

Plastic and Maxillofacial Training for War-Zones – A Systematic Review

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Abstract

Study Design: Injuries sustained in war-zones are variable and constantly developing according to the nature of the ongoing conflict. Soft tissue involvement of the extremities, head and neck often necessitates reconstructive expertise. However, current training to manage injuries in such settings is heterogenous. This study involves a systematic review.

Objective: To evaluate interventions in place to train Plastic and Maxillofacial surgeons for war-zone environments so that limitations to current training can be addressed.

Methods: A literature search of Medline and EMBase was performed using terms relevant to Plastic and Maxillofacial surgery training and war-zone environments. Articles that met the inclusion criteria were scored then educational interventions described in included literature were categorised according to their length, delivery style and training environment. Between-group ANOVA was performed to compare training strategies.

Results: 2055 citations were identified through this literature search. Thirty-three studies were included in this analysis. The highest scoring interventions were over an extended time-frame with an action-oriented training approach, using simulation or actual patients. Core competencies addressed by these strategies included technical and non-technical skills necessary when working in war-zone type settings.

Conclusions: Surgical rotations in trauma centers and areas of civil strife, together with didactic courses are valuable strategies to train surgeons for war-zones. These opportunities must be readily available globally and be targeted to the surgical needs of the local population, anticipating the types of combat injuries that often occur in these environments.

Keywords

plastic surgery, Maxillofacial surgery, training, war-zone

Introduction

The development of increasingly destructive weapons and the evolution of war tactics have transformed the nature of traumatic injuries in war-zones.^{1,2} Historically, battles occurred in rural areas, combat predominantly injured military personnel and military doctors provided emergency on-site care. A war-zone is a region involving fighting between opposing forces. In this study, a ‘war-zone’ is also defined by the combination of traumatic injury and volume of cases. Today, war injuries are not limited to battlefields, often involving built-up areas resulting in civilian casualties. The Syrian Network for Human Rights (SNHR) reports over 500 000 deaths since 2011 due to ongoing conflict, while the Human Rights Watch continues to report attacks against civilians and interference with the delivery of humanitarian

aid.³ The United Nations Assistance Mission in Afghanistan (UNAMA) October 2018 Report reveals record high civilian casualties by improvised explosive devices (IEDs) increasingly targeted towards women, children, medical personnel and journalists responding to attacks.⁴ At the time

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of writing, reports relating to the Beirut explosion detail over 5000 casualties with a death-toll rising by the hour.⁵ Closer to home, terrorist attacks in Paris, London and Manchester highlight the need for UK Defence Medical Services that include surgical expertise. In the event of attack, traumatic injuries are managed by civilian healthcare workers, many of whom are local A&E doctors who are not necessarily trained to manage high volumes traumatic casualties, as in a war-zone. Penetrating or blast trauma are uncommon occurrences in the UK. Meanwhile surgeons deployed to austere settings face a steep initial learning curve upon arrival.

Before arrival in a war-zone, it is essential that surgical training is tailored to working in such a setting. Though the United Kingdom and other developed countries provide substantial surgical training in all specialties, the safety of these countries limits surgical exposure to bullet, shell, stab and/or mine injuries resulting in mass trauma of the face, limbs and/or thorax.⁶ To optimise the preparation of surgeons prior to practicing in a war-zone, knowledge and understanding of the injuries likely to require treatment in such settings, as well as the degree of training such medics have achieved so far is therefore vital. However, literature describing injuries in various war-zones is heterogenous. Furthermore, there is no system-wide training including minimum core competencies and/or exposure for surgeons to regularly care for high volume of trauma patients.

Methodology

Aims

The primary aim of this systematic review is to establish the currently available Plastic and Maxillofacial Surgery training opportunities for the management of injuries sustained in war-zones. Secondary aims include ascertaining the most common injuries occurring in war-zones, as well as comparison of the efficacy and limitations of existing training opportunities highlighted by included literature. Included literature will be evaluated and applied to produce recommendations that can optimise the training of surgeons managing such injuries.

