National Student Research Institution (2026)

*Open Science • Student Research • 2026*

# Can Psychological Stress-Inoculation Training Improve Performance in Emergency Medicine Education?

*A Narrative Review*

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## Abstract

**Background:** Emergency medicine concentrates high-stakes decision-making, uncertainty, and severe time pressure into brief clinical encounters, and it does so precisely when acute stress most powerfully distorts cognition.

**Methods:** This narrative review examines stress-inoculation training (SIT) as a framework for preparing emergency medicine trainees to perform under pressure, and asks whether repeated, graduated exposure to simulated emergencies can produce durable stress adaptation.

**Results:** Synthesizing foundational work in cognitive-behavioural psychology, human-factors research from aviation and military settings, and a growing simulation-based literature in health professions education, the review finds converging evidence that acute stress degrades attention, memory retrieval, and decision-making during resuscitation, and that structured stress exposure paired with explicit coping-skills training can mitigate these impairments. The medical evidence also warrants caution: brief, one-off interventions rarely produce measurable improvements in objective performance outcomes, which suggests that the benefits of inoculation are dose-dependent and skills-mediated rather than resulting from stress exposure alone. Repeated simulation appears to improve performance under pressure not simply by familiarizing trainees with stress, but by rehearsing the cognitive and behavioural strategies that help preserve performance under acute stress.

**Conclusion:** The review closes with design principles for embedding longitudinal stress-inoculation curricula in emergency medicine training and priorities for future research.

**Keywords:** stress inoculation training, emergency medicine, simulation-based education, acute stress, performance under pressure

## 1. Introduction

When a patient arrives in the emergency department in cardiac arrest, the clinician who leads the resuscitation must manage an extraordinary cognitive load: integrating fragmentary information, directing a team, choosing among time-critical interventions, and executing psychomotor skills, all within seconds and under mounting physiological and psychological stress. The paradox of emergency medicine is that the situations demanding the clearest thinking are the same situations most likely to degrade it. A substantial body of research supports this concern: acute stress impairs attention, narrows perception, weakens working memory, and can interfere with the retrieval of well-learned knowledge (LeBlanc, 2009). In a specialty where hesitation may carry immediate consequences, this is not a peripheral concern but a central educational problem.

One influential answer emerges from cognitive-behavioral psychology. Stress-inoculation training (SIT), developed by Meichenbaum (1985) as a cognitive-behavioral treatment for anxiety, anger, and pain, rests on an immunological metaphor: just as a vaccine exposes the body to a weakened pathogen so that it can mount a defense against the real thing, SIT exposes learners to manageable doses of stress so that genuine emergencies produce less cognitive and behavioral disruption. Crucially, exposure alone does not constitute the intervention. Trainees first learn how stress affects cognitive and physiological functioning, then acquire and rehearse specific coping skills, and only then apply those skills under progressively realistic pressure (Meichenbaum & Deffenbacher, 1988).

In medical education, high-fidelity simulation offers a particularly well-suited platform for this kind of training. Simulated resuscitations are safe for patients, reproducible, and, importantly, capable of eliciting meaningful stress responses, reliably elevating heart rate, anxiety, and physiological influence in trainees (Bond & Spillane, 2002; DeMaria et al., 2010). If simulation can reproduce key elements of the stress experienced during real emergencies, perhaps it can be used to build resilience to its performance-degrading effects. This narrative review addresses that question directly: can repeated exposure to simulated emergencies improve performance under pressure? The sections that follow trace the theoretical foundations of SIT, examine evidence from other high-stakes professions, review the empirical literature in medical and emergency medicine education, consider the mechanisms by which stress adaptation may develop, and offer practical guidance for educators designing stress-inoculation curricula.

