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Trauma Care in India and Japan: Current Situation and Future Prospects

Edited by

Rajesh Malhotra

Yasumitsu Mizobata

Trauma Care in India and Japan: Current Situation and Future Prospects

Economic Research Institute for ASEAN and East Asia (ERIA)
Sentral Senayan II 6th Floor
Jalan Asia Afrika No. 8, Gelora Bung Karno
Senayan, Jakarta Pusat 10270
Indonesia

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Introduction

This report is part of an ongoing project on developing human resources in acute medicine, surgery, and trauma care, in response to the Memorandum of Cooperation (MOC) between The Office of Healthcare Policy, Cabinet Secretariat, Government of Japan; the Ministry of Health, Labour and Welfare (MHLW) of Japan; and the Ministry of Health and Family Welfare (MoHFW) of the Republic of India in the field of healthcare and wellness as of 29 October 2018.

The project is carried out by Medical Excellence JAPAN (MEJ) based on the Memorandum of Understanding (MOU) amongst MEJ, All India Institute of Medical Sciences (AIIMS), the Japanese Association for Acute Medicine (JAAM), and the Japanese Association for the Surgery of Trauma (JAST) to develop human resources for acute medicine, surgery, and trauma care.

AIIMS has comprehensive facilities for teaching, research, and clinical care. AIIMS conducts teaching programmes in medical and paramedical courses at undergraduate and postgraduate levels and awards its own degrees. Teaching and research are conducted in 42 disciplines. In terms of medical research, AIIMS produces more than 600 academic publications every year. Twenty-five clinical departments, including four superior specialty centres, manage practically all types of disease conditions with support from preclinical and paraclinical departments.

The JAAM, one of the leading medical associations in Japan, consists of 11,000 acute care physicians and surgeons seeking high-quality evidence of emergency medicine and emergency care. The JAAM provides training programmes in trauma care, stroke care, and cardio-pulmonary resuscitation for the citizens, including members of JAAM, and certifies acute care physicians, develops an integrated registry of the acutely ill patients. JAAM also organised The Academic Consortium on Emergency Medical Service and Disaster Medical Response Plan During the Tokyo Olympic and Paralympic Games in 2020.

The JAST consists of more than 2,000 medical doctors who have been engaged in the management of life-threatening trauma and who have been contributing to progress in traumatology by seeking quality improvement in cardio-pulmonary resuscitation within trauma care in Japan. The JAST works on training programmes on trauma care, the certification system for trauma experts, and the development of visceral organ injury scales and a trauma registry system. The JAST also organises annual scientific meetings, publishes a medical journal, and provides support for multi-institutional studies.

MEJ is an organisation that promotes international health cooperation amongst governments, medical communities, academic organisations encompassing associations of medical sciences, and the healthcare industry. MEJ has in-depth experience cooperating in the medical field with overseas government agencies, hospitals, and Japanese medical societies. Established in 2011, MEJ is an organisation experienced in facilitating international projects related to medical services and products.

Acknowledgements

This is a joint project amongst the members of the Working Group of All India Institute of Medical Sciences (AIIMS), the Japanese Association for Acute Medicine (JAAM), and the Japanese Association for the Surgery of Trauma (JAST). We acknowledge the support provided by everyone involved. We take this opportunity to thank the members of the Working Group; the Economic Research Institute for ASEAN and East Asia (ERIA); the Cabinet Secretariat of the Government of Japan; the Ministry of Health, Labour, and Welfare (MHLW) of Japan; and the Ministry of Health and Family Welfare (MoHFW) of the Republic of India.

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List of Authors

Rajesh Malhotra, MS, FRCS, FICS, FACS, FISMA, FAMS, FNASC: Professor and Head of the Department of Orthopaedic Surgery at All India Institute of Medical Sciences (AIIMS), New Delhi, India; and Chief at Jai Prakash Narayan Apex Trauma Center (JPNATC), New Delhi, India

Yasumitsu Mizobata, MD, PhD: Professor at the Department of Traumatology and Critical Care Medicine, Osaka City University Graduate School of Medicine, Osaka, Japan; and Chief at Committee of Human Resource Exchange Project of the Japanese Association for Acute Medicine (JAAM), Tokyo, Japan

Tetsuro Nishimura, MD, PhD: Associate Professor at the Department of Traumatology and Critical Care Medicine, Osaka City University Graduate School of Medicine, Osaka, Japan; and Member of the Committee of human resource exchange project of the Japanese Association for the Surgery of Trauma (JAST), Tokyo, Japan

