Erciyes Med J 2016; 38(3): 106-10 • DOI: 10.5152/etd.2016.0006

The Time Has Come to Rethink our Mass Casualty Preparedness Level in Response to Terrorist Attacks: Initial Contribution from the Department of War Surgery in Gülhane Military Medical Academy

ORIGINAL INVESTIGATION

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ABSTRACT

Objective: Urban terrorist attacks are increasing worldwide. After suicide bombings in Ankara and Urfa in 2015, the Department of War Surgery in Gülhane Military Medical Academy (GATA) started the "Current Approaches to Firearms Injuries Course" for training civilian doctors potentially unfamiliar with these injury mechanisms. Here we present the attending doctors' pretest and posttest results.

Materials and Methods: The course comprised 30 lectures from 16 departments. Medical deontology was excluded; the remaining 29 lecturers prepared one multiple-choice question each for the study. These questions were randomized in order to select 15 questions for the pretest. The order of the 15 questions was changed in the posttest.

Results: All 46 attendees were male, and their mean age was 36.8±6.3 years. General surgeons and thoracic surgeons accounted for 23 (50%) and 7 (15.2%) of the 46 attendees. Compared with their pretest scores, doctors' posttest scores were significantly higher. Most profoundly, 95.2% of attending doctors' answers on Chemical Biological Radiological and Nuclear (CBRN) were improved by the lecture. Overall, the accuracy of the posttest answers on 11 of the 15 (73.3%) trauma lectures was improved, and the difference was significant.

Conclusion: The severity of combat and terrorist attack injuries is higher than that of the usual civilian mechanisms of injury. The only question is when the next terrorist attack will occur instead of "if it will occur," and as such, all relevant clinical specialties and interested health care providers should participate in such trauma-training programs.

Keywords: Terror, civilian targets, explosion, mass casualty, disaster preparedness

This study was presented at the 51st Congress of the European Society for Surgical Research (Mini Oral Presentation - 89) May 25-28, 2016, Praque, Czech Republic.

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Submitted
17.01.2016

Accepted
01.07.2016

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INTRODUCTION

Trauma care presents unique challenges even for the most seasoned surgeons under optimum civilian hospital settings (1). Trauma care requires uninterrupted trauma life support in the prehospital period and management by trauma specialists. Survival and functional recovery are inversely proportional to the elapsed time to trauma management (2, 3). In military settings, these scenarios are complicated by the austerity of the environment, scarce logistic support, long distance transport times, use of more lethal weapons, and large numbers of casualties with multiple complicated injuries (4). Typically, the injuries inflicted by rifles and explosives are different from those inflicted by civilian trauma mechanisms (5). Thus, the majority of the expertise in the management of these injuries is confined to military medical settings (5).

After 2000, terrorism against both civilian and military settings has increased worldwide. In 2014, a total of 13463 terrorist attacks resulted in more than 32700 deaths and more than 34700 injured worldwide. There were 2.6 fatalities and 2.9 injuries per attack (6). Simultaneously, the unprecedented use of explosives against Turkish military personnel and Turkish citizens resulted in an increased casualty surge with multiple complex injuries (7). At present, Turkey neighbors at least four active military conflicts and has terrorism-related violence in close proximity to its borders.

The most feared aspect of terrorist attacks lies in its unexpected nature and its potential to create large-scale mass casualty incidents. Military surgeons are trained to operate in austere conditions, and the military health system depends on 7/24 trauma preparedness. In 2015, terrorist suicide explosions in Urfa and Ankara prompted the Department of War Surgery in Gülhane Military Medical Academy (GATA) to act for training civilian doctors potentially unfamiliar with these injury mechanisms. Thus, the first "Current Approaches to Firearms Injuries Course" was held in GATA Ankara on November 21 through November 25, 2015. The 5-day course aimed to convey the most up-to-date approaches in all possible aspects of terrorism-related trauma to surgeons and emergency medicine specialists. Course attendees were applied a pretest and posttest to compare each participant's change in knowledge as a result of the course. We hypothesized that course attendance was associated with significant gains in knowledge.