## 2. The Psychology of Stress and Performance

The relationship between stress and performance has been described for more than a century. The classic Yerkes-Dodson law holds that performance rises with influence up to an optimum and then deteriorates as influence becomes excessive (Yerkes & Dodson, 1908). The inverted-U is an acknowledged simplification, but it captures a pattern familiar to clinicians: a moderate degree of activation can sharpen focus, while overwhelming stress can impair performance. In a widely cited review of stress and performance in health professions education, LeBlanc (2009) documented the mechanisms more precisely: acute stress narrows the field of attention, impairs working memory, disrupts retrieval of previously learned information, and pushes decision-making toward rigid, habitual responses, a particularly concerning pattern when clinical circumstances deviate from familiar or expected presentations.

These findings are not confined to experimental settings. Hunziker et al. (2011) observed 120 medical students performing simulated resuscitations and found that self-reported stress and feelings of overload rose sharply during the scenario; critically, higher stress predicted measurably worse performance, with a significant negative association between the stress/overload index and hands-on time, a core quality metric of cardiopulmonary resuscitation. Piquette et al. (2014), in a randomized crossover study of residents, similarly showed that adding acute stressors to simulated resuscitation episodes impaired clinical performance. The emergency

department contains many of these stressors: time pressure, noise, incomplete information, emotional intensity, and the possibility of patient deterioration or death. These conditions underscore the relevance of simulation findings to real-world emergency care, while also highlighting the greater complexity of the clinical environment.

None of this implies that stress is uniformly detrimental. Moderate influences can mobilise attention and effort, and some degree of emotional activation may facilitate learning and memory encoding, a point to which we return below. The educational challenge is therefore not to eliminate stress, an unrealistic and potentially undesirable goal, but rather to train clinicians to function effectively under conditions of acute stress. That distinction lies at the conceptual core of stress-inoculation training.

## 3. Stress-Inoculation Training: From Clinic to Classroom

Meichenbaum (1985) originally designed SIT as a structured, three-phase intervention for clinical populations experiencing anxiety, anger, and pain. In the first phase, conceptualization, clients learn about the nature and effects of stress: how it manifests, physiologically and psychologically, how it influences cognition, and how individual appraisal of a situation shaped the stress response. In the second phase, skills acquisition and rehearsal, they build a repertoire of coping techniques, including controlled breathing, task-focused self-talk, imagery, and attentional cueing, and rehearse these strategies until they can be applied reliably. In the third phase, application and follow-through, they apply those skills during exposure to graded stressors, beginning with lower-intensity challenges and progressing toward increasingly realistic conditions, so that coping is rehearsed under conditions that approximate real life (Meichenbaum & Deffenbacher, 1988). The metaphor of inoculation is deliberate: the stressor must be sufficiently challenging to activate a meaningful stress response while remaining manageable enough to permit effective coping and learning.

The early evidence was encouraging. A meta-analysis of 37 studies encompassing 1,837 participants concluded that SIT effectively reduced performance anxiety and state anxiety while enhancing performance under stress, with effects that did not significantly vary according to trainer experience, setting, or trainee population (Saunders et al., 1996). These findings suggested that the approach could generalize beyond its original clinical context. Recognizing this potential for broader application, human-factors researchers adapted the clinical model for applied training environments. Driskell and Johnston (1998) described stress exposure training as a three-stage program: first, provide information about stress and its effects; second, develop cognitive and behavioural skills for maintaining performance under pressure; and third, practice the target task under simulated stress conditions.

This formulation is particularly relevant for medical education because it distinguishes between two approaches that may otherwise appear similar. Merely repeating stressful scenarios constitutes stress exposure, whereas stress inoculation requires that exposure be deliberately integrated with coping-skills training and structured reflection. The distinction becomes especially important when evaluating the medical literature, in which interventions very considerably in the extent to which they incorporate the complete SIT framework.

## 4. Lessons From Other High-Stakes Domains

Before stress inoculation was applied to resuscitation training, evidence for its underlying principles emerged from other professions characterized by performance under substantial pressure. In aviation, McClernon et al. (2011) demonstrated that pilots who received stress training performed better during a subsequent stressful flight scenario than untrained controls, suggesting that benefits may transfer from training conditions to subsequent operational stressors. Of particular relevance to educators is the work of Driskell et al. (2001), who examined the generalizability of stress training. Participants trained under one type of stressor retained their performance gains when confronted with a different stressor, and those trained on one task performed better when switched to a novel task. The findings suggest that training may foster more than a narrow stimulus-specific response, instead developing a broader capacity to maintain performance across changing stressors and task demands.

