Using an Individual Procedure Score Before and After the Advanced Surgical Skills Exposure for Trauma Course Training to Benchmark a Hemorrhage-Control Performance Metric ☆, ☆☆

Colin F. Mackenzie, MBChB,,† Evan Garofalo, PhD,*,‡ Stacy Shackelford, MD, FACS,§ Valerie Shalin, PhD,‖ Kristy Pugh, MS,* Hegang Chen, PhD,¶ Adam Puche, PhD,‡ Jason Pasley, DO, FACS,§ Babak Sarani, MD, FACS, Sharon Henry, MD, FACS,** and Mark Bowyer, MD, FACS††*

*Shock, Trauma and Anesthesiology Research Center, University of Maryland School of Medicine, Baltimore, Maryland; †Department of Anesthesiology, University of Maryland School of Medicine, Baltimore, Maryland; ‡Department of Anatomy and Neurobiology, University of Maryland School of Medicine, Baltimore, Maryland; §US Airforce Center for the Sustainment of Trauma and Readiness Skills, Baltimore, Maryland; ‖Department of Psychology, Wright State University, Dayton, Ohio; ¶Department of Epidemiology, University of Maryland School of Medicine, Baltimore, Maryland; Department of Surgery, George Washington University School of Medicine, Washington, District of Columbia; **Department of Surgery, University of Maryland School of Medicine, Baltimore, Maryland; and ††Department of Surgery, Uniformed Services University of the Health Sciences, Bethesda, Maryland

OBJECTIVE: Test with an individual procedure score (IPS) to assess whether an unpreserved cadaver trauma training course, including upper and lower limb vascular exposure, improves correct identification of surgical landmarks, underlying anatomy, and shortens time to vascular control.

DESIGN: Prospective study of performance of 3 vascular exposure and control procedures (axillary, brachial, and femoral arteries) using IPS metrics by 2 colocated and trained evaluators before and after training with the Advanced Surgical Skills Exposure for Trauma (ASSET) course. IPS, including identification of anatomical landmarks, incisions, underlying structures, and time to completion of each procedure was compared before and after training using repeated measurement models.

SETTING: Audio-video instrumented cadaver laboratory at University of Maryland School of Medicine.

PARTICIPANTS: A total of 41 second to sixth year surgical residents from surgical programs throughout Mid-Atlantic States who had not previously taken the ASSET course were enrolled, 40 completed the pre- and post-ASSET performance evaluations.

RESULTS: After ASSET training, all components of IPS increased and time shortened for each of the 3 artery exposures. Procedure steps performed correctly increased 57%, anatomical knowledge increased 43% and skin incision to passage of a vessel loop twice around the correct vessel decreased by a mean of 2.5 minutes. An overall vascular trauma readiness index, a comprehensive IPS score for 3 procedures increased 28% with ASSET Training.

CONCLUSIONS: Improved knowledge of surface landmarks and underlying anatomy is associated with increased

☆The article was presented at the Surgical Education Week, April 21-25, 2015, Seattle, WA, and has not been published nor is it under consideration to for publication elsewhere.

☆☆Disclaimer: This research and development project was conducted by the University of Maryland, School of Medicine and was made possible by a cooperative agreement that was awarded and administered by the U.S. Army Medical Research and Materiel Command (USAMRMC) and the Telemedicine and Advanced Technology Research Center (TATRC) at Fort Detrick, MD, under Contract no. W81XWH-13-2-0028. The views, opinions, and findings contained in this publication are those of the authors and do not necessarily reflect the views of the Department of Defense and should not be construed as an official Department of Defense position, policy, or decision unless so designated by other documentation. No official endorsement should be made.

Correspondence: Inquiries to Colin F. Mackenzie, MBChB, Shock, Trauma and Anesthesiology Research Center, University of Maryland School of Medicine, 11 South Paca St., Baltimore, MD 21201; e-mail: cmack003@gmail.com

  1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2015.06.009

IPS, faster procedures, more accurate incision placement, and successful vascular control. Structural recognition during specific procedural steps and anatomical knowledge were key points learned during the ASSET course. Such training may accelerate acquisition of specific trauma surgery skills to compensate for shortened training hours, infrequent exposure to major vascular injuries, or when just-in-time training is necessary. IPS is a benchmark for competence in extremity vascular control. (J Surg Ed 72:1278-1289.