Review Technique

This systematic review was registered on Prospero (ID: CRD42020200613) then performed in line with the 'preferred reporting instructions for systematic reviews and meta-analyses' (PRISMA) ([Supplementary file 1](#))⁷ and Cochrane Handbook for Systematic Reviews.

Search Strategy

Analysis was initiated with a search of literature published from inception to July 2021 using the online databases Medline and EMBase with the mesh terms; 'training',

'teaching', 'education', 'war', 'combat', 'austere', 'plastic surgery', 'reconstructive surgery' and 'maxillofacial surgery' ([supplementary file 2](#)). Medical literature identified by this search strategy was listed using a Microsoft® Excel 2015 database.

Inclusion and Exclusion of Literature

Inclusion or exclusion of findings was then determined achieved by reviewers, each provided with a study selection form to be used for assessment of literature ([supplementary file 3](#)). Any discrepancies in selection for inclusion were then discussed by both parties until a uniform decision could be made.

The study selection form involved 2 rounds of evaluation. During initial evaluation, the titles and abstracts of search findings were collected to exclude duplicate findings, literature not written in English and literature with no relation or applicability to Plastic or Maxillofacial surgery training or practice in austere environments ([supplementary file 3](#)). Full copies of all relevant and potentially relevant literature were then retrieved for analysis using the following validated scoring tools; The BestBETS Checklist for Reviews and Meta-analyses⁸ and the Cochrane Risk of Bias tool.⁹ A maximum of fifty points were available through these tools. Studies were also awarded up to ten points for their relevance to this study. The full scoring used to assess literature is detailed in [Supplementary File 3](#). Generating these scores provided a numerical means to assess the quality of literature included in this review and enabled direct comparison between the educational interventions evaluated. Literature scoring less than 30/60 was excluded. Citations of included literature were subsequently assessed so that any other relevant studies can be added to this analysis.

Evaluation of Included Literature

Educational interventions were categorised by: (1) length, (2) use of simulation and (3) training environment. Statistical analysis was performed using SPSS® Software. Mean scores were compared then between-group ANOVA was performed with ($P < .05$) taken as significant.

Results

The search strategy generated 2055 citations, of which, 32 were deemed eligible for inclusion. Manual searching of the bibliographies of included articles gave rise to 1 additional relevant report and so, 33 articles were included in this study ([Figure 1](#); [Table 1](#)). Literature consistently highlighted a need for surgeons trained to manage the breadth of trauma encountered in war-zones, including skills beyond that of one specialty. With this in mind, we incorporate the findings

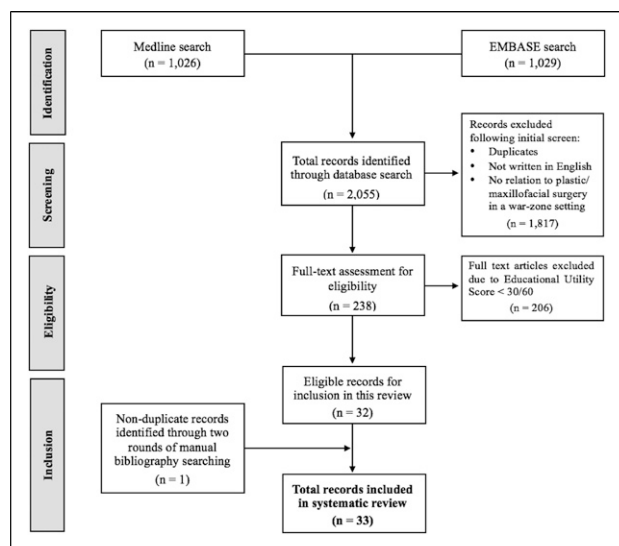


Figure 1. PRISMA diagram demonstrating the search strategy results, inclusion/exclusion process, and final records included in this review.

of both Plastic and Maxillofacial surgery-specific literature and studies with a focus on other surgical specialties, but applicability to Plastic and Maxillofacial surgery training. No conflicts of interest were disclosed by authors of included literature. Risk of bias is demonstrated in [supplementary file 4](#).