Surgery, the medical specialty with an established emphasis on stimulation, technical proficiency, and performance under pressure, has produced supportive evidence as well. A systematic review and meta-analysis by Rao et al. (2015) found that mental training, a group of techniques that overlaps with several coping and rehearsal components of SIT, improved the acquisition of technical surgical skills. Taken together, these literatures provide preliminary support for the proposition that performance under pressure can be trained and that benefits may generalize beyond the original training context. What they cannot establish is whether the same holds in the distinctive clinical environment of emergency care, where stress is shaped not only by task demands but also by patient suffering and team dynamics. Addressing that question requires examination of the simulation literature within medical education itself.

## 5. The Evidence in Medical and Emergency Medicine Education

A central premise of stress-inoculation training in medical education is that simulated emergencies can generate sufficient psychological and physiological stress to provide a meaningful training stimulus. The evidence generally supports this premise. Simulation has long been used for emergency medicine resident assessment (Bond & Spillane, 2002), and studies have demonstrated that simulated resuscitations elevate heart rate, anxiety scores, and physiological influence in trainees (DeMaria et al., 2010). Simulation, therefore, can function not only as a clinical rehearsal but also as a psychologically consequential learning experience.

Some of the strongest evidence that deliberately introduced stressors may influence learning comes from DeMaria et al. (2010), who randomly assigned medical students in an advanced cardiac life support course to a standard simulated cardiac arrest or to an identical scenario incorporating scripted emotional stressors, including a distressed family member, a disruptive intern, and an intravenous line accidentally dislodged. The emotional-content group reported significantly higher state anxiety (mean 35.0 versus 28.2) and showed significantly higher heart rates. Six months later, written knowledge did not differ between groups, but the stressed group significantly outperformed controls on the practical

mega code assessment (32.5 versus 25.0). The findings suggest that introducing emotional stress during simulation may strengthen the retention or subsequent application of procedural learning, even when it does not improve written knowledge. A follow-up study examining simulated patient death similarly found that the emotional intensity of a scenario influenced students' stress responses and their learning of resuscitation content (DeMaria et al., 2016).

If adding stress can enhance learning, can training to cope with stress protect performance? Hunziker et al. (2013) randomized 124 medical students to receive either a ten-minute instruction in a task-focusing strategy, which involved asking aloud about the patient's current condition and the immediate action required when participants felt overwhelmed, or no intervention, before a simulated cardiac arrest. The intervention group reported significantly less stress and overload and achieved approximately 10% more hands-on time, although this difference in performance was not statistically significant. These findings suggest that a brief cognitive strategy may influence the subjective experience of stress without necessarily producing a measurable improvement in objective performance. The limited duration and opportunity for rehearsal may have constrained the intervention's effect.

A similar lesson emerges from a direct evaluation of a stress-management intervention among emergency medicine trainees. Aronson et al. (2021) randomized second-year emergency medicine residents across seven programs to receive a didactic session on the "Breathe, Talk, See, Focus" mental performance tool, which incorporated controlled breathing, positive self-talk, visualization, and a cue word, or no training, and then measured stress responses during a standardized simulated resuscitation one month later. The trial found no significant differences between groups in anxiety scores, heart rate, or heart rate variability. Importantly, however, the intervention was limited to a single 20-minute session followed by a five-minute refresher, while independent practice was encouraged but not systematically monitored or reinforced. These features limit the extent to which the intervention represents a complete longitudinal SIT approach. Residents nevertheless perceived the training as relevant and valuable after applying it, and the authors suggested that more extensive and longitudinal training may be necessary to produce measurable effects.