Ichiro Takeuchi, MD, PhD: Professor at the Department of Emergency Medicine, Yokohama City University Graduate School of Medicine, Kanagawa, Japan

Shiei Kim, MD, PhD: Assistant Professor at the Department of Emergency and Critical Care Medicine, Nippon Medical School, Tokyo, Japan

Kazuki Hagiwara, MD, PhD: Medical Director, Advanced Emergency and Critical Care Medical Center (ECCMC), Yamanashi Prefectural Central Hospital, Yamanashi, Japan

Tomohisa Shoko, MD, PhD: Professor at the Department of Emergency and Critical Care Medicine, Tokyo Women's Medical University Medical Center East, Tokyo, Japan

Kazutaka Nishiyama, MD: General Manager, Care Medical Center, Kitakyushu City Yahata Hospital, Fukuoka, Japan

Naoki Nakamoto, MD: Medical Director, Critical Care and Trauma Center, Osaka Prefectural Hospital Organization, Osaka General Medical Center, Osaka, Japan

Abhinav Kumar, MS: Advisor, AIIMS, New Delhi, India

Samarth Mittal, MS: Advisor, AIIMS, New Delhi, India

Tetsuo Yukioka, MD, PhD: Executive Director, Medical Excellence JAPAN (MEJ); and President, Designated, Registered Agency, Japan Foundation for Emergency Medicine, Tokyo, Japan

List of Project Members

Shuzo Yamamoto, MD, PhD: Honorary President of Medical Excellence JAPAN (MEJ), Tokyo, Japan; and Honorary President of Japan Hospital Association, Tokyo, Japan

Tatsuya Kondo, MD, PhD: Chief Executive Officer of MEJ, Tokyo, Japan; and Chief Executive Emeritus of Pharmaceuticals and Medical Devices Agency (PMDA), Tokyo, Japan

Naoki Aikawa, MD, PhD, FACS: Advisor at MEJ, Tokyo, Japan; and Professor Emeritus at Keio University, Tokyo, Japan

Takeshi Shimazu, MD, PhD: Professor at the Department of Traumatology and Acute Critical Medicine, Osaka University Graduate School of Medicine, Osaka, Japan; and Chairperson of Board of Directors of Japanese Association for Acute Medicine (JAAM), Tokyo, Japan

Akio Kimura, MD, PhD: Director of the Emergency Medicine and Intensive Care Unit, Center Hospital of the National Center for Global Health and Medicine, Tokyo, Japan; Chairperson of the Board of Directors of Japanese Association for the Surgery of Trauma (JAST), Tokyo, Japan; and Member of the Committee on Human Resource Exchange Project of JAST, Tokyo, Japan

Randeep Guleria, MD, DM (Pulmonary Medicine), FAMS, FIMSA: Director of the All India Institute of Medical Sciences (AIIMS), New Delhi, India

Amit Gupta, MS, FACS, FCLS, FRCS (Glasg.): Professor at the Department of Surgery at the Division of Trauma Surgery & Critical Care, Jai Prakash Narayan Apex Trauma Center (JPNATC), AIIMS, New Delhi, India

Minu Bajpai, MS, MCh, PhD, FRCS, FACS, FAMS, DNB, ECFMG: Professor and Head of the Department of Paediatric Surgery and Professor-in-Charge of the International Co-operation, Domestic & International MoU, AIIMS, New Delhi, India

Yasuhiro Otomo, MD, PhD: Professor at the Department of Emergency Medicine, Tokyo Medical and Dental University Graduate School of Medicine, Tokyo, Japan; and Member of the Committee on Human Resource Exchange Project of the JAAM, Tokyo, Japan

Jun Oda, MD, PhD: Professor at the Department of Emergency and Critical Care Medicine, Tokyo Medical University, Tokyo, Japan; and Member of the Committee on Human Resource Exchange Project of the JAAM, Tokyo, Japan

Norio Sato, MD, PhD: Professor of the Department of Emergency Medicine, Ehime University Graduate School of Medicine, Ehime, Japan; and Member of the Committee on Human Resource Exchange Project of the JAAM, Tokyo, Japan

Shoji Yokobori, MD, PhD: Associate Professor at the Department of Emergency and Critical Care Medicine, Nippon Medical School, Tokyo, Japan; and Member of the Committee on Human Resource Exchange Project of the JAAM, Tokyo, Japan