Educational interventions reported in included literature were grouped as; one-day didactic courses (4 studies), multi-day didactic courses (12 studies), surgical rotations through pre-hospital or Level 1 Trauma unit (2 studies) and surgical rotation through army evacuation unit in war-zone (15 studies). Twenty-four educational interventions targeted to surgeons prior to work in a combat setting were reported by literature included in this review ([Table 2](#)). Didactic courses were further classified depending on inclusion of a simulation component. The statistics associated with educational utility scores allocated to interventions in these groups are reported in [supplementary file 5](#).

Longer training courses scored more highly than shorter courses of a similar delivery-style. The average score for the one-day didactic course groups with and without a

Table 1. Included Educational Literature Detailing Interventions and Competencies Targeted.

Educational Intervention	Competency			
	Technical Skill	Non-technical Skills		
		Work under Stress	Work in War-Zone Environment	Use Resources Wisely
One-day didactic course without simulation component	• Reed et al¹⁰		• Reed et al¹⁰	
One-day didactic course with simulation component	• Ranr et al¹¹	• King et al¹² • Laporta et al¹³ • Morrison et al¹⁴	• King et al¹² • Laporta et al¹³ • Mercer et al¹⁵	• King et al¹² • Morrison et al¹⁴ • Mercer et al¹⁵
Multi-day didactic course without simulation component	• Back et al¹⁶ • Barillo et al¹⁷ • Rosenfeld et al¹⁸	• Cohen et al¹⁹ • Rosenfeld et al¹⁸	• Back et al¹⁶ • Barillo et al¹⁷ • Bonnet et al²⁰ • Mathieu et al²¹ • Rosenfeld et al¹⁸	• Rosenfeld et al¹⁸
Multi-day didactic course with simulation component	• Knudson et al²²	• Pereira et al²³ • Sohn et al²⁴ • Knudson et al²²	• Pereira et al²³ • Sohn et al²⁴ • Pasquier et al²⁵	• Pereira et al²³ • Pasquier et al²⁵
Non-specific clinical rotation through pre-hospital or Level I trauma unit	• Hight et al²⁶ • Knudson et al²⁷	• Schreiber et al²⁸	• Schreiber et al²⁸	
Surgical rotation through army evacuation unit in war-zone	• Breeze et al²⁹ • Brooks et al³⁰ • Hoencamp et al³¹ • Ramasamy et al³² • Barbier et al³³	• Brennan et al³⁴ • Brisebois et al³⁵ • Franke et al³⁶ • Fries et al³⁷ • Jensen et al³⁸	• Knudson et al²⁷ • Scalzitti et al³⁹ • Shen-Gunther et al⁴⁰ • Tyler et al⁴¹ • Hammond et al⁴²	

Key According to Educational Utility Score (max: 60): Score ≥ 45 = Green; Score 35 - 45 = Amber; Score < 35 = Red; Score < 30 = Excluded from study.

Table 2. Educational Interventions Available for Surgeons Planning Work in War-zone.