KEY WORDS: clinical competence, psychomotor performance, hemorrhage-control skill, educational measurement instrument, observational evaluation, open vascular surgical procedures, resident education

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice, Patient Care

INTRODUCTION

Bleeding is the leading cause of preventable early death in military and civilian casualties. The rate of vascular injury in modern combat is 5 times greater than reported in previous wars. Extremity vascular injuries represent between 50% and 70% of all injuries treated during Operation Iraqi Freedom.[1,2] Hemorrhage was identified as the predominant mechanism of death in 80% of battle casualties who died of potentially survivable wounds after hospital admission, including 31% from extremity wounds and 21% from junction wounds.[3] Trauma surgeons must maintain proficiency in the surgical exposure and control of major blood vessels, a key factor in reducing preventable deaths.[4,5] However, various factors have resulted in an overall decrease in vascular surgical trauma training including limits on surgical training hours, a reduction in penetrating trauma nationwide, less injury from motor vehicle crashes owing to improved vehicular protection and use of interventional radiological approaches to control major hemorrhage.[6,7] As a result, surgeons lack access to these combat surgical skills in civilian practice before military deployment.

The Advanced Surgical Skills for Exposure in Trauma (ASSET) course was developed to fill this training gap. The course is a human cadaver-based 1-day course developed by the American College of Surgeons Committee on Trauma and adopted by military predeployment training platforms to teach surgeons how to expose and control major blood vessels. Vascular exposure is the requisite first step in achieving control of major hemorrhage[8] and the course reviews all the major vascular exposures in the body. ASSET training includes 59 procedures, and has been shown to increase self-confidence in performing these procedures.[9] However. no objective assessment of training outcomes has been done. None of the currently available surgical skills performance metrics were designed for emergency trauma surgery assessment or trauma-specific procedures.[10-16] Thus, a benchmark is needed to standardize individual surgeon's performance evaluations for emergency hemorrhage control. We tested the hypothesis that a novel assessment method, individual procedure score (IPS), can quantify the outcome of ASSET training among residents using combat-relevant upper and lower extremity emergency vascular exposure and control scenarios.

METHODS

All study procedures involving human subjects received Institutional Review Board approval by the University of Maryland, and the U.S. Army Office of Research Protection. Cadavers were supplied by, and cadaver use procedures approved by the State Anatomy Board of Maryland and the U.S. Army Office of Research Protection. General surgery residents and trauma fellow research subjects were recruited through surgical programs in Maryland, District of Columbia, Pennsylvania, Delaware, New Jersey, Virginia, and New England. Residents enrolled were provided with a study participation payment, in addition to ASSET course registration and travel to and from the University of Maryland, School of Medicine, Baltimore, for study participation before and within 2 weeks after completing the ASSET course. All residents underwent a formal consent process, had an opportunity to ask questions and completed informed consent before participation. Participants completed a demographics questionnaire (years in residency and numbers of upper and lower extremity vascular procedures performed), then performed axillary (AA), brachial (BA), and common, superficial, and profunda femoral artery (FA) vascular exposure procedures on unpreserved cadavers guided by a standardized script. The script included a patient scenario, patient management knowledge questions, and marking of the planned surgical incision, followed by completing the indicated procedure. To ensure capture of all procedures, responses to questions, and surgeon commentary on their actions, each research subject wore a head mounted laser-directed head camera (Looxcie LX2 Looxcie, Inc., Sunnyvale, CA) and headset boom microphone (Clear-com CB222/Clear-com CC-95 headset Clear-Com, LLC, Alameda, CA). Audio and video recordings were also made from ceiling-mounted microphones (Shure MX202 Ceiling Mic Shure Inc., Niles, IL) and pan-tilt zoom cameras (Vaddio Ceiling View 70 PTZ Camera Vaddio, Minnetonka, MN) at each location, and wall-mounted overview cameras at each of 6 instrumented cadaver table locations.

Metrics Development

The performance evaluation metrics for 3 upper and lower extremity vascular control procedures were developed and