Filling in the Gaps of Predeployment Fleet Surgical Team Training Using a Team-Centered Approach

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ABSTRACT

Background: Teamwork and successful communication are essential parts of any medical specialty, especially in the trauma setting. U.S. Navy physicians developed a course for deploying fleet surgical teams to reinforce teamwork, communication, and baseline knowledge of trauma management. **Method:** The course combines 22 hours of classroom didactics along with 28 hours of hands-on simulation and cadaver-based laboratories to reinforce classroom concepts. It culminates in a 6-hour, multiwave exercise of multiple, critically injured victims of a mass casualty and uses the "Cut Suit" (Human Worn Partial Task Surgical Simulator; Strategic Operations), which enables performance of multiple realistic surgical procedures as encountered on real casualties. Participants are graded on time taken from initial patient encounter to disposition and the number of errors made. Pre- and post-training written examinations are also given. The course is graded based on participants' evaluation of the course. **Results:** The majority of the participants indicated that the course promoted teamwork, enhanced knowledge, and gave confidence. Only 51.72% of participants felt confident in dealing with trauma patients before the course, while 82.76% felt confident afterward (p = .01). Both the time spent on each patient and the number of errors made also decreased after course completion. **Conclusion:** The course was successful in improving teamwork, communication and base knowledge of all the team members.

KEYWORDS: *fleet surgical team predeployment training course, fleet surgical team, Cut Suit, human worn partial task surgical simulator, trauma team training, educational gap in teamwork and communication, teamwork-centered training, military trauma training*

Introduction

Teamwork and successful communication are an essential part of any medical specialty, especially surgery. As such, even the most skillful surgeon will have suboptimal patient outcomes without a strong team. McLaughlin et al.[1] noted that "common factors for [successful healthcare] include a cohesive and well-integrated team structure with well-defined procedural organization. Although a multidisciplinary work force has clear advantages for improving today's quality of care, teamwork is not intuitive and requires training, guidance, and executive support." Not surprisingly, any breakdown in effective teamwork and communication will be detrimental, especially in the complex, fast-paced combat mass casualty care arena. Miller et al.[2] recognized the significance of this concept and implemented an in situ trauma simulation program at a Level I trauma center, which showed improvement in both teamwork and communication. Fleet Surgical Team Three (FST-3), an operational unit of the U.S. Navy, has also identified the significance of this crucial team phenomenon and has developed a course requiring participants to integrate the teamwork and communication necessary to effectively care for critically injured patients and respond to mass casualty situations. The training further promotes team cohesion by standardizing patient-centered knowledge across all participants in addition to making each aware of their individual role on the team.

Surface U.S. Navy predeployment medical training has traditionally focused on individual, first-responder readiness or on medical department mass casualty exercises, which tend to focus on patient transport and triage. However, these provide minimal training on specific injury patterns and their management. The Fleet Surgical Team Predeployment Trauma Training Course (FST PTTC) is designed to specifically address this critical gap in medical preparedness. It uses a team-based approach to educate personnel from corpsmen to physicians on how to effectively triage, stabilize, treat, and disposition a broad range of injured patients who may be encountered during deployed shipboard operations.

The course combines 22 hours of classroom didactics with 28 hours of hands-on simulation and cadaver-based laboratories to reinforce classroom concepts. The course is accredited by the Naval Medical Center San

Diego (NMCSD), San Diego, California, and awards 56 American Medical Association Physician's Recognition Award Category 1 Continued Medical Education credits for medical providers enrolled in the course. The classroom curriculum stresses the best practices drawn from civilian trauma, recent military combat trauma experience, and clinical practice guidelines that are currently used in theater. It also emphasizes common pitfalls encountered in medical practice. Lecture topics include but are not limited to military trauma triage, basic trauma physiology, shipboard blood product utilization, pain management, and multiple complex trauma injury patterns. Focused lectures provide team members with practical information on how Level II facilities, such as the Landing Helicopter Assault/Landing Helicopter Dock (LHA/LHD) amphibious assault platforms, can successfully deal with a variety of injury patterns potentially seen on expeditionary deployments. These lectures center around shipboard emergencies such as fire, man overboard, and combat wounds from penetrating, blast mechanisms, and complex combinations of the above from amphibious operations.

