Practicality of using galvanic skin response to measure intraoperative physiologic autonomic activation in operating room team members

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Background. *Physiologic and psychological stress are commonly experienced by operating room (OR) personnel, yet there is little research about the stress levels in OR teams and their impact on performance. Previously published procedures to measure physiologic activation are invasive and impractical for the OR. The purpose of this study was to determine the practicality of a new watch-sized device to measure galvanic skin response (GSR) in OR team members during high-fidelity surgical simulations.*

Methods. *Interprofessional OR teams wore sensors on the wrist (all) and ankle (surgeons and scrub nurses/technicians) during the orientation, case, and debriefing phases for 17 simulations of a surgical airway case. Data were compared across all simulation phases, collectively and for each professional group.*

Results. *Forty anesthesiology residents, 35 surgery residents, 27 OR nurses, 12 surgical technicians, and 7 CRNAs participated. Collectively, mean wrist GSR levels significantly increased from orientation phase to the case (0.40–0.62 μS;* $P < .001$*) and remained elevated even after the simulation was over (0.40–0.67 μS;* $P < .001$*). Surgery residents were the only group that demonstrated continued increases in wrist GSR levels throughout the entire simulation (change in GSR = 0.21 to 0.32 to 0.11 μS;* $P < .01$*). Large intraindividual differences (≤200 times) were found in both wrist and ankle GSR. There was no correlation between wrist and ankle data.*

Conclusion. *Continuous GSR monitoring of all professionals during OR simulations is feasible, but would be difficult to implement in an actual OR environment. Large variation in individual levels of physiologic activation suggests complementary qualitative research is needed to better understand how people respond to stressful OR situations. (Surgery 2015;158:1415-20.)*

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Successful surgery in the operating room (OR) requires a high performance team, yet research on the actual factors that influence an OR team's performance is lacking, especially with regards to perception and management of physiologic stress by each member of the OR team.[1] Physiologic activation is a person's response to environmental conditions or stimuli. An individual's response is modulated partly by an assessment of the demands placed on him or her by the situation and then a follow-up assessment of the resources that are currently available. If the demands outweigh the needed resources, then a physiologically activated individual will feel "stressed" which may be mediated through an activated hypothalamic–pituitary–adrenal axis. Stimulation of the hypothalamic–pituitary–adrenal axis results in increases in hormones, including cortisol and catecholamines, as well as an increase in basal body temperature, pupil constriction, blink rate, blood pressure, and heart rate.[2]

However, the resulting stress from physiologic activation is not necessarily a negative condition. In fact, the cognitive psychology literature

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demonstrates that activation has an "inverted U" relationship with performance in that some levels of activation may help an individual to perform at a level that is higher than their baseline state.[3] LeBlanc et al[4] noted that general surgery residents had improved technical performance on task trainers when subjected to moderate stress conditions. On the other hand, excessive activation may lead to severe stress that overwhelms an individual or team, with resulting impairment in memory, attention, decision making, and general performance, regardless of previous training.[5]

Despite our recognition that high levels of autonomic activation are experienced in the OR, little research has quantified physiologic activation in OR teams and its impact on performance. Current techniques to measure activation or stress in research subjects such as salivary tests for cortisol, α-amylase, or chromogranin A levels are not practical for OR teams because they are invasive, episodic, interfere with normal workflow, and can be difficult to interpret.[6,7] The recent development of wireless physiologic monitoring devices to record electrodermal activity, electroencephalography, heart rate variability, or blood pressure may be useful measurements of stress or activation during simulation sessions. In particular, electrodermal activity as measured by galvanic skin response (GSR), is a well-accepted indicator of reticular activation and, therefore, of emotion and cognition.[8] This study examined the practicality of a new watch-sized device (Neumitra, Inc, Boston, MA) that measures GSR. Specifically, we sought to describe and analyze physiologic activation of different professional groups within an OR team during a high-fidelity team-training simulation while simultaneously evaluating the feasibility of using GSR sensors in real operating rooms.

METHODS

OR simulation room and participants. We used an in situ OR simulator for all of the sessions from September 2013 to January 2014. With few exceptions, all equipment, drugs, and supplies were real and exactly the same as would be found in an actual clinical OR. The "patient" in these simulations was a SimMan Essential high-fidelity patient simulation mannequin whose changing physical characteristics and vital signs were controlled from an observational deck above the OR separated by 1-way glass (Fig 1). With the approval of the Institutional Review Board (Partners Healthcare, Boston, MA), this study was conducted with a mixed group of OR team members for each scenario: typically 2 anesthesiology residents (a postgraduate year (PGY)3 or 4 paired with a PGY2) or a PGY4 anesthesia resident paired with a certified registered nurse anesthetist (CRNA), 2 general surgery residents (a PGY4 or 5 paired with a PGY1), and 2 practicing OR nurses or 1 OR nurse and 1 surgical technician.

Fig 1. A high-fidelity simulation operating room at the Massachusetts General Hospital.

Simulation scenario. Each OR simulation began with an orientation phase in which participants were introduced to each other, reviewed the goals for crisis resource management training, discussed special considerations for in situ OR simulation, and reviewed the paperwork for the simulation case. This structure promoted a psychologically safe learning environment for the participants.

Next, all participants were moved to the in situ OR for the simulation case phase. Each team member met the mannequin patient who was a morbidly obese 39-year-old woman undergoing elective total thyroidectomy for papillary thyroid cancer. A Joint Commission of Accredited Hospital's preoperative "time-out" was conducted and the patient was given medications for general anesthesia. The patient then quickly desaturated and the team was faced with a "cannot mask, cannot intubate" situation. The OR team needed to recognize indications for cricothyrotomy and then accomplish it in a timely manner. Ideal behaviors included the declaration of an event manager or coordinator, and demonstration of closed loop communication between all OR team members to mobilize resources and supplies as it