Early crisis nontechnical skill teaching in residency leads to long-term skill retention and improved performance during crises: A prospective, nonrandomized controlled study

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Background. *Medical error is common in crises, and the majority of observed errors are nontechnical in nature. The long-term impact of teaching crisis nontechnical skills to residents has not been evaluated. The objective of this study was to determine the effect of simulation-based teaching of crisis nontechnical skills compared to controls one year after initial teaching.*

Methods. *This was a prospective study using both historical controls and a before-and-after methodology to evaluate the effect of a high-fidelity simulation curriculum that used crisis resource management principles to teach nontechnical skills. Postgraduate year 2 and 3 residents were invited to take part in a prospective training course over 2 years. The primary outcome was leader performance evaluated by expert raters using the previously validated 7-point Ottawa Global Rating Scale.*

Results. *Overall, 23 residents performed 30 simulations over the 2 years with the intervention group of 7 residents being assessed in both years. After adjustment, the postgraduate year 3 intervention group who received training the previous year had significantly higher overall performance scores than all postgraduate year 2 scores (1.09 95% confidence interval 0.70–1.47,* $P < .001$*) and the historical postgraduate year 3 cohort who received no prior training (1.20, 95% confidence interval 0.37–2.03,* $P = .005$*). There was no decay of skills noted over the course of the study.*

Conclusion. *Postgraduate year 3 residents who had prior training had significantly improved crisis performance compared to historical postgraduate year 3 controls and untrained postgraduate year 2 residents. There were no significant differences between the crisis performance of postgraduate year 2 residents and the untrained postgraduate year 3 controls. This confirms the beneficial effect and long-term retention after crisis nontechnical skill training. (Surgery 2016;■:■-■.)*

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Flawed behaviors have been increasingly recognized as the origin of a large proportion of avoidable adverse events by surgeons, occurring in as many as 78% of malpractice claims with failure in communication being the most pervasive.[1,2] The effects of these behaviors become amplified in a crisis as ambient noise, crowding, diagnostic ambiguity, and rapidly evolving scenarios can confound cohesive team behaviors and pose a direct threat to patient safety.

Accordingly, medical error is common during trauma resuscitations, occurring in all settings regardless of the experience of the practitioner.[3] Many of the errors stem from poor leadership, ineffective communication, and an inability to cope cognitively with the changing resources and situations that arise.[4-6]Acute stress among team members

can further affect team performance, promoting a loss of team-based perspective, degradation of shared mental models, and faulty or heuristic-based decision-making.[7-9]

In commercial and military aviation, standardized crew resource management training has been developed and broadly implemented as a specific countermeasure to human error.[10,11] This robust, interprofessional training strategy utilizes high-fidelity flight simulation to improve safety by training teams in "nontechnical" skills, such as closed-loop communication, cross-checking and cross-monitoring, leadership, resource utilization, and situational awareness, and has been credited in part for the steady decline in fatal aviation events during the past 3 decades.[10,12,13] Lessons from these high-hazard, high-reliability industries has influenced the development of crisis resource management (CRM) principles and teaching courses in trauma.[14,15]

Evidence as to the effect of teaching these skills during residency is sparse. Generally, residents enjoy the training, find it useful, and it can lead to short-term improvements, but a prevailing thought is that these skills develop naturally as residents progress in their training and so the utility of specific teaching may be dubious.[16-18] To this point, it has not been established that these skills need to be explicitly taught during residency but rather only assessed as they are thought to naturally develop, similar to technical skills, as residents progress through training.

Accordingly, several regulatory bodies mandate their assessment in recent guidelines, but the exact implementation is flexible.[19,20] The objective of this study is therefore to determine how postgraduate year 3 (PGY-3) general surgery residents with previous crisis training perform compared to untrained residents with the same experience level and whether teaching these skills lead to durable results.

METHODS

Design. This was a prospective study using both historical controls and a before-and-after methodology with external validation to evaluate the effect of a high-fidelity simulation curriculum to teach crisis nontechnical skills to general surgery residents (Fig 1). Residents during their PGY-3 year who received training through the curriculum as PGY-2s served as the intervention group. PGY-3 residents from the first year of the study who did not receive previous CRM training served as historical controls.

The scores as PGY-2 residents of the intervention group are the before-and-after control group. This

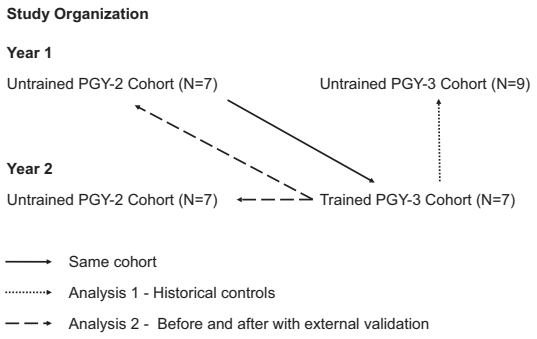

Fig 1. Study design.

group was combined with scores from a second cohort of PGY-2 residents who provided external validation of the findings. All PGY-2 residents who participated did not have prior CRM training. This project was reviewed by the Hamilton Integrated Research Ethics Board of McMaster University and Hamilton Health Sciences.

Participants. Three consecutive cohorts of trainees participated in this study during their PGY-2 and PGY-3 years from the McMaster University General Surgery Residency Program. The format of the residency program is such that all residents rotate through a dedicated 2-month trauma rotation and at least 2 months of general surgery at the trauma center during their first 2 years. During these junior rotations, they serve as the general surgery team members on the trauma teams, but trauma fellows and senior residents serve as the trauma team leaders. During the PGY-3 year, there are no mandatory trauma rotations.

Environment. The course was held at the McMaster University Centre for Simulation-Based Learning (CSBL) over 2 years. The CSBL utilizes the SimMan 3G (Laerdal, Wappingers Falls, NY), an operator-controlled, full-sized, human-patient simulator that can breathe and speak, has palpable pulses, an audible heartbeat, and breath sounds. The "health" of SimMan 3G can be interactively manipulated on the basis of management decisions and can be made to either improve or deteriorate based on the appropriateness of interventions. A single experienced operator controlled all scenarios. To add realism to the operative scenarios and setting, confederates not associated with the surgery program were utilized in lieu of other residents to play the major scripted ancillary roles for the scenarios.

Training days. Participants were randomly divided into teams of 3 trainees at the same PGY level. Teams received a standard orientation to the simulator environment. Teams then participated in 3,