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TITLE: Emergency Refreshing of Combat Surgical Skills

PRINCIPAL INVESTIGATOR: Samuel A. Tisherman, MD

RECIPIENT:
University of Maryland, Baltimore
Baltimore, MD 21201

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1. **INTRODUCTION:** Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.

This research project aims to maximize healthcare professionals' performance of life saving trauma management cognitive and psychomotor skills by use of near time emergency refreshing interventions. The interventions to be tested consist of (1) pre- and intraoperative video review and (2) intra-operative telementoring assistance. The primary outcome measure is surgeons' performance of 4 critical trauma procedures on cadavers. In addition to testing these specific performance enhancing tools, information into underlying behavioral models of surgeon performance will be studied so that these cognitive models can be used to guide the design of future interventions.

2. **KEYWORDS:** Provide a brief list of keywords (limit to 20 words).

Vascular injury, Combat wounds, Surgical training, Education, Surgical intervention, Telementoring, Video review, Skill retention, Error prevention, Error correction

3. **ACCOMPLISHMENTS:** The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency grants official whenever there are significant changes in the project or its direction.

What were the major goals of the project?

List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

1. Assessment of whether static video refreshing of knowledge or dynamic interaction with a telementor are effective at improving outcome of trauma surgical performance of vascular exposure and fasciotomy versus a no refresher control condition in unpreserved cadavers.
2. Development of video / image tools (Surgical Technical Assistance Tool [STAT]) for video mental review (VMR) of key steps in the vascular exposure and fasciotomy procedures.
3. Development of a telementoring system (Telementor Initiated Procedure Support [TIPS]) for remote dynamic interactive telementoring (DIT) in trauma procedures.
4. Evaluate 'think-aloud' from the surgeon audio recordings for content and affective metrics, as well as surgeons' self-reported perceptions of self-confidence/helpfulness from VMR and DIT.

What was accomplished under these goals?

For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

1. Recruitment and testing for experimental and control participants continued in this year of the award. Subjects are surgeons who have taken the Advanced Surgical Skills for Exposure in Trauma (ASSET) course within 2-6 years and completed training or are in their final year of training, equivalent to being at or near deployment ready. A total of 56% (59 out of 105) of evaluations have been finished, with 11% of the total recruitment (12 out of 105) completed since the last annual report and 2% of the total recruitment (2 out of 105) during this quarter.
2. Initial comprehensive data analysis on the lower extremity fasciotomy (LEF) and upper extremity fasciotomy (UEF) shows a highly significant improvement in performance with both the video (STAT) and telementoring (TIPS) interventions.
3. These interventions (STAT/TIPS) focus upon correct performance of the procedure and not on patient management or pathophysiology understanding of the clinical procedure. Thus, when we examined the pathophysiology Individual Procedure Score (IPS), there was no difference between interventions (Figure 1A-B).

4. In contrast, we hypothesized that both interventions would improve procedural performance. Indeed, both STAT and TIPS significantly improved the IPS procedural component score of participating surgeons (Figure 1C-D; $P < 0.00001$).

5. Ultimately, it is successful outcome of the procedures that is most important for the patient. The STAT and TIPS intervention improved LEF and UEF success in the number of compartments or constrictions correctly released (Figure 1 E-F; $P < 0.000001$). The TIPS intervention was more effective than STAT, which we conjecture represents the ability of a live telementor to redirect dynamically from an error or incorrect choice compared to a video checklist. We also observed that some study participants failed to utilize the STAT tool fully and made errors that a quick second review of the tool during the procedure would have rectified. This suggests that for STAT to have the greatest utility during deployment, it should be part of surgeon pre-deployment training to provide familiarity with the tool.