The didactic topics are then incorporated into simulation laboratory (Sim-Lab) sessions using physiologic and procedural trainers to reinforce key concepts and employ hands-on experience (Figures 1–4). Cadaver laboratories ensure that participants appreciate the anatomic complexity and tactile experience of performing procedures on human tissue. The course concludes with a 6-hour, multiwave session of critically injured, multivictim, mass-casualty exercise using the "Cut Suit" (Human Worn Partial Task Surgical Simulator; Strategic Operations, San Diego, CA; Strategic-operations.com. http://www.strategic-operations.com/products/cut-suit). The "Cut Suit" is an anatomically accurate simulator that can be safely worn by humans and allows for the performance of a variety of complex, realistic surgeries and procedures as encountered in real casualties. This provides the team with numerous opportunities to operate in a realistic, high-stress, and fast-paced environment. Participants perform triage, resuscitation, surgical operations, postoperative care, packaging, and evacuation all while managing critical, multilayer communication, patient tracking, and organized flow.

This course is unique to the Fleet Navy with its team-based approach to medical training, specifically trauma resuscitation. It parallels a similar course taught at the U.S. Marine Corps (USMC) 1st Medical Battalion, but it applies concepts specific to the shipboard and amphibious combat environments and is enhanced by the introduction of cadaver laboratories and amphibious assault injury scenarios. Additionally, on completion of other team-based courses, those participants disperse back to their original units to deploy. The FST PTTC

Figures 1 and 2 *Airway management Sim-Lab. CDR Hoang is demonstrating how to perform percutaneous cricothyroidotomy.*

trains teams that deploy together, the FST, the ship, and USMC medical units. That means the training effect is preserved and the integrated training that occurs between these teams develops and fine-tunes the true casualty response capability of a deploying Amphibious Ready Group. This course is even more important in some ways than similar courses taught to ground-based units because of the austere environment and finite resources that are unique to shipboard medicine.

Even though FST PTTC is not specifically geared toward Special Operations Medicine, the ship platforms have been and continue to be used as launch and recovery points for Special Operations, SEAL anti-piracy operations, VBSS (Visit, Board, Search, and Seizure), rescue, and other clandestine missions. As such, there is a distinct

Figure 3 *Airway management Sim-Lab. CRNA instructor with extensive experience during his deployment to Afghanistan is demonstrating appropriate airway management techniques to the course participants.*

Figure 4 *Polytrauma Sim-Lab. The participants have just completed the resuscitation of a patient with electrical and flash burns and with cardiac injury from shipboard generator electrocution.*

possibility that shipboard medical teams will be caring for injured Operators, personnel, and captured high-value targets from these missions.

Materials and Methods

Course Design

The FST PTTC takes place over 11 days, the layout of which is demonstrated in Tables 1a and 1b. The participants are divided into teams consisting of a physician and four hospital corpsmen, with the physician acting as the team leader. The other members who participate in the resuscitation but are not part of the "bed team" are nurses, certified registered nurse anesthetists (CRNAs), and ancillary staff. This report will focus on the first two FST PTTCs for which the data were collected, with a total of 29 participants. Day 11 signals completion of the course and culminates in a 6-hour, multiwave of multiple, critically injured victims of a mass casualty exercise that uses the "Cut Suit."* Using the "Cut Suit" allows performance of multiple realistic surgical procedures as encountered on real casualties (Figures 5–9). Each "bed team" is exposed to different trauma patterns with the overall mix being representative of afloat/ground combat patterns of injuries.

Figure 5 *Mass casualty exercise using the Cut Suit. The human-worn Cut Suit is simulating a cardiac arrest in the operating room, necessitating initiation of cardiac pulmonary resuscitation (CPR). CPR is in progress, and the emergent thoracotomy is being set up. The team has successfully stopped the hemorrhage from the left lower extremity amputation with a tourniquet.*

Figure 6 *Mass casualty exercise using the Cut Suit. The human-worn Cut Suit is simulating an improvised explosive device blast, resulting in multiple chest, abdominal wounds, traumatic amputation, and severe shock.*

Table 1a *FST PTTC Days 1–4 Detailed Schedule Description*

FAST, focused assessment with sonography in trauma; ATLS, advanced trauma life support; US, ultrasound; IO, intraosseous; CVL, central venous line; OR, operating room; BLS, basic life support; ACLS, advanced cardiac life support; ICU, intensive care unit.

