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ORIGINAL ARTICLE

# Preparing Japanese surgeons for potential mass casualty situations will require innovative and systematic programs

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**Abstract**

*Introduction* The ongoing state of global geo-political instability means that it is prudent to prepare civilian surgeons to manage major military-type trauma. Japan has enjoyed a prolonged period of peace and consequently it is unlikely that surgeons will have been exposed to a sufficient volume of cases. This study reviews the state of trauma training and preparedness in Japan and reviews the trauma workload of a major Japanese emergency medical center and compared with a major South African trauma center with the intention of quantifying and comparing the time needed to gain adequate exposure to major trauma at the two centers.

*Materials and methods* The literature describing the surgical burden from a number of recent military missions was reviewed and the core surgical skills to manage military-type injuries were identified. We then went on to review all patients admitted to both Kurashiki Central Hospital (KCH) and Pietermaritzburg Metropolitan Trauma Service (PMTS) following trauma between the period September 2015 and August 2016. The burden of trauma at each center was quantified and the number of core surgical competencies or procedures performed at each center was then reviewed. These were then compared with the number of the core procedures which were performed on the reported military missions.

*Results* Three reports on military surgical missions were reviewed. These came from the Dutch, French and British military surgical services. The average number of each core procedures performed on each reported military surgery mission are tabulated in the text. The most common procedures were wound debridement and orthopedic fixation, followed by trauma laparotomy, neck exploration and thoracotomy. During the 12 month study period, 309 trauma patients were admitted to KCH. Of which 206 (67%) were male, and the mean age was 57 years. There were 10 penetrating injuries and 299 blunt injuries. Of the penetrating injuries there were no gunshot wounds. The mechanisms of injury for blunt trauma were as follows: Road traffic accidents (RTAs); 141 (47%), fall; 136 (46%) and other injuries; 22 (7%). In the same period, 2887 trauma patients were admitted by the PMTS. There were 1244 cases (43%) of penetrating trauma and 1644 cases (57%) of blunt trauma in PMTS. The mechanisms of injury for penetrating trauma were as follows: stab wounds (SWs); 955 (77%), gunshot wounds (GSWs); 252 (20%), and other injuries; 37 (3%) and for blunt trauma were as follows: assault; 739 (45%), RTAs; 669 (41%), fall; 166 (10%), and other injuries; 70 (4%). The exposure to all the key competencies required to manage

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trauma is overwhelmingly greater in South Africa than in Japan. The length of time needed to obtain an equivalent trauma exposure to that achieved in South Africa, working in Japan is prohibitively long.

*Conclusion* Trauma training in Japan is hamstrung by a lack of clinical material as well as by systematic factors. Training a trauma surgeon is difficult. Developing a trauma system in the country may help address some of these deficits. South Africa in contrast has a huge burden of trauma and sufficient infrastructure to ensure that surgeons working there have adequate exposure to major trauma. Developing an academic exchange program between Japan and South Africa may allow for the transfer of trauma experience and skills between the two countries.

**Keywords** Trauma surgical training · Core surgical skills · Trauma system · Exchange program

## Introduction

The global geo-political situation appears to be in a state of flux. There are several ongoing military conflicts around the globe. The alliances as well as long standing balances of power both regionally and globally appear to be shifting. The scourge of urban terrorism is raising its head in increasing numbers of major cities which have known relative peace for over seventy years. The implication is that even civilian healthcare services are required to be prepared for a broad range of casualties at unexpected times. Since the end of the Second World War, Japan has not been involved in any military operations and has only operated a self-defense force rather than a conventional military force [1]. However, Japan currently faces a number of existential threats in the form of potential regional conflicts and urban terrorism. It may come to pass that Japan is called upon to respond to a mass casualty situation either from urban terrorism, or a major regional military conflict. Civilian surgical services therefore need to be prepared to manage large volumes of major trauma victims at short notice.