Read together, these studies suggest that the intensity, duration, and structure of stress training may be important determinants of its effectiveness. More comprehensive approaches combining coping-skills training with repeated or graded stress exposure have demonstrated benefits in other settings (Rao et al., 2015; Saunders et al., 1996). Emotional stress embedded in simulation may enhance longer-term practical performance even without explicit skills training (DeMaria et al., 2010). By contrast, brief, single-session interventions in medical trainees have produced changes in subjective stress or nonsignificant trends in performance, while failing to demonstrate consistent improvements in objective outcomes (Aronson et al., 2021; Hunziker et al., 2013). Rather than demonstrating that SIT is ineffective in emergency medicine, these findings highlight a mismatch between the multidimensional, progressive nature of SIT and the comparatively brief interventions evaluated to date. The question of whether repeated exposure helps therefore remains incompletely resolved, but the available evidence supports a model in which stress exposure is most likely to be beneficial when it is graduated, repeated, and integrated with deliberately practiced coping strategies.

## 6. How Stress Adaptation Develops: Candidate Mechanisms

Why should rehearsing under stress produce durable adaptation? Several complementary mechanisms may contribute. The most obvious is habituation: with repeated exposure, the novelty and unpredictability of emergency scenarios may diminish, potentially reducing the physiological arousal associated with unfamiliarity. But habituation alone cannot explain the generalization findings of Driskell et al. (2001), in which training benefits persisted despite changes in both the stressor and the task. These findings suggest that stress training may also develop skills or responses that transfer across contexts.

A second mechanism is the increasing automaticity of coping responses. Skills such as controlled breathing, task-focused self-talk, and attentional cueing are easy to describe but more difficult to implement when cognitive resources are already strained. Repetition under stress may increase the fluency and automaticity of these strategies, making them more readily accessible when deliberate cognitive processing is compromised (Driskell & Johnston, 1998; Meichenbaum, 1985). Third, inoculation may alter how trainees appraise stressful situations. A trainee who has successfully navigated repeated difficult, simulated resuscitations may approach subsequent scenarios with greater familiarity and confidence, interpreting the stressor as a manageable challenge rather than an unfamiliar threat. This shift from threat to challenge may help preserve cognitive flexibility under pressure and may also contribute to greater self-efficacy.

Finally, stress itself may contribute to learning. The findings of DeMaria et al. (2010) are consistent with evidence that emotional arousal can influence the encoding and retention of salient experiences. In this view, the stress of simulation is not merely something to be tolerated on the way to competence; when appropriately calibrated, it may contribute to the salience and durability of the learning experience. The goal of SIT, then, is not to produce a stress-free trainee, but to develop a clinician who can recognize, regulate, and perform effectively despite the presence of stress.

## 7. Designing a Stress-Inoculation Curriculum for Emergency Medicine

For program directors and simulation educators, the literature suggests several concrete design principles, which together support implementing SIT as a longitudinal, three-phase training model rather than as an isolated educational intervention.

- **Teach the science first.** Begin with an explicit conceptualization phase in which residents learn how acute stress can affect attention, working memory, information retrieval, and decision-making. This foundation may help trainees recognize their own stress responses and understand the rationale for subsequent coping-skills training (Meichenbaum, 1985).
- **Train specific, rehearsable skills.** Tools such as "Breathe, Talk, See, Focus" provide concrete techniques, but these strategies require deliberate and repeated rehearsal if they are to become readily accessible under conditions of acute stress (Aronson et al., 2021).
- **Grade the dose.** Sequence scenarios from lower-intensity stressors toward increasingly complex and realistic conditions, progressively incorporating time pressure, distractors, emotional content, and when educationally appropriate, simulated patient deterioration or death. The aim is to generate sufficient stress to challenge coping skills without producing levels of distress that interfere with learning (DeMaria et al., 2010; Driskell & Johnston, 1998).
- **Vary the stressors.** Training benefits may generalize across different stressors and tasks, varying the sources and types of pressure during simulation may promote more transferable stress-management skills than repeatedly exposing trainees to the same scenario conditions (Driskell et al., 2001).
- **Debrief the coping, not just the case.** Post-scenario reflection should address trainees' recognition and regulation of stress alongside clinical reasoning, technical performance, and teamwork. Debriefing can therefore reinforce both what trainees did and how they maintained, or lost, effective performance under pressure.
- **Sustain it longitudinally.** The null results of brief interventions suggest that isolated sessions may provide insufficient opportunity for coping strategies to become established and transferable. Stress-inoculation training may therefore be better incorporated throughout residency, with repeated exposure, skills rehearsal, and periodic reinforcement (Aronson et al., 2021; Hunziker et al., 2013).