Day One	Day Two
0930 Course Introduction	*0930 Fluid resuscitation and Massive transfusion protocol* – Understand definition and shipboard transfusion capability – Consequences of massive transfusion – Permissive hypotension – Techniques that improve outcome
0935 Triage in mass casualty – Understand triage in Level II facility – Compare and contrast triage in routine and mass casualty	
0955 En route care – Understand En route Care concepts – Equipment and team members – Techniques and capabilities – Priorities, limitations, issues with current system	*1000 Walking blood bank* – Overview of walking blood bank policy and instruction – Timing, logistics, equipment – Deglycerolization of frozen blood
1015 Trauma code – ATLS outline and video – Understand goals	*1030 Break*
	1040 Trauma bags – Concept and contents
1035 Trauma team roles – Understand tasks assigned to each member of trauma team	*1100 Lethal triad* – Hypothermia, acidosis, coagulopathy – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations
1055 Break	
1105 Airway – Bagging, Intubation and Cricothyroidotomy – Airway issues specific to shipboard environment – Constraints – Important approaches, techniques to improve outcome	*1130 Lunch*
1125 Pneumothorax – Needle decompression and chest tube – Indication for intervention – Technique, pitfalls and common errors	*1230 Sim-Lab 1 – FST skills lab* – Airway – Cricothyroidotomy – Suturing – IO access – FAST exam – Needle decompression – Tube thoracostomy – CVL placement
1145 X-ray in trauma – Films necessary – Portable machine familiarization	
1200 US – FAST exam – Understand goals and limitations	
1210 Lab tests in trauma – Specific tests	

(continues)

Evaluations and Data Collection

At the end of each day, the participants evaluate each instructor and the topics presented based on delivery, content, details, applicability and practices on a scale of 1 ("strongly disagree") through 5 ("strongly agree"). Data are also collected during the multiwave, mass casualty scenarios, specifically on the time it takes to correctly manage each patient and the number of errors that are made during this process. After the mass casualty simulation, the participants are asked to evaluate the course overall with a 15-question survey (Table 2).

A 25-question multiple-choice written exam is administered to the course participants at the beginning of the week and again after the course to measure improvements in fund of knowledge. This is important because the course is taught to multiple levels of healthcare providers with differing levels of experience from hospital corpsmen to nurses and physicians. The exam was included in the course for the second of the FSTs, and data are not included here as they are still being analyzed.

Statistical Analysis

All items are analyzed in terms of descriptive statistics and reported as mean with SD values. Significance is determined with χ^2 value of 6.343. Statistical testing is performed using Microsoft Excel 2010 for PC (Microsoft Corporation, Redmond, WA).

Results

Thus far, there have been a total of two FST PTTCs conducted, and the data are being presented here. The primary objectives of the course were to emphasize and improve teamwork by effective communication, as well as to instill the baseline knowledge of trauma care for

Table 1a *Cont.*

Day Three	Day Four
0930 Anesthesia – Approaches, techniques to improve outcomes – Pitfalls and limitations	*0930 BLS/ACLS review* – Review of protocols
1000 Pain management – Patterns of injury and pain – Approaches, techniques to improve outcomes – Pitfalls and limitations	*1000 IMPACT ventilation machine* – Equipment familiarization – Troubleshooting
1030 Break	*1030 Break*
1040 Shock – Understand classification and types of shock in trauma – Indicators and markers of shock state – Intro to therapies for shock	*1040 Crash cart setup* – Familiarization with standard setup of cart, equipment
1110 OR orientation – Equipment: rapid infuser, ex-fix device, fluid warmers	*1110 ICU orientation* – Introduction to common medications and drips – ICU monitoring equipment
1130 Damage control – Laparotomy, Thoracotomy – Understand indications and goals – Approaches, techniques to improve outcomes – Pitfalls and limitations	*1140 Hemorrhage control – tourniquets, adjuncts* – Basic hemorrhage control techniques – Available equipment/technology – Proper use
1200 Lunch	*1210 Medical Regulating and Control Officer / Medical Administration Officer role* – Function and pitfalls
1230 Cadaver lab – Airway – Needle decompression – Tube thoracostomy – Thoracotomy – IO access and CVL placement – Venous cutdown – Extremity and pelvis external fixation device – Fasciotomy	*1240 Lunch* *1330 Sim-Lab 2* – Trauma team role familiarization – ATLS overview – Airway scenario