This raises the issue of how to ensure that busy civilian surgeons have appropriate surgical trauma training. Globally, the modern surgeon is increasingly sub-specialized and focused on complex elective operations in a well-controlled environment. Non-operative management and minimally invasive surgery have become more common for a number of acute surgical conditions. Preparing a modern surgeon to manage mass shooting or terrorist related injuries remains an ongoing challenge in many countries [2–7]. The literature from recent military missions has highlighted a number of core surgical skills which trauma surgeon must be au fait with [8–14]. In the event of a major terrorist incident, civilian surgeons, who may be confronted with similar patients, will need to be competent in terms of these key skills. There is no consensus on how many of these key skills a surgeon needs to see or perform to achieve competence.

Following the events of September 11, 2001, the primary author realized that exposure to major trauma is essential and consequently worked for a year with the Pietermaritzburg Metropolitan Trauma Service (PMTS) in Pietermaritzburg, South Africa. Following this he periodically returned for a shorter period and began working on a project to help formalize and consolidate trauma training in Japan. This paper contrasts the trauma workload of a major Japanese emergency medical center, with that of the PMTS as well as with a number of contemporary military deployments. By objectively quantifying the length of clinical time needed to be exposed to the core surgical skills needed to manage major trauma, it is hoped that we will be able to develop norms for achieving and maintaining competency in these core skills. Ultimately, development of both curricula and exchange programs may allow for better preparation of civilian surgeons who may be called upon to care for the victims of a major urban terrorist incident.

## Materials and methods

### Clinical settings

*Kurashiki Central Hospital (KCH)*

Okayama prefecture is located in the west side of Japan and Kurashiki is the second largest city in Okayama prefecture. Half a million people reside in the city of Kurashiki. Kurashiki Central Hospital (KCH) is a major general hospital which has 1200 beds and has one of the largest emergency departments in Japan. The hospital serves a population of covers over 800,000 people from the west side of Okayama prefecture. All medical and surgical emergencies, including all trauma patients are admitted to the department. Approximately 60,000 emergency patients are managed annually. The emergency department is managed by specialist emergency physicians. All trauma patients are initially assessed by the emergency physicians and once the trauma team protocol has been activated, trauma surgeons provide all definitive trauma care. However, there are no dedicated trauma fellows or residents and patients are admitted and managed by emergency physicians. Patients with isolated traumatic brain injury or isolated orthopedic trauma requiring admission are managed by the respective specialties.

*Pietermaritzburg metropolitan trauma service (PMTS)*

The province of Kwa-Zulu Natal (KZN) is on the eastern seaboard of South Africa. Pietermaritzburg is the capital

city and is situated one hour inland from the urban conurbation of Durban. A million people reside in the city of Pietermaritzburg. The PMTS provides definitive trauma care to the city of Pietermaritzburg, as well as the western third of the province. The PMTS covers a total catchment population of over three million people. It is also one of the largest academic trauma centers within the province. Due to the extremely high incidence of interpersonal violence, gang related and criminal activities throughout the entire province, approximately 3000 patients are admitted per year, with around 50% penetrating trauma. The PMTS functions with a trauma team, which is headed by a duty full-time trauma surgeon, along with a trauma fellow, a chief resident, a junior resident, and a number of interns. Almost all patients are managed by the trauma team, with the exception of those with isolated orthopedic trauma. The only patients that require transfer out of our trauma center are those with traumatic brain injuries requiring surgical intervention, in which the neurosurgical unit is located at Inkosi Albert Luthuli Central Hospital (IALCH) in Durban.

### The study

Ethics approval for this study was formally endorsed by the Biomedical Research Ethics Committee (BREC) of the University of Kwa Zulu Natal (BCA221/13, BE 207/09) and the Institutional Review Board (IRB) of Kurashiki Central Hospital. The literature describing the surgical burden from a number of recent military missions was reviewed and the core surgical skills to manage military-type injuries were identified. We then went on to review all patients admitted to both KCH and PMTS following trauma between the period September 2015 and August 2016 using the respective electronic databases and compared. Following this, the burden of trauma at each center (KCH and PMTS) was quantified and the number of key surgical skills or procedures performed at each center was reviewed. Basic demographic data, including mechanism of injury and body region injured were reviewed and all operative procedures were categorized. Operative volume was calculated for each center and reported as number of key skills per year. This was then compared to the published military data.