Two cautions deserve emphasis. First, psychological safety remains foundational: the purpose of stress exposure is to facilitate adaptation and learning, not simply to maximize distress. Stressors should therefore be purposeful, appropriately calibrated, and accompanied by adequate preparation and debriefing, with facilitators attentive to signs that distress has exceeded the intended educational challenge. Second, evaluation should accompany implementation. Programs that add stress to scenarios without measuring its effects using complementary subjective, physiological, and performance-based outcomes will be unable to distinguish an appropriately challenging intervention from stress that adds little educational value.

## 8. Limitations and Future Directions

This review is narrative rather than systematic, and the underlying literature has several important limitations. Studies are generally small, frequently conducted at single centres, and disproportionately involve medical students rather than emergency medicine residents or practicing physicians. Interventions are highly heterogeneous in content, intensity, and duration, complicating direct comparison across studies: interventions ranging from brief didactic sessions to longitudinal training programs may be grouped under the broad category of stress training. Outcome measurement is likewise inconsistent, with studies variously assessing subjective anxiety, clinical performance metrics, and physiological markers of stress. Physiological measures such as heart rate variability are also susceptible to potential confounding factors, including caffeine consumption, baseline fitness, medication use, and sleep deprivation (Aronson et al., 2021). Most importantly, the question of transfer to clinical practice remains unresolved: most evidence comes from simulated environments, and although it is plausible that adaptations developed during simulation may transfer to actual resuscitations, this assumption has received limited empirical testing.

Future research should prioritize longitudinal, multicentre trials evaluating comprehensive SIT curricula using standardized and repeated objective outcome measures. Physiological monitoring during actual clinical resuscitations may provide one avenue for determining whether adaptations observed in simulation persist in real-world practice. Investigators should also consider outcomes beyond immediate clinical performance, including longer-term measures of psychological well-being and occupational stress, while recognizing that these outcomes may involve mechanisms extending beyond the intended effects of SIT. Finally, the field needs to determine not only whether SIT is effective, but which trainees benefit most, under what conditions, and at what stage of training. The optimal intensity, frequency, duration, and progression of stress exposure, and the extent to which these should be individualized, remain important unanswered questions.

## 9. Conclusion

Can repeated exposure to simulated emergencies improve performance under pressure? The available evidence suggests that repeated exposure may improve performance, provided that it is incorporated within a structured and comprehensive stress-inoculation framework. Acute stress can impair cognitive processes essential to effective resuscitation, including attention, working memory, information retrieval, and decision-making. Evidence from cognitive psychology, human-factors research, and simulation-based medical education further indicates that the capacity to maintain performance under stress may be enhanced through systematic training. Importantly, however, stress exposure alone should not be equated with stress inoculation.

Repeated exposure without explicit coping-skills training, structured reflection, and progressively challenging conditions may be insufficient to produce meaningful or durable adaptation. Rather, the available literature suggests that stress-inoculation training is most likely to be effective when stress exposure is graduated, varied, paired with deliberately rehearsed cognitive and behavioural coping strategies, and reinforced longitudinally. Under these conditions, training may foster not only familiarity with stressful situations but also a transferable capacity to preserve effective cognitive and behavioural performance under pressure. For emergency medicine education, future efforts should therefore focus on the rigorous implementation and evaluation of longitudinal stress-inoculation curricula, with particular attention to optimal training intensity and duration, individual variability in response, and the extent to which improvements demonstrated in simulation transfer to clinical resuscitation.

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