all team members. The participants were divided into teams with a physician as the team leader. The physicians were either family practice or general surgery trained with variable backgrounds of postresidency experience. All, however, were new to the FST PTTC. Two and three resuscitation "bed teams" were created during FST-3 and FST-5 groups, respectively, for a total of five "bed teams" who completed the training course (n=29). A standardized evaluation form was developed to grade each "bed team" (Figure 10). The teams were first assessed at the start of the course to obtain baseline performance (Pre 1Pt in Table 3). During this initial assessment, the teams were completely unaware that they are being evaluated. They were evaluated again on completion of the course, at which point they knew that they were being retested (Post 1Pt in Table 3). Part of the evaluation consisted of time taken to appropriately triage, treat, and finalize the patients' disposition with the least number of errors. Time started with the initial encounter and ended with the final disposition. Individual "bed teams" improved their time from a mean ± SD of 25 ± 9.201 minutes to 13 ± 3.559 minutes. A reduction in the mean critical errors per "bed team" was also noted (5.5 ± 0.577 error in the initial evaluation and 1 ± 0.816 error in the final evaluation). Unfortunately, most of the data for "bed team" 3 from FST-5 are missing except for one patient encounter (Pt 3 in Table 3).

The setups of the FST-3 and FST-5 courses varied due to personnel manning and thus influenced the outcomes during the mass casualty scenarios. FST-3 consisted of two, fully functional teams with two monitored beds and one unmonitored, unattended ("overflow bed"). FST-5 was made up of three fully functional teams with three monitored beds. It was noted that the two FST-3 teams were able to successfully handle two simultaneous casualties, but the third patient in the "overflow bed" experienced delay in care (Scenario 1 in Table 3). During the third scenario, the FST-3 teams applied the lessons learned to future mass casualty experiences, which enabled them to effectively triage and treat three patients with still only having two fully staffed and equipped bed teams. However, the fourth patient experienced a delay in care due to lack of staff and equipment (Scenario 3 in Table 3). On the other hand, the three FST-5 teams successfully maintained performance during all three scenarios (Table 3). Also, each "bed team" was exposed

Table 1b *FST PTTC Days 5–11 Detailed Schedule Description*

Day Five	Day Six
1230 Long bone fractures, dislocations, compartment syndrome – Patterns of injury – Approaches, techniques to improve outcomes	*0930 Catheterization* – Technique and pitfalls
1300 Blunt trauma / Blast injury – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations	*0945 Spine Injuries* – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations
1330 Amputation / Vascular – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations	*1015 Drowning* – Approaches, techniques to improve outcomes – Pitfalls and limitations
1415 Sim-Lab 3 – Multiple fractures – Traumatic amputation	*1045 Break*
	1055 Burns/Electrocution – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations
	1125 Lunch
	1230 Sim-Lab 4 – Drowning with hypothermia – Spinal injury with shock

Day Seven	Day Eight
1230 Falls – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations	*0930 Blood donation for walking blood bank* – Standard Operating Procedure – Logistics of blood draw evolution – Equipment – Pitfalls and chokepoints
1330 Polytrauma – Patterns of injury in multisystem trauma – Approaches, techniques to improve outcomes – Pitfalls and limitations	*1000 Neck* – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations
1400 Splints – Goals and limitations – Familiarization with upper/lower extremity splints	*1030 Break*
1430 Sim-Lab 5 – Polytrauma – Blast injury – Fall	*1040 Tranexamic acid* – Indications for use – Efficacy – Pitfalls and limitations
	1100 Ocular Trauma – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations
	1130 Lunch
	1230 Sim-Lab X – Complex polytrauma multi-casualty

Day Nine	Day Ten
0930 CNS injury – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations	*0900 Sim-Lab 7* – Multiple casualty with polytrauma, burns, and blasts – Multiple traumatic amputations – Chest injury
1000 Shipboard Toxic Exposure – Liquid fuel and toxic gas exposure: – Ingestion, Inhalation, and Contact effects – Pharmacologic toxins – Acetaminophen – General overdose management principles	**Day Eleven**
	0900 Mass Casualty Exercise

(continues)

Table 1b *cont.*

Day Nine	
1030 Break	
1040 Pelvic fractures /Urogenital trauma – Patterns of injury – Approaches, techniques to improve outcomes – Pitfalls and limitations	
1140 Lunch	
1230 Sim-Lab 6 – Multiple casualty with polytrauma, burns, and blasts – Multiple traumatic amputations – Chest injury	

Table 2 *The Course Evaluation Questionnaire and Responses (Corresponds with Figures 12 [Questions 1–7] and 13 [Questions 8–15])*