MATERIALS and METHODS

Our study was prospectively designed as within–subjects pretest–posttest to evaluate the effectiveness of the course. Twenty-nine lecturers from 15 of 16 medical departments were asked to prospectively prepare one multiple-choice question each on the core issues of their lectures. Medical deontology lecture was excluded from the pretest and posttest study. Twenty-nine questions were gathered. Each question was assigned random numbers and a blinded medical doctor randomized these numbers by using a Research Randomizer (8) to select 15 questions for the study (Table 1).

Starting from November 21, from the entire applicant doctors from hospitals in Turkey, 50 surgeons and emergency medi-

Table 1. Details of course content and distribution of the randomized questions

Department of medical specialty	Number of lectures	Number of randomized questions	Lecture subjects
General surgery	8	3	Injury mechanisms of firearms,
			Principles of war surgery,
			High-velocity missile-related abdominal injuries,
			Principles of damage control surgery,
			Combat-related injuries of the anus, rectum, and perineum,
			management of complicated combat wounds,
			Approach for retained missile fragments in the body,
			Triage of combat casualties.
Orthopedic surgery	5	4	Combat-related injuries of the spine and spinal cord,
			Injury of the extremities and pelvis,
			Soft tissue and articular injuries,
			Extremity amputations.
Ophthalmology	1	-	Eye injuries.
Urology	1	1	Urogenital injuries.
Plastic and reconstructive surgery	3	-	Management of combat burn, Management of hand, face, neck, and nerve injuries.
Thoracic surgery	1	1	Management of thoracic injuries.
Cardiovascular surgery	1	-	Combat-related cardiovascular injuries.
Ear nose throat surgery	1	-	Airway management.
Emergency medicine	1	1	Hemorrhage control, shock, and casualty resuscitation.
Anesthesiology	1	1	Anesthesia of the combat casualty and management in the intesive care unit.
Infectious disease and blood banking	2	1	Provision and transfusion of blood and blood components in Role 1 and 2 Hospitals,
			Combat wound infections,
			Prevention of epidemics and use of antibiotics in war.
Chemical Biological Radiological and Nuclear (CBRN) defense medicine	1	1	Management of CBRN injuries.
Brain surgery	1	1	Combat-related traumatic brain injuries.
Naval medicine and hyperbaric center	1	1	Hyperbaric oxygen treatment of combat wounds.
Psychiatry	1	-	Psychological trauma in war.
Medical deontology	1	-	Ethical rights of enemy casualties and medical personnel.
TOTAL	**30**	**15**	

cine specialists attended the first course. Four attendees were excluded from the study due to incomplete attendance to the whole course lectures. The course comprised 30 lectures from 16 different medical specialties (Table 1). The attendees were given 15 minutes and were asked to answer the pretest questions before the first lecture of the course. After the completion of the pretest, each attendee was asked to remember the unique number on the pretest paper and to rewrite it on the posttest paper for matching each participant's performances. On the posttest, the arrangement of the questions and multiple choices were also changed to decrease the possibility of memory and maturation effects and to improve the validity of the study. After the completion of the last course lecture, the attendees were given 15 minutes to answer the posttest questions.

The age of the attendees and test performances were shown as the mean ± standard deviation. For statistical analysis, right and wrong answers were graded as 1 and 0 point, respectfully. The overall and subgroups of participants' differences between the pretests and posttests were analyzed using the Wilcoxon test. McNemar's test and hi-squared tests were used to analyze the differences based on the lecture-specific pretest and posttest questions, as appropriate. In order to analyze the results according to the cities of participants' present occupation, F1_LD_F1 design was used. Statistical analyses were performed using IBM Statistical Package for the Social Sciencessoftware (released Ver. 21.0. IBM SPSS Inc.; NY, USA) "nparLD" inside-R package program. Microsoft Excel 2013 was used for the graphic design. The statistical significance was set at $p<0.005$.