Type of Intervention	Name of Intervention
<i>Courses</i>	• Advanced burn Life support (ABLS) Course + Combat burn life support module • Advanced surgical skills for Exposure in trauma Course • Advanced trauma Operative management Course • Advanced trauma and Life support Course • battlefield Advanced trauma and Life support Course • Combat Casualty Care Course • Damage Control surgery Course • Definitive surgical trauma Course • Emergency management of Severe burns Course • Extremity war surgery Course • French Advanced Course for deployment surgery • German war surgery Course • Joint forces Combat trauma management Course • Management of oral and maxillofacial trauma from IEDs (1-day course) • Military Emergency Crisis management Course • Surgical training for Austere Environments (STAE) Course • Trauma Exposure Course
<i>Simulation Programmes</i>	• Scenario and medical simulator-based exercises • 'Whole hospital exercises' • Simulated battlefield exercises • Virtual reality programmes (serious games)
<i>Hospital-based Training</i>	• Craniofacial fellowship (Birmingham, UK) • Craniomaxillofacial trauma fellowship (North Carolina, US) • Major trauma and reconstruction fellowship (Birmingham, UK) • Standard training programme in plastic and reconstructive or maxillofacial surgery

simulation component were 37.667 and 40. Meanwhile, multi-day didactic teaching groups had mean scores of 45.333 (with simulation component) and 41.5 (no simulation component). To test the hypothesis that length of educational intervention had a significant effect on the resulting score, a between-group ANOVA was performed. This highlighted a statistically significant difference in scores between one-and multi-day course groups where a simulation component was included (P -value = .022). For didactic course groups without a simulation component, there was no statistically significant difference (P -value = .683) but the multi-day didactic course group had a higher mean Educational Utility Score. Interestingly, training interventions over a longer period than these courses, including surgical rotations through pre-hospital/level 1 Trauma units or an army evacuation unit in a war-zone did not have higher mean scores.

There is a role for action-oriented surgical training. The highest scoring educational intervention categories were the multi-day didactic course group with a simulation component and the cohort training at a Level 1 Trauma Centre (average scores 45.333 and 42.6, respectively). However, direct comparison with other educational intervention groups, including training in the war-zone did not confirm a statistically significant difference in scores.

Studies including surgical rotation through army evacuation units in war-zones were further explored to establish the technical skills obtained while in combat settings (Table 3). Skills were categorised according to the war-zone setting and whether they involved soft tissue reconstruction, hard tissue (bone) reconstruction, maxillofacial procedures or surgeries of other specialties.

Afghanistan had the highest number of studies¹⁰ describing educational interventions in one of its army evacuation units. Only 3 studies involved training in Iraq and 1 pertained to training in Africa. The procedures practiced differed between these settings. Wound debridement was the most commonly reported procedure in all combat settings. However, the report was highest in the Central African Republic (66%), followed by Iraq (56.3%), Afghanistan (28.9%) and Mali (22.5%). In Afghanistan, the incidence of open reduction and internal fixation of maxillofacial fractures performed was higher than that reported for Iraq, where trainees had higher reports of performing tracheostomies and neck explorations.

Trainees in war-zones were often required to perform plastic reconstructive and/or maxillofacial procedures, regardless of whether or not this was their primary training specialty at home. In Afghanistan, surgeons developed skills in burn management, skin grafting and performing

Table 3. Technical Skills Obtained During Surgical Rotation Through Army Evacuation Unit in War-zone.