Questions Asked:	Not Helpful % ± StDV	Helpful % ± StDV	Very Helpful % ± StDV
1. Materials are focused and relevant to my coming deployment	0 ± 0	20.69 ± 1.414	79.31 ± 0.577
2. The course helped prepare me for possible trauma encounters on my coming deployment	0 ± 0	0 ± 0	100 ± 4.509
3. The didactics helped set the tone and focus for my job	3.45 ± 0	17.24 ± 0	79.31 ± 1.528
4. The didactics helped set the tone and focus the team for the job	3.45 ± 0	3.45 ± 0	93.10 ± 4.359
5. The Sim-Lab helped focus what I need to know for my coming deployment	0 ± 0	17.24 ± 2.121	82.76 ± 5.196
6. The Sim-Lab helped focus the team	0 ± 0	0 ± 0	100 ± 6.429
7. The Sim-Lab helped individuals to come together and function as a team	0 ± 0	0 ± 0	100 ± 7.371
8. The course helped the team to fuction as a cohesive unit	0 ± 0	0 ± 0	100 ± 7.371
9. The instructors were knowledgeable in their lecture topics	0 ± 0	3.45 ± 0	96.55 ± 6.807
10. The "Cut-Suit" practical application was critical in helping bring the team together	3.45 ± 0	10.34 ± 0.707	86.21 ± 7.506
11. I would recomment the course to other FST teams	0 ± 0	3.45 ± 0	96.55 ± 7.767
12. I would recomment the course to ship medical	0 ± 0	3.45 ± 0	96.55 ± 8.737
13. This course would be beneficial to Blue/Green integration	0 ± 0	6.90 ± 0	93.10 ± 5.568
14. Having taken the course, I believe my confidence level for these complex traumas before the course was	13.79 ± 1.414	27.59 ± 1.155	51.72 ± 1
15. My confidence level after the course for these complex traumas was	0 ± 0	10.34 ± 0.707	82.76 ± 3

to different number of patients, with FST-3 "bed team" 1 evaluating six patients and "bed team" 2 evaluating only two patients (Table 3). The number of patients encountered was dependent on the severity of the current patient, the availability of the team to take on the next patient, and what other obligations the team had at the time (i.e., assist in the operating room), which is similar to what will happen in a real scenario.

At the completion of each Sim-Lab, the participants were asked to grade the appropriateness of the delivery, content, details, applicability and practices on a scale of 1 ("strongly disagree") to 5 ("strongly agree") (Figure 11). Of the participants, 73.03 ± 14.12% strongly agreed that the Sim-Labs were appropriate in content, 74.07 ± 15.95% strongly agreed that Sim-Labs contained appropriate amount of detail, 73.67 ± 16.68% strongly agreed that the Sim-Labs were applicable to their practices, and 57.25 ± 21.81% strongly agreed that the Sim-Labs coincided with their medical practice protocols.

The participants were also asked to evaluate the course overall on a scale of 1 to 10 (Figures 12, 13, Table 2). Scores 1 through 4 were considered as being "not helpful"; scores 5 through 7 were considered as being "helpful"; and scores 8 through 10 were considered as being "very helpful." The overwhelming majority of the participants rated the course as being "very helpful" in response to the following: Materials are focused and relevant to my coming deployment, the didactics helped set the tone and focus for my job, the didactics helped set the tone and focus the team for the job, the Sim-Lab helped focus what I need to know for my coming deployment, the instructors were knowledgeable in their

Table 3 *Data Obtained From the FST-3 and FST-5 Training During the Course*

The time to complete the task from pre- to post-course assessment: Individually, participants decreased time to completion from a mean of 25 minutes to 13 minutes; As a team, they decreased time to completion by 48 minutes total; The critical errors decreased from a mean of 5.5 errors per subject to 1 error; As a team, they decreased critical errors by a count of 18; The time to complete the task pre-course: mean of 25 minutes with an SD (StDv) of 9.201; The time to complete the task post-course: mean of 13 minutes with an SD of 3.559; The improvement in time to complete the task value: mean 12 minutes with an SD of 5.715; The critical error pre-course: mean 5.5 with an SD of 0.577; the critical error post-course: mean 1 with an SD of 0.816; The improvement (critical errors missed) value: mean 4.5 with an SD of 0.500. Pt, patient; CXR, chest radiograph; FP, family practice; GS, general surgery.