RESULTS

All 46 attendees were male, and their mean age was 36.8±6.3 years. General surgeons and thoracic surgeons accounted for 23 (50%) and 7 (15.2%) of the 46 attendees, respectively (Table 2). Overall, the pretest and posttest median success points of the doc-

Table 2. Attending doctors' specialties and cities of occupation

Specialty	n (%)
General surgeon	23 (50.0)
Thoracic surgeon	7 (15.2)
Orthopedic surgeon	4 (8.7)
Plastic surgeon	2 (4.3)
Emergency medicine	3 (6.5)
Ophthalmologist	2 (4.3)
Brain surgeon	2 (4.4)
Cardiovascular surgeon	2 (4.3)
Urologist	1 (2.2)
City-Country of occupation	
İstanbul-Ankara-İzmir	16 (34.8)
Other*	30 (65.2)

*Muğla, Malatya, Van, Elazığ, Konya, Diyarbakır, Gaziantep, Adana, Ordu, Düzce, Yozgat, Ağrı, Hakkari, Azerbaycan.

Table 3a. Comparison of pretest and posttest answers according to lectures

		Posttest		
Lectures	**Pretest**	**Right (%)**	**Wrong (%)**	**p**
CBRN	Right 25	24 (96.0)	1 (4.0)	**<0.001**
	Wrong 21	20 (95.2)	1 (4.8)	
Brain surgery	Right 28	21 (75.0)	7 (25.0)	0.629
	Wrong 18	10 (55.5)	8 (44.5)	
Inf. disease/Blood	Right 21	20 (95.2)	1 (4.8)	**<0.001**
	Wrong 25	16 (64.0)	9 (36.0)	
Emergency medicine	Right 31	30 (96.8)	1 (3.2)	0.070
	Wrong 15	7 (46.7)	8 (53.3)	
Hyperbaric center	Right 37	37 (100.0)	0 (0.0)	0.004
	Wrong 9	9 (100.0)	0 (0.0)	
Thoracic surgery	Right 29	29 (100.0)	0 (0.0)	0.004
	Wrong 17	9 (52.9)	8 (47.1)	
Anesthesiology	Right 10	8 (80.0)	2 (20.0)	**<0.001**
	Wrong 36	24 (66.7)	12 (33.3)	
Urology	Right 28	18 (64.3)	10 (35.7)	1.000
	Wrong 18	9 (50.0)	9 (50.0)	

Table 3b. Comparison of pretest and posttest answers according to lectures *(continued)*

		Posttest		
Lectures	**Pretest**	**Right (%)**	**Wrong (%)**	**p**
Orthopedics 1	Right 40	37 (92.5)	3 (7.5)	1.000
	Wrong 21	20 (95.2)	1 (4.8)	
Orthopedics 2	Right 36	36 (100.0)	0 (0.0)	0.004
	Wrong10	9 (90.0)	1 (10.0)	
Orthopedics 3	Right 30	30 (100.0)	0 (0.0)	0.002
	Wrong 10	10 (100.0)	0 (0.0)	
Orthopedics 4	Right 16	15 (63.7)	1 (6.7)	**<0.001**
	Wrong 30	20 (66.7)	10 (33.3)	
General surgery 1	Right 21	20 (95.2)	1 (4.8)	**<0.001**
	Wrong 25	17 (68.0)	8 (32.0)	
General surgery 2	Right 8	7 (87.5)	1 (12.5)	**<0.001**
	Wrong 38	27 (69.4)	11 (30.6)	
General surgery 3	Right 26	24 (92.3)	2 (7.7)	0.002
	Wrong 20	15 (75.0)	5 (25.0)	

tors were 8 (min–max: 5–15) and 12 (min–max: 7–14), respectively. Compared with their pretest scores, the doctors' posttest scores were significantly higher (z=5, p<0.001). The most profound increase in success rates was in the Chemical Biological Radiological and Nuclear (CBRN) Defense Medicine lecture, where the posttest results showed that 95.2% of the attending doctors' answers on CBRN were improved by the lecture (Table 3). Overall, the accuracy of the posttest answers on 11 of 15 (73.3%) trauma lectures was improved, and the difference was significant (p<0.05) (Tables 3a, b).