#### *Military data*

A comparison with published data on recent military surgical missions was undertaken. The literature describing the surgical burden from a number of recent military missions was reviewed and the core surgical skills to manage military-type injuries were identified. Papers which focused on specific injuries such as vascular, thoracic or colorectal trauma were rejected in favor of papers presenting a broad review of the general trauma workload at the most forward type of military medical facilities. These reports were analyzed and the reported workload noted. As was done with the KCH and PMTS data, an attempt was made to quantify the reported military workload into key skills by year. These were then compared to the workload for each key skill by year for KCH and PMTS.

## Results

### The KCH cohort

During the 12 month study period, 309 trauma patients were admitted to KCH; 206 (67%) were male, and the mean age was 57 years. There were 10 penetrating injuries and 299 blunt injuries. Of the penetrating injuries, there were no gunshot wounds (GSWs). The mechanisms of injury for blunt trauma were as follows: road traffic accidents (RTAs); 141 (47%), fall; 136 (46%) and other injuries; 22 (7%).

### The PMTS cohort

During the same 12 month period, 2887 patients were admitted by the PMTS. There were 1244 cases (43%) of penetrating trauma and 1644 cases (57%) of blunt. The mechanisms of injury for penetrating trauma were as follows: stab wounds (SWs); 955 (77%), GSWs; 252 (20%), and other injuries; 37 (3%). The mechanisms of injury for blunt trauma were as follows: assault; 739 (45%), RTAs; 669 (41%), fall; 166 (10%), and other injuries; 70 (4%). Table 1 compares the mechanism of trauma in the KCH cohort and the PMTS cohort and estimated length of time needed to obtain the equivalent trauma exposure in KCH. Table 2 compares the number of injuries for each mechanism in Japan and South Africa according to body region.

**Table 1** Mechanism of trauma and the length of time needed to obtain the equivalent trauma exposure in Japan

| | Japan/year | South Africa/year | Requiring years to obtain (years) |
|---|---|---|---|
| Total (*n*) | 309 | 2887 | 9.3 |
| Penetrating | 10 | 1244 | 124.4 |
| Gunshot wounds | 0 | 252 | 252 |
| Stab wounds | 9 | 955 | 106.1 |
| Other | 1 | 37 | 37 |
| Blunt | 299 | 1644 | 5.5 |
| Road traffic accident | 141 | 669 | 4.7 |
| Fall | 136 | 166 | 1.2 |
| Assault | 0 | 739 | 739 |
| Other | 22 | 70 | 4.4 |

**Table 2** Number of injuries for each mechanism

| | Japan/year | | South Africa/year | |
|---|---|---|---|---|
| | Penetrating | Blunt | Penetrating | Blunt |
| Total injuries (*n*) | 13 | 597 | 1821 | 2654 |
| Head | 0 (0%) | 144 (24%) | 207 (11%) | 1016 (38%) |
| Face | 0 (0%) | 38 (6%) | 98 (5%) | 289 (11%) |
| Neck | 1 (8%) | 47 (8%) | 191 (11%) | 104 (4%) |
| Chest | 1 (8%) | 132 (22%) | 530 (29%) | 360 (14%) |
| Abdomen | 6 (46%) | 64 (11%) | 399 (22%) | 274 (10%) |
| Pelvis | 1 (8%) | 53 (9%) | 41 (2%) | 91 (3%) |
| Upper limb | 2 (15%) | 63 (11%) | 203 (11%) | 250 (9%) |
| Lower limb | 2 (15%) | 56 (9%) | 152 (8%) | 270 (10%) |

## Operative exposure

Three reports on military surgical missions were reviewed. These came from the Dutch, French and British military surgical services. The most common procedures were wound debridement and orthopedic fixation, followed by trauma laparotomy, neck exploration and thoracotomy. Table 3 summarizes the number of procedures performed each year in KCH and PMTS and then compares them to the published burden from three different national military surgical missions. Table 4 attempts to establish the length of time needed to achieve clinical exposure to the key operative competencies in KCH and PMTS.