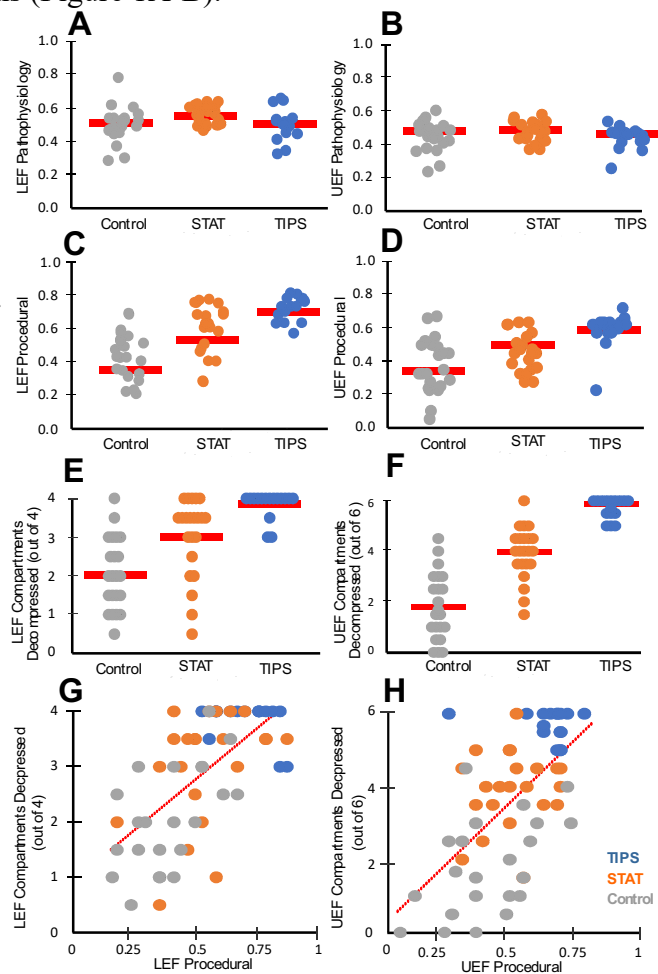


Figure 1: Pathophysiology, procedural, and successful compartment decompression between control, STAT, and TIPS groups in performance of LEF and UEF.

6. We also began cross correlation analysis of predictors of success. When comparing success in number of compartments or constrictions released against the procedural IPS score there was a strong positive correlation (Figure 1 G-H; $P < 0.0000001$). As expected, surgeons with STAT or TIPS assistance were in the upper region of the graph compared to controls who lacked assistance which cluster with lower scores in the graphic.
7. This initial analysis is consistent with our past data showing that IPS scores over approximately 0.6 are strong predictors of accurate performance of the procedure.

What opportunities for training and professional development has the project provided?

If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. "Training" activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. "Professional development" activities result in increased knowledge or skill in one's area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

1. Experienced evaluators (surgeons and anatomists) trained new evaluators on the procedures and protocols of the project and reviewed each procedure to ensure proficiency of new evaluators.
2. The project is supporting a human growth factors graduate student contributing to the incorporation of key medical issues in human factors.

How were the results disseminated to communities of interest?

If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

Nothing to Report.

What do you plan to do during the next reporting period to accomplish the goals?

If this is the final report, state "Nothing to Report."

Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

- In the next quarter, we plan to continue recruitment to catch up on lost recruitment time due to covid-19 and continue evaluation of surgical performance with the scheduled STAT and TIPS interventions to get as close as possible to our initial recruitment projections. Although high significance to the outcome has already been achieved on our primary goals, additional recruitment will enhance statistical power for secondary analyses and cognitive process analysis.
- Transcription of the audio recordings of the evaluations will continue for comprehensive ‘think-aloud’ cognitive analysis.
- Evaluation of the participant surgical performance and comprehensive data analysis will continue.

4. IMPACT: Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

What was the impact on the development of the principal discipline(s) of the project?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

Our data suggests that there is significant improvement in surgeon performance with the STAT and TIPS interventions compared to the control group. The impact on surgical performance of a simple intervention of a video check list (STAT) is significant and has a low cost for implementation. Furthermore, the impact of introducing a telementor has an even larger impact on surgical performance, although this has higher technological requirements for field deployment. The error rate by unassisted surgeons is high. The presence of a simple video review or a telementor tool provides highly significantly effective assistance.

What was the impact on other disciplines?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

The project aids the incorporation of key medical issues to human factors research.

What was the impact on technology transfer?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use, including:

- *transfer of results to entities in government or industry;*
- *instances where the research has led to the initiation of a start-up company; or*
- *adoption of new practices.*

The tools (video review tool, telementor scripts, and audio-visual technology) have been finalized for this project and could be used by the military and in other hospital settings to help improve the outcome of these four surgical procedures. This approach could be applied to other critical and time-sensitive procedures.