Skill		Mean Frequency of Procedures Performed in War-Zone Settings, Reported as (%) of all Procedures					
		Afghanistan		Iraq		Other	
		%	Studies	%	Studies	%	Studies
<i>Soft tissue reconstructive procedures</i>	Burns:	18.4	29,33	<i>Not reported</i>		Mali: 14.9	33
	• Dressing change	14.9	36			<i>Not reported</i>	
	• wound excision	5.4	29,31-33,35-37			Mali: 1.9	
	• skin grafting	5.3	36			<i>Not reported</i>	
	• Scar revisions			<i>Not reported</i>			
	Flap procedures:	6.7	36			Mali: .6%	33
	• Local advancement flap	0.2	36			CAR: 3.0%	
	• Local latissimus dorsi flap	1.0	36				
	• Local myocutaneous flap	1.6	36,37				
	• Local fasciocutaneous flap	1.5	36				
	• Gastrocnemius flap	0.5	36,37				
	• Groin flap	0.5	37				
	• Posterior interosseous artery flap	0.5	36,37				
	• Sural artery flap	0.5	37				
	• Anterolateral thigh flap	0.5	36,37				
	• Latissimus dorsi flap	1.6	29,33				
	• non-specified flap						
	Escharotomy/Fasciotomy	3.2	29,31-33,35,37,40	<i>Not reported</i>		Mali: 1.2	33
						CAR: 1.0	
	Debridement	28.9	29,31-33,35-37	56.3	41	Mali: 22.5	33
						CAR: 66.0	33
	Tendon repair/transfer	1	29,37	<i>Not reported</i>		<i>Not reported</i>	
<i>Hard tissue procedures</i>	Other non-specified soft tissue reconstructive procedures	14.7	30,35,40	8.7%	41	SEA (navy): 11.6	38
		13.9%	39				
	Manipulation under anaesthesia	3.1	29,31,32,35,40	<i>Not reported</i>		D	
	Intra-medullary nailing	11.9	29			<i>Not reported</i>	
	External bone fixation	9.2	29,31-33,35,40			Mali: 18.6	33
						CAR: 8.0	
	Open reduction internal fixation	5.9	29,31,33,35,40			Mali: 3.7	33
						CAR: 6.0	
	Segmental bone resection	3.4	36			<i>Not reported</i>	
	Distraction osteogenesis	1.8	36				
	Free fibular transfers	1.1	36				
	Fibular transfer for tibial reconstruction	0.4	36				
	Amputation	3.7	29,31-33,35,36,40	5.4	41	Mali: 3.1	33
						CAR: 3.0	
	Revision of amputation	6.0	29	<i>Not reported</i>		<i>Not reported</i>	
	Other non-specified	29	29,30,36			SEA (navy): 8.1	38
<i>Oral and maxillofacial procedures</i>	Facial laceration repair	22.5	29,34	33	34	<i>Not reported</i>	
	Intermaxillary fixation	5.8	34,35	5.7	34		
	Open reduction internal fixation	10.0	29,34,35	3.3	34		
	Tracheostomy	8.8	29,34,35,40	12.7	34,41		
	Neck exploration	1.8	34,35,40	8.2	34,41		
	Other non-specified	6.0	30-32,35,40				
		12.7	39			SEA (navy): 2.4	38

(continued)

Table 3. (continued)

		Mean Frequency of Procedures Performed in War-Zone Settings, Reported as (%) of all Procedures					
		Afghanistan		Iraq		Other	
Skill		%	Studies	%	Studies	%	Studies
<i>Other</i>	General surgery procedures	23.6	29-31,35,37,40	<i>Not reported</i>		SEA (navy): 25.4	38
	Neurosurgical procedures	1.9	29,32,35			Mali: 2.5	33
	Otolaryngologic procedures	16.8 ³⁹				CAR: 1.0	
	Paediatric procedures	<i>Not reported</i>				SEA (navy): 9.1	38
						SEA (navy): 7.7	38

Abbreviations: CAR, Central African Republic; SEA, South East Asia.

flap procedures. Additional skills obtained included fixation of limb and/or facial fractures, bone reconstruction and procedures of the head/face/neck. Included literature confirms the value of war-zones for Plastic/Maxillofacial Surgery training but also highlights the need for training in other specialties. Although in war-zones, trainees performed orthopaedic, general surgical, neurosurgical, otolaryngologic and paediatric surgery procedures. Technical skills in these specialties as well as the ability to work as part of a multi-disciplinary team in resource-limited stressful settings should therefore also be considered in training educations designed for those planning to work in war-zones.