**Table 3** Number of procedures performed each year and comparison with published literature

| Operations /year | | | | | |
|---|---|---|---|---|---|
| | Japan | South Africa | Dutch (12–14) Hoencamp et al. | French (9) Bonnett et al. | British (10) Ramasamy et al. |
| Neck exploration | 0 | 34 | 43 | NA | 97 |
| Thoracotomy | 7 | 86 | 6 | 16 | 16 |
| Laparotomy—non damage control | 16 | 299 | 46 | 42 | 53 |
| Laparotomy—damage control | 8 | 22 | 31 | NA | NA |
| Laparoscopy | 2 | 41 | NA | NA | NA |
| Orthopedic procedure | 17 (Ex-fix) | 146 | 92 | NA | NA |
| Vascular exploration | 3 | 52 | 5 | 10 | 13 |
| Limb amputation | 2 | 9 | 32 | NA | 43 |
| Wound debridement | 8 | 142 | 231 | 17 | NA |
| Fasciotomy | NA | 21 | 15 | NA | 23 |
| Skin grafting | 2 | 32 | 28 | NA | 23 |
| Maxillofacial fixation | NA | 46 | NA | NA | NA |
| Neurosurgical | NA | 67 | NA | NA | 20 |

**Table 4** The length of time needed to achieve clinical exposure to the key operative competencies in Japan

| | Operations/year | | Requiring years to obtain (years) |
|---|---|---|---|
| | Japan | South Africa | Japan |
| Neck exploration | 0 | 34 | 34.0 |
| Thoracotomy | 7 | 86 | 12.3 |
| Laparotomy—non damage control | 16 | 299 | 18.7 |
| Laparotomy—damage control | 8 | 22 | 2.8 |
| Laparoscopy | 2 | 41 | 20.5 |
| Orthopedic procedure | 17 (Ex-fix) | 146 | 8.6 |
| Vascular exploration | 3 | 52 | 17.3 |
| Limb amputation | 2 | 9 | 4.5 |
| Wound debridement | 8 | 142 | 17.8 |
| Fasciotomy | NA | 21 | NA |
| Skin grafting | 2 | 32 | 16.0 |
| Maxillofacial fixation | NA | 46 | NA |
| Neurosurgical | NA | 67 | NA |

## Discussion

In our comparative study of two major trauma centers in Japan and South Africa, it would appear that the volume of trauma in Japan is relatively limited for civilian surgeons to gain sufficient exposure. The significant difference between the two major trauma centers in Japan and South Africa is almost ten times. Furthermore, penetrating trauma is also rare in Japan. One year in PMTS provided an equivalent exposure to penetrating trauma that one would otherwise require 124 years to gain in KCH. Furthermore, the number of major operative procedures (e.g. neck exploration, vascular exploration, laparotomy, etc.) would require over fifteen years to acquire. Practical exposure to the management of trauma patients is essential if one hopes to train civilian surgeons with the necessary skill set to manage these injuries. Didactic courses such as the Definitive Surgical Trauma Care (DSTC) course which combines lectures, case solving and the use of animal models has recently been introduced in Japan. Although this course provides a solid theoretical background for trauma care, slots with places on the course are still limited.

A similar situation is likely to exist in other Asian and Western European countries. These "peaceful countries" simply do not have sufficient trauma to ensure that those managing it develop and maintain the appropriate surgical skill set. However, the current unstable global situation is replete with potential threats of war and urban terrorism. This means that even in these countries surgeons may suddenly and unexpectedly be required to deal with military-type injuries. In light of this, it is imperative that countries develop comprehensive response systems capable of managing a sudden unexpected demand for trauma care. An effective system requires preparedness, which means regular major trauma exercises. The limited trauma exposure makes it difficult to train trauma surgeons and to develop an adequate trauma team or system capable of dealing with future calamities. South Africa historically has a high burden of trauma [15]. Its burden of interpersonal violence and penetrating trauma is amongst the highest in the world. South Africa has a well-developed surgical training system with a track record of providing both academic and clinical trauma training to surgeons from around the world.

