett T. Warrior resilience training in operation Iraqi freedom: Combining rational emotive behavior therapy, resiliency, and positive psychology. US Army Med Dep J. 2008 Jul-Sep:32-38.

63. Lester PB, McBride S, Bliese PD, Adler AB. Bringing science to bear: An empirical assessment of the Comprehensive Soldier Fitness program. Am Psychol. 2011;66:77-81. DOI: 10.1037/a0022083.

64. Reivich KJ, Seligman ME, McBride S. Master resilience training in the US Army. Am Psychol. 2011;66:25-34. DOI: 10.1037/a0021897.

65. Sutton H. Mindfulness-based training leads to improved health for law enforcement. Campus Security Report. 2018 Dec;15(8):9. DOI: 10.1002/casr.30453.

66. Hyland Mindful Nation UK – Report by the Mindfulness All-Party Parliamentary Group (MAPPG). J Vocat Educ Train. 2016;68:133-136. DOI: 10.1080/13636820.2015.1123926.

67. Deshauer S, McQueen S, Mutabdzic D, Moulton CA. Mental Skills in Surgery: Lessons Learned from Virtuosos, Olympians, and Navy Seals. Ann Surg. 2019. DOI: 10.1097/SLA.0000000000003573.

68. Spiotta AM, Buchholz AL, Pierce AK, Dahlkoetter J, Armonda R. The Neurosurgeon as a high-performance thlete: Parallels and lessons learned from sports psychology. World Neurosurg. 2018;120:e188-e193. DOI: 10.1016/j.wneu.2018.08.013.

69. Lebares CC, Hershberger AO, Guvva EV, et al. Feasibility of formal mindfulness-based stress-resilience training among surgery interns: a randomized clinical trial. JAMA Surg. 2018;153:e182734-e182742. DOI: 10.1001/jamasurg.2018.2734.

70. Khalsa SS, Rudrauf D, Feinstein JS, et al. The pathways of interoceptive awareness. Nat Neurosci. 2009;12:1494–1496. DOI: 10.1038/nn.2411.

71. Ho ̈lzel BK, Lazar SW, Gard T, et al. How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. Perspect Psychol Sci. 2011;6:537–559. DOI: 10.1177/1745691611419671.

72. Baird B, Mrazek MD, Phillips DT, et al. Domain-specific enhancement of metacognitive ability following meditation training. J Exp Psychol Gen. 2014;143:1972–1979. DOI: 10.1037/a0036882.
73. Lebares CC, Guvva EV, Olaru M, et al. Efficacy of mindfulness-based cognitive training in surgery: additional analysis of the mindful surgeon pilot randomized clinical trial. JAMA network open. 2019;2:e194108. DOI: 10.1001/jamanetworkopen.2019.4108.
74. Stefanidis D, Anton NE, McRary G, et al. Implementation results of a novel comprehensive mental skills curriculum during simulator training. Am J Surg. 2017;213:353-361. DOI: 10.1016/j.amjsurg.2016.10.016.
75. Anton NE, Howley LD, Pimentel M, Davis CK, Brown C, Stefanidis D. Effectiveness of a mental skills curriculum to reduce novices' stress. J Surg Res. 2016;206:199-205. DOI: 10.1016/j.jss.2016.07.019.
76. Anton NE, Howley LD, Davis CK, Brown C, Stefanidis D. Minimizing deterioration of simulator-acquired skills during transfer to the operating room: A novel approach. Curr Surg Rep. 2017;5:16-. DOI: 10.1007/s40137-017-0181-6.
77. Prabhu A, Smith W, Yurko Y, Acker C, Stefanidis D. Increased stress levels may explain the incomplete transfer of simulator-acquired skill to the operating room. Surgery. 2010;147:640-645. DOI: 10.1016/j.surg.2010.01.007.
78. Stefanidis D, Anton NE, Howley LD, Bean E, Yurco A, Pimentel ME, Davis CK. Effectiveness of a comprehensive mental skills curriculum in enhancing surgical performance: Results of a randomized controlled trial. Am J Surg. 2017;213:318-324. DOI: 10.1016/j.amjsurg.2016.10.016.