Discussion

Injuries and Surgical Practice in the Combat Setting

The use of explosive devices in heavily populated areas results in mass civilian casualties on a semi-regular basis with high volumes of trauma requiring surgical intervention. These are most commonly penetrating or blast injuries. Breeze et al²⁹ reported the site of traumatic injuries managed by trainees at the Role 3 Multinational Field Hospital (Khandar, Afghanistan). The majority involved the extremities (40% lower limb, 23% upper limb) followed by the head and neck. Interestingly, similar analysis of trainees in Iraq by Brennan et al³⁴ demonstrated a higher incidence of head and neck than limb trauma. This difference is important when tailoring surgical training for different war-zone settings since the 'optimal' training approach for one combat setting may not be ideal for another. Further analysis of procedures performed indicated that wound debridement is the most commonly performed procedure in all war-zone environments, followed by burn management and facial laceration repair. The majority of limb injuries were managed by orthopaedic or general surgeons. However, concurrent soft tissue injury often necessitated plastic reconstructive expertise, including the ability to perform flap procedures, where free flap procedures were

considered too risky, local or pedicle flaps were performed.^{36,37} Preparatory training for war-zones should therefore provide an understanding of how and when to repair soft tissue injuries, and what to do when microsurgical reconstruction is not an option for logistical and safety reasons. Additional traumatic injuries reported involved children, typically as a result of complex attacks (e.g. improvised explosive devices), aerial operations or, as commonly reported in Afghanistan, accidental detonation of previously undiscovered landmines.^{32,43} Maxillofacial, vascular, general and neuro-surgical injuries were also commonly reported. Surgeons in such environments therefore need general trauma and specialty specific expertise. They should also be prepared to work as part of a multi-disciplinary team under stressful conditions and with limited resources.

Current Preparation of Surgeons to Manage Mass Trauma in Austere Environments

Current training strategies include short-term and longer-term training strategies. Breeze et al⁴⁴ evaluated the benefit of these interventions, concluding that experience at Level 1 Trauma Centres is essential then can be supplemented through courses. Hospital-based learning can be through specialist training or fellowship programmes. Plastic Surgery specialty training programmes provide surgical exposure to many of the injuries encountered in war-zones (Table 3). Surgeons can supplement this experience with specific trauma and burns surgery by undertaking a fellowship. The UK offers over fifty fellowship programmes in Plastic Surgery.⁴⁵ The Reconstructive Trauma Surgery Interface Fellowship at the Queen Elizabeth Hospital, Birmingham, strives to ensure proficiency in the management of trauma. Trainees also have direct exposure to surgical patients brought directly from combat-settings.^{42,45} The importance of hospital-based training prior to work in combat settings was demonstrated by three studies included in this

systematic review.²⁶⁻²⁸ Of these, the training strategy described by Hight et al²⁶ had the highest score. This group established that surgical experience at Level 1 Trauma Centres is more comparable to that in war-zone settings than that at Level 2 Trauma Centres, Civilian Level III Trauma Centres and/or US Military Training Facilities that are not officially a designated trauma centre. Where it is not feasible to receive training at these trauma centres, collaboration with other surgical teams, including those in war-zones, may improve the training and management of combat-type injuries.²⁷

Most surgeons working report satisfaction with their training prior to work in a war-zones.⁴⁶⁻⁴⁸ However, they note a need for further training in the management of paediatric, fracture and burn injuries.^{47,48} Limitations to current UK hospital-based training include the volume, breadth and specific trauma pathology encountered. Retrospective analysis of UK military operating theatre records in Southern Afghanistan (01/05/2006–01/05/2008) equate the exposure to penetrating trauma within a six-week deployment to Helmand Province to that obtained in a UK NHS trauma unit over a three-year duration.³² This limited surgical exposure is partly due to the Modernising Medical Careers (MMC) who streamlined core surgical training (CT1-CT2) to two years before beginning specialty training, but also since injuries typically occurring in the UK are not wholly representative of the pathology that arises in combat settings.