No such transfer has occurred as the technology is still being tested but within the next year progress will be made to disseminate what we have created to ASSET course directors and other educational programs.

What was the impact on society beyond science and technology?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

Nothing to Report.

- 5. CHANGES/PROBLEMS:** The PD/PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency grants official whenever there are significant changes in the project or its direction. If not previously reported in writing, provide the following additional information or state, “Nothing to Report,” if applicable:

Changes in approach and reasons for change

Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.

Nothing to report.

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

- The covid-19 pandemic has interrupted all recruitment and testing within this quarter and is projected to impact the next quarter as well. Since the average lead time frame for scheduling surgeons is 2-3 months, all testing sessions have been moved into fall 2020. We have budget to cover the anticipated cost efficiency diminishment of the altered plans and do not require additional funds for successful completion of the project.
- Between exhausting the total pool of ASSET trained surgeons with our outreach and with the impact of the pandemic we are behind on total study participant enrollment in this phase of the study.
- During the pandemic, we have remained productive and, instead, have moved ahead with comprehensive data analysis.
- Overall, the interventions we developed had larger impact on performance than originally projected and even with somewhat reduced total enrollment we have highly significant findings on the utility of these interventions. Thus, we are able to fully meet the stated goals of the proposal with current enrollment levels.

Changes that had a significant impact on expenditures

Describe changes during the reporting period that may have had a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

Nothing to report.

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, biohazards, and/or select agents during the reporting period. If required, were these changes approved by the applicable institution committee (or equivalent) and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Significant changes in use or care of human subjects

Nothing to Report.

Significant changes in use or care of vertebrate animals

Nothing to Report.

Significant changes in use of biohazards and/or select agents

Nothing to Report.

6. PRODUCTS: List any products resulting from the project during the reporting period. If there is nothing to report under a particular item, state “Nothing to Report.”

- **Publications, conference papers, and presentations**

Report only the major publication(s) resulting from the work under this award.

Journal publications. *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to Report.

Books or other non-periodical, one-time publications. *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

“Quantitative analysis of compartments in the leg and implications for trauma surgery.” Agandi, L. Successfully defended Masters Thesis presentation and paper.

Other publications, conference papers and presentations. *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year (international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.*

“Can a telementor improve incision placement & vessel identification in exposure of femoral artery?” Agandi L, Pugh K, Tisherman S and Puche A. Oral platform presentation at the American Association of Clinical Anatomists (AACCA) annual meeting in Tulsa, OK, June, 2019.

“Surface landmark identification & compartment decompression in performance of upper extremity fasciotomy” Pugh K, Agandi L, Tisherman S, and Puche A. Poster presentation at the American Association of Clinical Anatomists (AACCA) annual meeting in Tulsa, OK, June, 2019.

“Emergency, Just-In-Time Refreshing of Combat Trauma Surgical Skills, Via Video Review or Telementoring, Dramatically Improves Surgeon Performance of Extremity Fasciotomies” Tisherman SA, Puche A, Pugh K, Agandi K. Oral platform presentation at the Military Health System Research Symposium, Orlando, FL, August, 2019.

- **Website(s) or other Internet site(s)**

List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Nothing to Report.

- **Technologies or techniques**

Identify technologies or techniques that resulted from the research activities. Describe the technologies or techniques were shared.

Nothing to report.

- **Inventions, patent applications, and/or licenses**

Identify inventions, patent applications with date, and/or licenses that have resulted from the research. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

Nothing to Report.

- **Other Products**

Identify any other reportable outcomes that were developed under this project. Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the understanding, prevention, diagnosis, prognosis, treatment and /or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

- data or databases;
- physical collections;
- audio or video products;
- software;
- models;
- educational aids or curricula;
- instruments or equipment;
- research material (e.g., Germplasm; cell lines, DNA probes, animal models);
- clinical interventions;
- new business creation; and
- other.

Nothing to Report.

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Provide the following information for: (1) PDs/PIs; and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source

of compensation (a person month equals approximately 160 hours of effort). If information is unchanged from a previous submission, provide the name only and indicate “no change”.