79. Anton NE, Bean EA, Hammonds SC, Stefanidis D. Application of mental skills training in surgery: a review of its effectiveness and proposed next steps. J Laparoendosc Adv Surg Tech A. 2017;27:459-469. DOI: 10.1089/lap.2016.0656.
80. Lebares CC, Guvva EV, Desai A, et al. Key factors for implementing mindfulness-based burnout interventions in surgery. Am J Surg. 2020;219:328-334. DOI: 10.1016/j.amjsurg.2019.10.025.
81. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implement Sci. 2009;4:1-5. DOI: 10.1186/1748-5908-4-50.
82. King HB, Battles J, Baker DP, et al. TeamSTEPPS: Team strategies and tools to enhance performance and patient safety. In: Henriksen K, Battles JB, Keyes MA, et al. eds. Advances in Patient Safety: New Directions and Alternative Approaches, vol. 3. Rockville, MD: Agency for Healthcare Research and Quality. 2008.
83. Fredrickson BL. The broaden–and–build theory of positive emotions. Philos Trans R Soc Lond B Biol Sci. 2004;359:1367-1377. DOI: 10.1098/rstb.2004.1512.
84. George BC, Dunnington GL, DaRosa DA. Trainee autonomy and patient safety. Ann Surg. 2018;267:820-822. DOI: 10.1097/SLA.0000000000002599.
85. Vonlanthen R, Slankamenac K, Breitenstein S, et al. The impact of complications on costs of major surgical procedures: A cost analysis of 1200 patients. Ann Surg. 2011;254:907-913. DOI: 10.1097/SLA.0b013e31821d4a43.

86. Arendt JF, Pircher Verdorfer A, Kugler KG. Mindfulness and leadership: communication as a behavioral correlate of leader mindfulness and its effect on follower satisfaction. Front Psychol. 2019;10:667-683. DOI: 10.3389/fpsyg.2019.00667.

87. Kirkpatrick DL. Evaluation of training. In R. L. Craig (Ed.), Training and development handbook: A guide to human resource development. New York, NY: McGraw Hill. 1976.

Table 1. Practical and conceptual differences: traditional MBSR[a], ESRT-beta[b], and final ESRT[c]

Modification	Traditional MBSR	ESRT-beta[b]	Purpose of Modification	Final ESRT[c]	Purpose of Modification
Practical					
Class number	**9 wk** Intro session + 8wks	**6wk**	(L) To utilize 6wk summer gap in didactics	**5 wk**	(C) Further minimize clinical disruption
Class duration	**2.5h** Emergent, metaphorical, breaks, didactics	**1.5h** Focused discussions and didactics, no break	(L) Provide protected time, while preserving 80h work-week, educational and OR time	**1h** Explicit, short video-based conceptual content	(L, C) To enhance acceptability and accessibility
Retreat	**8h** silent sitting retreat, off-site meditation center	**3h** 'Medi Hike', outdoors	(C) Request for fresh air and exercise	**No change**	
Assigned daily practice time	**45 min** daily	**20 min** daily	(C) Responsive to time-compressed surgical lifestyle	**Goal is consistency**, ideal is 20 min, emphasis on informal ("all day long") practice	(C) 'Failing' at 20 min, added to participant stress *(Type A personality)*
Conceptual					
Class content	**1.5h** – Meditation **1h** – sharing, stories, meandering approach	**1h** – Meditation **30min** – Less sharing, more focused approach	(L) Preserve experiential focus, shorten class time	**45-50min** – Meditation **10-15min** – Explicit concepts	(C) Capitalize on culture of skills training, fast learners
Emphasis	Insight, life-long learning about self, world. Broad health enhancement.	Skill set for stress resilience, in general	(C) Application to life, relationships, training, career longevity	Resilience skill set, specific work application, cognitive training.	(C) Growing distress and burnout, modeling ESRT in work, life.
Contextualization	Broad application of concepts, awareness to all interactions	Application to personal and professional situations	(C) Skills applied to surgeons' life and work	Emphasize applied techniques, all day, various scenarios	(C) Explicit skills for explicit situations, clear mental model
Expectation	**Committed formal practice**	**Daily practice** mostly formal, less informal	(C) Reinforce 'some is better than none at all'	**Train formally, but 'Live your practice'.** Informal practice, anywhere, all day	(C) Capitalize on natural tendency for repetition and ritual

[a] MBSR = Mindfulness-Based Stress Reduction

[b] ESRT-beta =Enhanced Stress Resilience Training early version, 6 wk, 1.5h classes, 20min/day home practice.

[c] ESRT-Final = Enhanced Stress Resilience Training final post-iterative version, 5 weekly, 60-minute classes, progressive amount of daily formal practice, heavily emphasized informal practice.