Courses and simulation training strategies are gaining increasing popularity. Many of these courses provide increase the trainee's ability to triage critically ill surgical patients. The Advanced Trauma and Life Support (ATLS) course is mandatory in core surgical training to ensure junior surgeons have the minimal ability to manage trauma patients in a hospital setting. The majority of courses described in this review are targeted to those with existing specialist surgical experience, in the two-year period leading up to work in a war-zone. Their aim is to minimise the learning curve once in the combat setting. During the Afghanistan war, The Royal College of Surgeons of England, Royal Centre for Defence Medicine and Academic Department of Military Surgery and Trauma (ADMST) provided a highly successful training course twice a year to those about to deploy to Afghanistan: The Military Operational Surgical Training (MOST) Course.^{44,49} This encompassed general, orthopaedic and plastic surgical training as well as a day of cadaveric-based teaching in the management of head, face and neck injuries from explosive weaponry and high energy bullets.⁵⁰ With live links to surgeons in Afghanistan and tutors with recent practice in military environments, training incorporated authentic clinical cases. Currently, the Royal College of Surgeons offers the Surgical Training for Austere Environments (STAE) Course; a five-day cadaveric-based course providing practice in basic trauma management as

well as essential skills in general surgery, facial trauma, plastic surgery, orthopaedic trauma, obstetrics and gynaecology that are often necessary in war-zones, areas of humanitarian crisis or post-catastrophic incident.⁵⁰

Multi-day didactic courses with a simulation component had the highest scores (45+). This supports the implementation of action-oriented training interventions delivered over an extended time-frame. Realistic simulation training can be delivered using live animals¹² but increasing restrictions regarding animal cruelty limits their use. Alternative options include virtual reality programmes,^{19,25} medium-fidelity medical simulators ('Sim Man'),¹⁴ human performance simulators^{13,22} and simulated battlefield experiences.¹⁵ Simulated battlefield exercises are particularly useful in improve trainee's ability to work under stressful circumstances, in war-zone environments and with limited resources. The combination of interactive hands-on learning with authentic scenarios applicable to war-zone settings provides trainees the opportunity to improve both clinical reasoning and non-technical skills that are required in the combat setting.

Training Limitations and Scope for Improvement

Though various training opportunities exist, they are not widely available and only a small minority are mandatory. Mandatory completion of programmes tailored to performing commonly required surgeries in war-zones, and working as part of a multidisciplinary team in a stressful setting may help standardise training. Training programmes should include combat injury management, with a focus on orthoplastic reconstructive procedures, burns care and paediatric trauma care. Surgeons who are planning to work in a war-zone should be able to provide evidence of having independently surgically managed such cases. Wholly-immersive simulation exercises are also advisable as they provide an excellent artificial environment where errors can be made without risking harm to a patient. Given that highly technical simulation models are expensive, there is a role for the development of cost-effective, high-fidelity simulation models. Concerns regarding exposure to high-volumes of trauma and managing patients with minimal resources can potentially be overcome through clinical experience in low-income countries. Since both low-income countries and combat settings are afflicted by substantial case-loads, limited personnel and equipment constraints, this could serve as a very effective measure to bridge the gap between operating in safe, well-resourced hospitals and units in conflict-zones.

Conclusion

This systematic review highlights the heavy burden of Plastic and Maxillofacial surgical disease as well as the challenges posed by treating complex combat-type

injuries in war-zone settings. This includes an inadequate number of surgeons with training that is not always specific to the job in hand and often having to make use of rudimentary facilities and limited resources. Prior to working in a war-zone surgeons should undertake surgical rotations in trauma centres so that they can independently perform the most common surgeries required in war-zones (Table 3). A logbook of such cases should be kept, and a mandatory minimum case-log may ensure that surgeons are able to perform these procedures with confidence before working in a war-zone. Supplemental training should then include a combination of courses and simulation-based workshops to better prepare surgeons for the war-zone setting itself. Technological and telecommunication advances of recent years should be used to enhance the training process and facilitate its worldwide dissemination.

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Supplemental Material

Supplement material for this article is available online.

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