We also analyzed the changes in the test results of doctors from big cities (İstanbul-Ankara-İzmir) and others. The results showed that the increase in the test scores was similar between the two groups (ANOVA test statistic 0.181, p=0.67). The pretest and posttest points of the two groups of doctors were also similar (p>0.05), and the posttest scores were significantly higher (p>0.001) (Figure 1). The relative effect changes in the test scores are shown in Table 4.

Table 4. Distribution of test points according to city groups

	Cities			
Tests	**Big cities**	**Others**	**Z**	**p**
Pretest				
Median (Min-max)	9.0 (6.0–12.0)	8.0 (5.0–13.0)	1.418	0.156
Mean±SD	8.94±1.88	8.10±1.71		
Mean rank	31.63	23.58		
Relative treatment Effect	0.34	0.25		
Posttest				
Median (Min-max)	12.0 (11.0–14.0)	12.0 (7.0–14.0)	0.793	0.428
Mean±SD	12.50±1.10	12.03±1.73		
Mean rank	70.09	64.77		
Relative treatment Effect	0.76	0.70		
Z	3.422	4.678		
p	**0.001**	**<0.001**		

SD: standard deviation

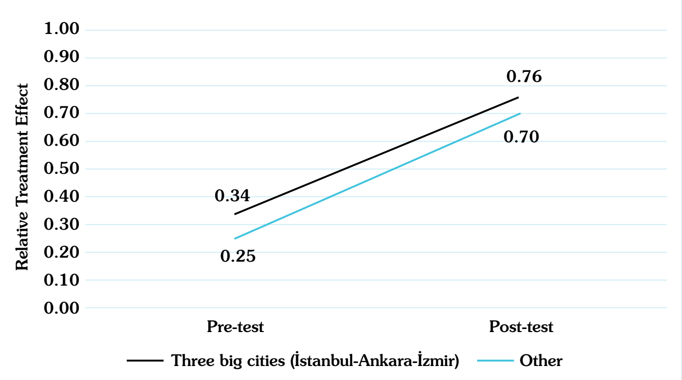

Figure 1. City-based change in relative treatment effects in pre- and posttraining phases

DISCUSSION

As in the example of Ankara bombings in 2015, modern military warfare is shifting to civilian settings more frequently and millions of civilians now live under the threat of such terrorist attacks, and any surgeon in a civilian hospital could potentially encounter mass casualty incidents and the need to treat the consequences of blast and secondary effects of an explosion (9). Thus, in order to attain a higher level of preparedness in civilian hospitals, military surgeons in the Turkish Armed Forces (TAF) can provide a precious opportunity to their civilian counterparts to learn and apply the lessons learned in military hospitals.

Among many reports, Brown et al. (10) reviewed the United Kingdom's military casualties with extremity injuries and demonstrated that the prognosis is worse after military vascular trauma if there is an associated fracture, probably due to higher energy transfer. Their study concluded that torso vascular injuries were associated with poor prognosis and few survived to surgery, while peripheral vascular injuries were less fatal but they were frequently associated with multiple traumas that could lead to death. They also showed that almost half of the casualties with isolated extremity vascular injuries were associated with physiological signs of shock and anatomic factors that required amputation.

A primary blast wave inflicts the gas-containing organs, such as ears, lungs, and intestinal organs, and may be overlooked by most clinicians if not military affiliated (11). Pulmonary primary blast injury may be evident upon presentation or may manifest as late as 48 hours from the time of the explosion (12). Secondary fragment-related injuries of the abdomen are more frequent than the primary blast injuries (12, 13). However, primary blast-related delayed intestinal (terminal ileum and caecum) perforation has also been reported and careful clinical follow up for 48 hours has been suggested (14).