(L)=logistical modification, (C)=cultural modification

Table 2. Indiana University Mental Skills Curriculum

0	Overview and Introduction to MSC	Overview of mental skills training	The goal of this session will be to introduce the learner to the curriculum and reinforce the need for mental skills training in surgical practice. By participating in this session, the learner will… • Briefly describe the history of Mental Skills Training (MST) • Report the rationale for MST in medicine • Describe the process of the MSC
1	The Science of Attention, Focus, and Concentration	Overview of the science of neurology and how it relates to the skills in this curriculum	• The goal of this session will be to continue to introduce the learner to the curriculum and teach them the neurological science behind attention, focus, and concentration. By participating in this session, the learner will…Describe the differences between bottom-up and top-down neurological processes • Review Nideffer's attentional model of performance excellence
2	Goal Setting	Role of clear, effective goals in achieving performance excellence and building confidence; importance of clarifying both the tasks and processes essential for success in a procedure; includes • Technical (e.g., nodal points; clear performance plan) • Process (e.g., slow and steady; breathe to remain calm; optimal team behavior)	The goal of this session will be to equip the learner with the knowledge and skills to establish clear and effective performance goals. By participating in this session, the learner will… • Define and differentiate between outcome, performance, and process goals • Identify characteristics of his or her ideal performance state • Set technical goals for a procedure (for example, identify 2-3 nodal points of a procedure) • Identify process goals for a procedure (e.g., staying calm, confident, and relaxed; optimal team behavior)
3	Activation Management	Skills to relax physically and mentally, as well as techniques for raising energy level when fatigued	The goal of this session will be to equip the learner with the knowledge and skills to manage physical and mental states. By participating in this session, the learner will… • Demonstrate breathing and attention techniques to achieve greater states of physical and mental calm. (Sample Outcome: Reduce heart rate 6 beats in 12 seconds) • Demonstrate techniques to raise physiological activation and attention. (Sample Outcome: Raise HR 6 beats in 12 seconds)
4	Attention Management	Techniques for maintaining attention on what is essential and ignoring distractions • Thought stopping • Self-talk • Re-directing attention	The goal of this session will be to equip the learner with the knowledge and skills to effectively maintain attention. By participating in this session, the learner will… • Identify personal negative self-talk in performance situations and effective strategies for managing self-talk • Demonstrate ability to redirect attention from a distraction to a target behavior
5	Imagery	Techniques for mental rehearsal of both technical aspects and non-technical skills (e.g., managing emotions; successfully dealing with stressful events)	The goal of this session will be to equip the learner with the knowledge and skills to effectively mentally rehearse. By participating in this session, the learner will… • Identify strategies for maximizing effective use of imagery and mental rehearsal • Incorporate imagery into practice and performance situations
6	Refocusing Strategies	Techniques and principles for handling various events that can be stress inducing or disruptive; learning how to develop specific, individualized strategies for coping; plans address both technical and non-technical aspects of situation, including team interactions	The goal of this session will be to equip the learner with the knowledge and skills to confront challenging events in the OR. By participating in this session, the learner will… • Identify events which are particularly stress inducing or distracting to the surgeon • Devise personalized and specific strategies for managing these situations
7	Preoperative Mental Routines	Techniques and principles to ensure that one is mentally ready to perform, as well as physically and technically ready; includes preparation for both the initiation of a procedure and resuming after a break or loss of focus	The goal of this session will be to equip the learner with the knowledge and skills to develop pre-performance mental routines. By participating in this session, the learner will… • Develop a clear pre-performance "mental readiness" routine for OR performance

Table 3. Mapping of influential factors to CFIR constructs and domains

Influential Factors		**Consolidated Framework for Implementation Research (CFIR)**	
Theme	Sub-Theme	CFIR Construct	CFIR Domain
Culture	Establishing value	Intervention source Design quality and packaging Cost Patient needs and resources Culture Implementation climate Planning, Reflecting and evaluating	Intervention characteristics Outer setting Inner setting Characteristics of individuals Process of implementation
	Knowledge of evidence	Evidence strength and quality Networks and communications Knowledge/ beliefs about intervention	
	Personal experience	Relative advantage Trialability Peer pressure Culture, Self-efficacy/Stage of change Knowledge/beliefs about intervention Engaging	
Infrastructure	Time	Complexity Design quality and packaging Implementation climate Planning, Executing	Intervention Characteristics Outer setting Inner setting Characteristics of individuals Process of implementation
	Protection	Cost External policies and incentives Networks and communications Culture Implementation climate Planning, Reflecting and evaluating	
	Allowance	Cost Peer pressure Structural characteristics Networks and communications Culture Implementation climate Knowledge, beliefs about intervention	
Adaptability	Identification	Design quality and packaging Culture, Self-efficacy Knowledge, beliefs about intervention Identification with organization Engaging	Intervention Characteristics Outer setting Inner setting Characteristics of individuals Process of implementation
	Practicality	Adaptability Structural characteristics Implementation climate Self-efficacy Planning, Executing	
	Relevance	Patient needs and resources Culture, Self-efficacy/ Stage of change Knowledge, beliefs about intervention Engaging	

CFIR=Consolidated Framework for Implementation Research