Time to Patient Disposition

FST Pre-deployment Trauma Training Course						Mass Casualty								
						Scenario 1			Scen 2	Scenario 3				
Team	BedTeam	Team Leader Specialty	Pre 1Pt (min)	Post 1Pt (min)	Time Improvement	Pt 1	Pt 2	Pt 3	Pt 1	Pt 1	Pt 2	Pt 3	Pt 4	Pt 5
FST 3	1	FP	25	13	12		8	31	10		18	20	60	
	2	GS	18	11	7	7				12				
FST 5	1	FP	38	18	20	20			15	27				
	2	FP	19	10	9		15	9			22		10	
	3	GS										15		
		Time to complete	100	52	Improvement	48 min								
		Mean	25	13		12								
			9.201	3.559	StDv	5.715								

Number of Critical Events Missed*

FST Pre-deployment Trauma Training Course						Mass Casualty								
						Scenario 1			Scen 2	Scenario 3				
FS Team	BedTeam	Team Leader Specialty	Pre 1Pt count	Post 1Pt count	Critical error improvement	Pt 1	Pt 2	Pt 3	Pt 1	Pt 1	Pt 2	Pt 3	Pt 4	Pt 5
FST 3	1	FP	5	0	5		0	2	0		0	0	0	
	2	GS	5	1	4	0				1				
FST 5	1	FP	6	2	4	0			0	0				
	2	FP	6	1	5		1	2			0		0	
	3	GS										0		
		Error count	22	4	Improvement	18								
		Mean	5.5	1		4.5								
		StDv	0.577	0.816	StDv	0.577								

*Bed setup/ prep/ recognition of injury patterns
Airway management/IV adjustment/ CXR-FAST
Communication/ Blood Bank management/ Hemorrhage control

lecture topics, the "Cut Suit" practical application was critical in helping bring the team together, I would recommend the course to other FST teams, I would recommend the course to ship medical, and this course would be beneficial to US Navy/Marine Corps medical integration (Figure 14, Table 2).

Further, 100% of participants thought that the course was "very helpful" (rated 8–10) in the following areas: The course helped prepare me for possible trauma encounters on my coming deployment (SD 4.509), the Sim-Lab helped focus the team (SD 6.429), the Sim-Lab helped individuals to come together and function as a team (SD 7.371), and the course helped the team to function as a cohesive unit (SD 7.321, Figure 14, Table 2). Last, when evaluating confidence, only 51.72 ± 1% of the participants felt confident with complex traumas prior to the course, while 82.76 ± 3% were confident on completion (Figure 14, Table 2). The null hypothesis of no difference is rejected based on statistical significance (with 1 *df* and a χ^2 value of 6.343, $p = .01$, thus completing the course was associated with a significant increase in course attendees' perceived confidence).

Discussion

Medical errors are an unfortunate but significant part of healthcare delivery. In 1999, the Institute of Medicine (IOM) reported that nearly 100,000 deaths occur annually due to medical errors, costing an estimated $25 billion.[3] The IOM concluded that implementation of team training programs could be an integral part in error reduction.[3] More recently, Classen et al.[4] noted that overall medical errors occurred in 33.2% of hospital admissions in the United States, or 91 events per 1,000 patient-days. As there is already a high rate of medical errors in controlled medical settings, the increased stress and added chaos of mass casualties and deployments may contribute to an even greater number of errors in patient care for military casualties. Fleet Surgical Team

Figure 7 *Mass casualty exercise using the Cut Suit. The human-worn Cut Suit is simulating an exploratory thoracotomy and tractotomy for a gunshot wound to the chest, before laparotomy can be performed for multiple shrapnel wounds to the abdomen.*

Figure 8 *Mass casualty exercise using the Cut Suit. The human-worn Cut Suit is used to simulate the performance of a tractotomy.*

Three has been one of few to note the lack of team training, effective communication, and multidisciplinary preparedness prior to medical personnel deployment that may be to blame. The FST PTTC is designed specifically to address this critical gap in training.

There is currently no training being offered within the Fleet Navy (Blue-side) medical community that is analogous to this course. The FST PTTC has already proved itself to be an invaluable tool in preparing units such as the FSTs for deployments. An additional role of this type of training includes providing training to aircraft carrier medical department, integrated training between the shipboard medical departments, and embarked medical personnel directly supporting expeditionary USMC units in order to improve the capability of healthcare providers to care for multiple, traumatically injured patients.