Terror- and combat-related injuries are more severe than civilian mechanisms of injury (15). In Israel, terrorist bombing activities have almost been a daily occurrence between the years 2000 and 2003, killing 632 and injuring 4274 civilians (16). Typically, these victims require a longer in-hospital care and have higher morbidity and mortality rates than other types of trauma (16). Kluger (17) reported that 30% of terrorist attack victims had ISS>16, 53% required surgical interventions, 23% required intensive care unit stay, and 20% needed to be hospitalized for >14 days.

The above-mentioned few examples of explosives-related injuries show the importance of civilian surgeons having adequate knowledge of the pathophysiology of explosives-related injuries. The terrorist bombing in Madrid on March 11, 2004, instantly killed 177 and injured >2000 people. In their report, Gutierrez de Ceballos et al. (18) concluded that they still lacked a fully functional national and regional trauma system and policymakers should be committed to trauma education and well-staffed hospital emergency services to create such a system.

Even after man-made disasters, health care workers suffer from denial (e.g., "it will not happen here, it will not happen to me, someone else will be there to take care of the problem") issues. Johannigman suggests health experts should be concerned about when the next terrorist attack will occur instead of "if it will happen" and participate in training processes to be prepared for different disaster scenarios (19).

Unfortunately, many surgeons on various specialties today have not had substantial trauma experience or have had inadequate training on trauma. A general surgeon is unlikely to encounter a significant number of trauma cases affecting body regions other than the abdomen. Trauma surgery has become a separate subspecialty in North America, while the curriculum for a trauma fellowship program is being developed by the Royal Australasian College of Surgeons.

Currently, TAF Health Command has several dedicated Role 2 and Role 3 trauma centers with enhanced trauma capabilities. Over the past 30 years of combat and terror incidents, trauma experience has accumulated to develop a military trauma and trauma-related mortality database, advanced resuscitation strategies, strategic cryopreserved blood and blood component stores, advanced tourniquet devices, early blood transfusion during casualty transport by military helicopters, and tremendous experience in treating contaminated and complicated soft tissue wounds.

As some of the above-mentioned advances may not be applicable to civilian medical system, many others offer a great opportunity to implement these advances to civilian medical care. The first "Current Approaches to Firearms Injuries Course" has been designated to achieve this goal. The pretest and posttest results show a significant improvement in the attending doctors' military trauma knowledge. On March 20, 1995, Tokyo was targeted in five coordinated attacks with sarin gas, and the medical care provider casualty rate was above 20% due to a lack of training and recognition (19, 20). As CBRN attacks may also target the civilian population, the current course also fills the knowledge gap in this most dreaded type of trauma.

CONCLUSION

Continuing efforts to implement trauma-training opportunities are required to achieve reciprocal learning between the civilian and military health systems, which will improve trauma care, both on the combat field and in the civilian population. Combined efforts in developing such training modules will probably be substantiated by the ambitious attendance of national health care providers.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gülhane Military Medical Academy.

Informed Consent: Written informed consent was obtained from doctors who participated in this study.

Peer-review: Externally peer reviewed.