In Japan, the low level of clinical exposure to major military-type trauma is exacerbated by the disparate nature of the trauma system. Although the low burden of trauma in Japan should make it easier to concentrate trauma patients at a designated trauma center, each of which covers a population of 2–3 million people, this has not been done. In Tokyo, there are more than twenty-five emergency centers for a population of 13 million people [16, 17]. This translates into one emergency center per 520,000 population. In addition, trauma patients are dispersed to smaller hospitals and facilities, thus further diluting the number of trauma patients presenting at the major emergency centers. There is currently no verification system for trauma centers in Japan. This is in contrast to the situation in the United States of America where trauma centers are ranked by the American College of Surgeons, from Level 1 which provides a comprehensive service to Level 3 center which provides a lower level of trauma care [18]. The different levels also take account of resources available in each institution and the number of patients admitted per annum. These categories define national standards for trauma care in hospitals and trauma centers are regularly re-verified.

In addition to the lack of trauma center verification in Japan, there is currently no board type sub-specialty qualification for trauma surgery. There is a lack of early surgical input into trauma care. Trauma care is often administered primarily by emergency physicians without the appropriate involvement of trauma surgeons capable of delivering definitive care. When surgeons are involved, they are usually gastrointestinal or cardiovascular surgeons who are not primarily trained to manage severely injured patients. For historical reasons, the Japanese Surgical Society has not been involved in planning for trauma management and no specific trauma surgical training program exists. Whilst the current system appears to be adequate to manage low volumes of predominantly blunt trauma, in the event of a major terrorist incident the system may not be resilient enough to manage the sudden influx of major trauma patients with military-type injuries. Planners need to strategize around this problem as recent events have shown that cities which have enjoyed long periods of peace are now at risk for major unexpected mass terror events.

One potential solution is the development of clinical fellowships and exchange programs which allow surgeons from countries such as Japan to spend time in high volume trauma centers either in South Africa or North America [5]. It must, however, be understood that modern trauma care is a team effort. The archetypal modern war injury is a blast injury and managing these complex injuries requires input from a diverse group of people. These include orthopedic, plastic, urological, burn and general surgeons as well as intensivists and anesthetists. In addition, allied medical staff such as emergency nurses, respiratory and physiotherapists and occupational therapists all play essential roles in the acute care and rehabilitation of these patients. This means that exposing a single surgeon to trauma in a high-volume center will not ensure the development of a collective institutional knowledge of trauma management at the parent institution. If an exchange program is set up it must look to send a broad range of staff to the high-volume training center. In addition, programs at the parent institution must be set up under the leadership of staff who have attended the high-volume center to

ensure that the trauma skills they acquired are passed on to these institutions.

This study has a number of limitations, which include the fact that there are no nationwide data available to compare the overall trauma experience between the two countries, and the only military data available are those which have been reported in the literature. In addition, there is little consensus on the number of each of these key skills which needs to be seen and managed before a surgeon can be considered to be clinically competent. It is hoped that this paper may provide a stimulus to more meaningful planning and data collection. As stated in the introduction, the global geopolitical situation seems to be extremely tense and replete with potential and actual conflicts. For this reason, endeavors such as the one described in this article are of the utmost importance. It may well be that major relief organizations as well as various military medical services need to collaborate to attempt to co-ordinate such a project.

## Conclusion

Trauma training in Japan is hamstrung by a lack of clinical material as well as by systematic factors. Training a trauma-competent military or civilian surgeon in such an environment is difficult. Developing a trauma system in the country may help address some of these deficits. In addition, developing academic exchange programs with countries which can offer broader trauma experience is essential, however, it is important to integrate these skills back into a trauma system once the individual returns to Japanese practice.

#### Compliance with ethical standards

**Conflict of interest** No conflict of interest declared. VK, GO, WB, GL, JB, DC are all Advanced Trauma Life Support (ATLS) Instructors. HU, GO, JB, DC are also DSTC instructors.

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