Figure 9 *Mass casualty exercise using the Cut Suit. The human-worn Cut Suit is being used as an exploratory laparotomy simulation platform for multiple abdominal shrapnel wounds.*

Figure 10 *The Standardized Participating Team Evaluation Form.*

FST 1/3/5/9 Trauma Team Resuscitation/CUT-SUIT evaluation (circle one):

Date:

Team leader:

1. Resuscitation
   time begin: time of disposition decision:
   time end: total:
2. Number of critical events missed:
   a. Bed setup/prep
   b. Recognition of pattern of injury
   c. Airway management
   d. IV access
   e. Hemorrhage control
   f. CXR/FAST
   g. Team communication
   h. Blood bank
   i. Operative management
   j. Evacuation
3. Team Procedure expertise (rate from 1 to 10):
   a. Rapid recognition of procedures required:
   b. Appropriate designation of procedure experts:
   c. Expertise of procedure performed:

Evaluator:

During the 6-hour, multiwave, mass casualty simulation using the "Cut Suit," teamwork and effective communication were found to be crucial elements in successful patient care. The FST-3 group was limited in the number of beds and personnel, resulting in delay of care for the third patient in the first scenario. Applying the lessons learned to future mass casualty experiences, they were able to organize a much better patient flow for the

Figure 11 *Participants' evaluation of the Sim-Labs: scale of 1 through 5: (1) strongly disagree, (2) disagree, (3) neither agree nor disagree (4) agree, (5) strongly agree. The error bars represent SD.*

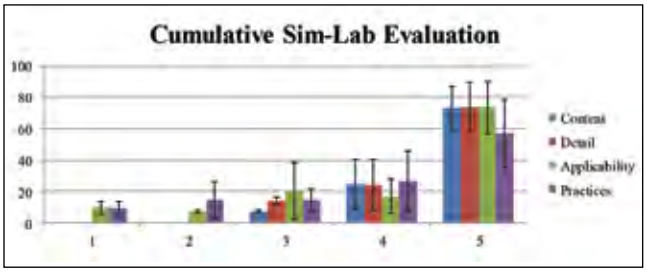
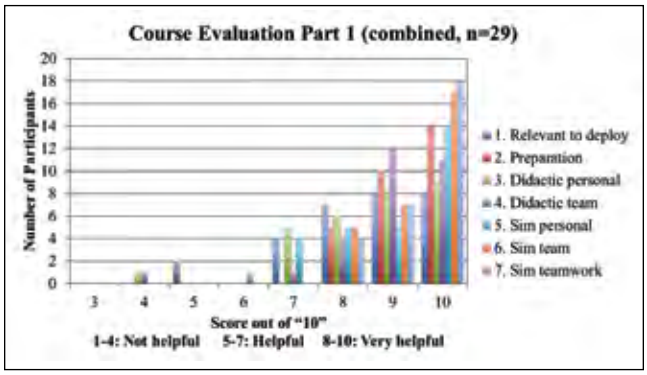


Figure 12 *The overall course evaluation questions 1–7. å***1.** *Materials are focused and relevant to my coming deployment;* **2.** *The course helped prepare me for possible trauma encounters on my coming deployment;* **3.** *The didactics helped set the tone and focus for my job;* **4.** *The didactics helped set the tone and focus the team for the job;* **5.** *The Sim-Lab helped focus what I need to know for my coming deployment;* **6.** *The Sim-Lab helped focus the team;* **7.** *The Sim-Lab helped individuals to come together and function as a team.*



subsequent scenarios. This again strongly emphasizes the impact of team communication, cohesion, and effort. It should be pointed out that during the third scenario, FST-3 and FST-5 were varied in the time it took to care for the fourth patient, with FST-5 taking much shorter time than FST-3. This can be explained by the limitations placed on FST-3 from the provider and supply perspective. Thus, despite adequate and efficient training, limitations in personnel, supplies, and space will likely remain rate-limiting steps in patient management during mass casualty situations. This encourages an even greater emphasis on team training to avoid adding yet another limitation to effective patient care during mass casualties.

The impact that this course has had on already-trained medical providers is astounding. With over 90% of the participants rating this hyper-realistic training as being very helpful, there is no question as to whether or not additional mass casualty training exercises are necessary

Figure 13 *The overall course evaluation questions 8–15.* **8.** *The course helped the team to function as a cohesive unit;* **9.** *The instructors were knowledgeable in their lecture topics;* **10.** *The "Cut Suit" practical application was critical in helping bring the team together;* **11.** *I would recommend the course to other FST teams;* **12.** *I would recommend the course to ship medical;* **13.** *This course would be beneficial to Blue/Green (U.S. Navy/Marine Corps) integration;* **14.** *Having taken the course, I believe my confidence level for these complex traumas before the course was;* **15.** *My confidence level after the course for these complex traumas was.*