Authors' Contributions: Conceived and designed the experiments or case: AU, MU, SK. Performed the experiments or case: OH, ŞK, MU. Analyzed the data: NZ, AU, PO. Wrote the paper: AU, MU. Supervision & Critical Reviews: NZ. All authors have read and approved the final manuscript.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Glassberg E, Nadler R, Erlich T, Klien Y, Kreiss Y, Kluger Y. A decade of advances in Military Trauma Care. Scand J Surg 2014; 103(2): 126-31. [CrossRef]
2. Kelly JF, Ritenour AE, McLaughlin DF, Bagg KA, Apodaca AN, Mallak CT, et al. Injury Severity and Causes of Death from Operation Iraqi freedom and Operation Enduring Freedom: 2003-2004 Versus 2006. J Trauma 2008; 64: S21-7. [CrossRef]
3. Gerhardt RT, Cap AP, Cestero R, Dubick MA, Heiner J, Koller AR, et al. The Remote Trauma Outcomes Research Network: Rationale and Methodology for the study of prolonged out-of-hospital transport intervals on trauma patient outcome. J Trauma Acute Care Surg 2013; 75(Supplement 2): S137-41. [CrossRef]
4. Mabry RL, De Lorenzo RA. Improving role of battlefield casualty care from point of injury to surgery. US Army Med Dep J 2011; 2: 87-91.
5. Alisa D. Gean. Brain Injury. Applications from war and Terrorism (Textbook). 1st Ed. Philadelphia: Lippincott Williams & Wilkins. 2014. Chapter 6. Transferring Lessons to the Home Front; pp. 315-6.
6. National Consortium for the Study of Terrorism and Responsen to Terrorism: Annex of Statistical Information. Country Reports on Terrorism 2014, U.S Department of State. Available from: URL: http://www.state.gov/j/ct/rls/crt/2014/239416.htm.
7. Unlu A, Cetinkaya RA, Ege T, Ozmen P, Hurmeric V, ozer MT, Petrone P. Role 2 military hospitals: results of a new trauma care concept on 170 casualties. Eur J Trauma Emerg Surg 2015; 41(2): 149-55. [CrossRef]
8. Urbaniak GC, Plous S. Research Randomizer (Version 4.0). Retrieved on June 22, 2013. http://www.randomizer.org.
9. Aylwin CJ, Konig TC, Brennan NW, Shirley PJ, Davies G, Walsh MS, Brohi K. Reduction in critical mortality in urban mass casualty incidents: analysis of triage, surge, and resource use after the London bombings on July 7, 2005. Lancet 2006; 368: 2219-25. [CrossRef]
10. Brown KV, Ramasamy A, Tai N, MacLeod J, Midwinter M, Clasper JC. Complications of extremity vascular injuries in conflict. J Trauma 2009; 66(4 Suppl): S145-9. [CrossRef]
11. Owers C, Morgan JL, Garner JP. Abdominal trauma in primary blast injury. Br J Surg 2011; 98(2): 168-79. [CrossRef]
12. Asensio JA, Trunkey DD. Current Therapy in Trauma and Critical Care. Current therapy series. ISBN 978-0-323-07980-8.
13. Unlu A, Petrone P, Karsidag T, Asensio JA. Unexpected multiple intra-abdominal injuries after projectile fragmentation: report of three cases. Ulus Travma Acil Cerrahi Derg. 2012; 18(6): 531-4. [CrossRef]
14. Paran H, Neufeld D, Shwartz I, Kidron D, Susmallian S, Mayo A, et al. Perforation of the Terminal Ileum Induced by Blast Injury: Delayed Diagnosis or Delayed Perforation? J Trauma 1996; 40(3): 472-5. [CrossRef]
15. Bala M, Rivkind AI, Zamir G, Hadar T, Gertsenshtein I, Mintz Y, et al. Abdominal trauma after terrorist bombing attacks exhibits a unique pattern of injury. Ann Surg 2008; 248(2): 303-9. [CrossRef]
16. Singer P, Cohen JD, Stein M. Conventional terrorism and critical care. Crit Care Med 2005; 33(suppl 1): S61-S5. [CrossRef]
17. Kluger Y. Bomb explosions in acts of terrorism-detonation, wound ballistics, triage and medical concerns. Isr Med Assoc J 2003; 5: 235-40.
18. Gutierrez de Ceballos JP, Fuentes FT, Diaz P, Sanchez MS, Llorente CM, Sanz JEG. Casualties treated at the closest hospital in the Madrid, March 11, terrorist bombings. Crit Care Med 2005; 33(1 Suppl): S107-12. [CrossRef]
19. Johannigman JA. Disaster preparedness: It's all about me. Crit Care Med 2005; 33(Suppl. 1): S22-8. [CrossRef]
20. Rosenfeld JV. Training the military surgeon: Definitive Surgical Trauma Course (DSTC) and the development of a military module. ADF Health 2002; 3: 68-70.