Example:

Name: Mary Smith
Project Role: Graduate Student
Researcher Identifier (e.g. ORCID ID): 1234567
Nearest person month worked: 5

Contribution to Project: Ms. Smith has performed work in the area of combined error-control and constrained coding.
Funding Support: The Ford Foundation (Complete only if the funding support is provided from other than this award.)

Name: Samuel A. Tisherman
Project Role: Co-PI
Researcher Identifier (e.g. ORCID ID): 0000-0003-3810-3729
Nearest person month worked: 0.6
Contribution to Project: Dr. Tisherman has performed work in the development and implementation of surgical intervention development and evaluation on surgical performance.
Funding Support: W81XWH-17-2-0011

Name: Adam C. Puche
Project Role: Co-PI
Researcher Identifier (e.g. ORCID ID): 0000-0002-6847-1218
Nearest person month worked: 3
Contribution to Project: Dr Puche has performed work in the development and implementation of surgical intervention development and evaluation on surgical performance.
Funding Support: W81XWH-17-2-0011

Name: Kristy Pugh
Project Role: Research Lead Specialist
Researcher Identifier (e.g. ORCID ID): n/a
Nearest person month worked: 12
Contribution to Project: Kristy has performed work in the development and implementation of surgical intervention development and evaluation on surgical performance.
Funding Support: W81XWH-17-2-0011

Name: Lorreen Agandi
Project Role: Research Assistant, Clinical
Researcher Identifier (e.g. ORCID ID): n/a
Nearest person month worked: 12
Contribution to Project: Lorreen has performed work in the development and implementation of surgical intervention development and evaluation on surgical performance.
Funding Support: W81XWH-17-2-0011

Name: Valerie Shalin
Project Role: Sub-award recipient
Researcher Identifier (e.g. ORCID ID): n/a
Nearest person month worked: 0.75
Contribution to Project: Dr. Shalin has contributed to the development of the scenario scripts for dynamic interactive telementoring.
Funding Support: W81XWH-17-2-0011

Name: Claire Shah
Project Role: Sub-award recipient
Researcher Identifier (e.g. ORCID ID): n/a
Nearest person month worked: 4
Contribution to Project: Claire has contributed to the development of the scenario scripts for dynamic interactive telementoring.
Funding Support: W81XWH-17-2-0011

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

If the active support has changed for the PD/PI(s) or senior/key personnel, then describe what the change has been. Changes may occur, for example, if a previously active grant has closed and/or if a previously pending grant is now active. Annotate this information so it is clear what has changed from the previous submission. Submission of other support information is not necessary for pending changes or for changes in the level of effort for active support reported previously. The awarding agency may require prior written approval if a change in active other support significantly impacts the effort on the project that is the subject of the project report.

Nothing to Report.

What other organizations were involved as partners?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed.

Provide the following information for each partnership:

Organization Name:

Location of Organization: (if foreign location list country)

Partner’s contribution to the project (identify one or more)

- *Financial support;*
- *In-kind support (e.g., partner makes software, computers, equipment, etc.,*

- *available to project staff);*
- *Facilities (e.g., project staff use the partner's facilities for project activities);*
- *Collaboration (e.g., partner's staff work with project staff on the project);*
- *Personnel exchanges (e.g., project staff and/or partner's staff use each other's facilities, work at each other's site); and*
- *Other.*

Organization Name: Wright State University

Location of Organization: Dayton, Ohio, USA

Partner's contribution to the project: contributed to the development of the scenario scripts for dynamic interactive telementoring.

Organization Name: Maryland State Anatomy Board

Location of Organization: Baltimore, Maryland, USA

Partner's contribution to the project: Provides cadavers and lab space for the project.

8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS: For collaborative awards, independent reports are required from BOTH the Initiating Principal Investigator (PI) and the Collaborating/Partnering PI. A duplicative report is acceptable; however, tasks shall be clearly marked with the responsible PI and research site. A report shall be submitted to <https://ers.amedd.army.mil> for each unique award.

QUAD CHARTS: If applicable, the Quad Chart (available on <https://www.usamraa.army.mil>) should be updated and submitted with attachments.

9. APPENDICES: Attach all appendices that contain information that supplements, clarifies or supports the text. Examples include original copies of journal articles, reprints of manuscripts and abstracts, a curriculum vitae, patent applications, study questionnaires, and surveys, etc.

The quad chart is attached.