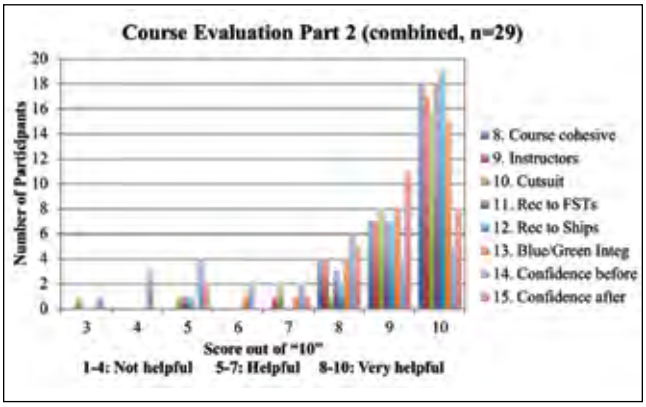
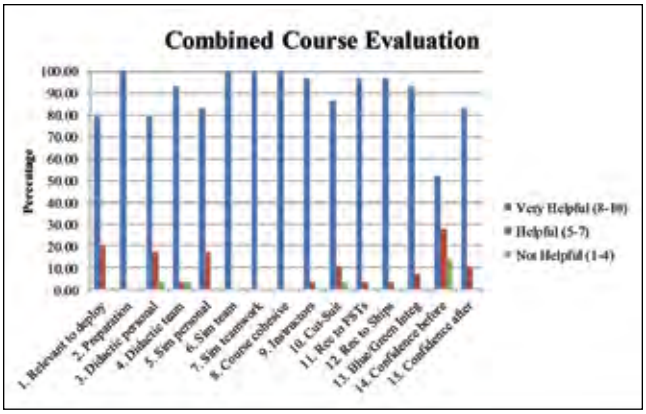


Figure 14 *The combined course evaluation. Showing the percentage of participants that graded different parts of the course as being very helpful, helpful or not helpful. Of note, questions 14 and 15 represent the participants' confidence before and after the course respectively. The participants were asked to put a numerical value to their confidence level on the scale of 1–10.*



for medical personnel, especially in the military setting. With new training technology, programs are now capable of simulating realistic scenarios, environments, and stressors that even healthcare providers with many years of experience are still in need of. By addressing the need for team and group training prior to deployment, this course offers a potential solution to this deficit. However, stopping with just a single training course will likely not yield long lasting positive results. As noted by Miller et al.,[2] the observed benefits of the simulation training significantly declined once the simulation

program was stopped in their Level One trauma center. We also agree that a likely key to maintaining successful outcomes is through continuous reinforcement of teamwork and communications, as well as baseline trauma knowledge. We will retest and reinforce the topics covered and the skills learned during this course with the current participants within six months of their course.

Future Plans

The FST PTTC is an evolving course with constant improvements based on lessons learned during the course execution applied to future courses. For example, we plan to modify The Course Evaluation Questionnaire (Table 2) to include two additional questions: After taking the course, I will change how I work in mass casualty scenarios, if agree, how; the course is effective in reducing errors that occur in mass casualty scenarios. We also realize that the current questionnaire (Table 2) is structured in a way that is not optimum as a psychometric design of a survey instrument. We intend to changes questions 1, 3, 4, and 7 to not include "and," which links two questions in a single item. We will likely separate them into two individual question items. We have also designated few of the lectures for physicians only as they are most pertinent to their practice. There are two more FST PTTCs being planned now.

Conclusion

From the data, it can be concluded that the FST PTTC is not only beneficial to the individual medical providers but also crucial to the enhancement and efficacy of team performance in the trauma setting. The preliminary data suggest that despite personal competencies in practice, functioning as a member of a team is a skill that must be trained and fine-tuned. From the pre- to post-course testing, robust improvements were noted in the time taken to triage, care for, and disposition a patient as well as in the errors made during the exercises. Individually, the participants improved, but most notably were those improvements made in the overall team statistics. This correlates well with the previous works showing promising results of improved teamwork in team-centered simulation training.[2,5]

Finally, based on the course evaluations on appropriateness, effectiveness, relativity to deployment, use of didactics and simulators, and confidence resulting from the course, it can be concluded that the course has significant value and future implications in training Fleet Surgical Teams prior to deployment. Furthermore, the team performance after the course can potentially be used in operational planning, calculating the number of FSTs required for a specific engagement based on the projected casualty numbers. Since the completion of this report, there have been three subsequent FST PTTCs that took place, the data from which are currently being analyzed. They preliminarily suggest similar outcomes from the participants. These data should likely be used in combination with after-action reports from real-world operations to guide or inform operational planning.

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Disclosures

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