Hiroaki Watanabe, MD, PhD: Professor of the Department of Acute Care Surgery, Shimane University Faculty of Medicine, Shimane, Japan; and Member of the Committee on Human Resource Exchange Project of the JAST, Tokyo, Japan

Hiroaki Iwase, MD, PhD: Director of the Orthopaedic surgery at Advanced Emergency and Critical Care Medical Center (ECCMC), Yamanashi Prefectural Central Hospital, Yamanashi, Japan; and Member of the Committee on Human Resource Exchange Project of the JAST, Tokyo, Japan

Takashi Fujita, MD, PhD, FACS: Associate Professor of the Division of Acute Care Surgery, Department of Emergency Medicine, Teikyo University, School of Medicine, Tokyo, Japan, and Member of the Committee of human resource exchange project of Japanese Association for the Surgery of Trauma (JAST), Tokyo, Japan

Osuke Komazawa, MD, PhD: Special Advisor on Healthcare and Long-Term Care Policy, Economic Research Institute for ASEAN and East Asia (ERIA)[1]

Amit Lathwal, MS: Assistant Professor, AIIMS, New Delhi, India

Chisato Fujiwara: Project Secretary at Osaka City University, Osaka, Japan; and MEJ, Tokyo, Japan

Eriya Kitano: MEJ, Managing Director, Tokyo, Japan

Naoya Yamazaki: Director, MEJ, Tokyo, Japan

Hikaru Kobayashi: Manager, MEJ, Tokyo, Japan

Junko Haseyama: Project Secretary, MEJ, Tokyo, Japan

Yuko Honda: MEJ, Assistant Manager, Tokyo, Japan

[1] Moved to the National Institute of Infectious Diseases, Tokyo, Japan on 1 August 2021.

Abbreviations and Acronyms

AIIMS	All India Institute of Medical Sciences
ASSET	Advanced Surgical Skills for Exposure in Trauma
ATLS	Advanced Trauma Life Support
CT	computed tomography
ECCMC	emergency and critical care medical centre
ER	Emergency Room
ERIA	Economic Research Institute for ASEAN and East Asia
ISS	Injury Severity Score
IVR	Interventional radiology
JAAM	Japanese Association for Acute Medicine
JAST	Japanese Association for the Surgery of Trauma
JATEC	Japan Advanced Trauma Evaluation and Care
JETEC	Japan Expert Trauma Evaluation and Care
JPTEC	Japan Prehospital Trauma Evaluation and Care
JTCR	Japan Trauma Care and Research
JTDB	Japan Trauma Data Bank
MEJ	Medical Excellence JAPAN
MHLW	Ministry of Health, Labour and Welfare of Japan
MoHFW	Ministry of Health and Family Welfare of the Republic of India
MOU	Memorandum of Understanding
REBOA	Resuscitative Endovascular Balloon Occlusion of the Aorta
SSTT	Surgical Strategy and Tactics for Trauma
TAE	transcatheter arterial embolisation

Executive Summary

Background

As trauma deaths have increased whereas age-standardised mortality rates have declined, improving trauma care is an issue of crucial importance for both developed and developing countries.

Objectives of the project

This project's final goal is to find a way to limit the social burden posed by trauma victims. The first phase of the project reported herewith aims to find a shareable approach to creating beneficial effects and synergies by exchanging advanced and multidimensional perspectives through interactive communication between trauma surgeons in India and Japan.

Exchange of experts

To establish a strong communication bridge between two countries, the All India Institute of Medical Sciences (AIIMS), the Japanese Association for Acute Medicine (JAAM) and Japanese Association for the Surgery of Trauma (JAST) jointly concluded a Memorandum of Understanding (MOU) on the mutual exchange of surgeons and related experts. Six doctors were selected from the Japanese joint association and participated in trauma care in 'AIIMS-JPN Trauma Center.' Meanwhile, five AIIMS members, including the Director of AIIMS, Dr. Guleria, visited and observed trauma care facilities, ambulance systems, and trauma training progammes in Japan.

Activities

Japanese members participated in the treatment of several trauma cases and pointed out differences in resuscitation approaches between the AIIMS and Japanese institutions. They suggested that the mutual exchange and share of trauma care techniques and instruments could strengthen both countries' trauma care quality. Moreover, the Japanese comprehensive emergency system is predicted to contribute to improving the prehospital system in India. To improve the approach in trauma care, training in technical and non-technical skills is needed. Japan's trauma care training courses are known for their effectiveness and, from this perspective, Japan's surgeons could contribute to upgrading the level of trauma care in India.

The AIIMS' members learned a lot about using advanced technology in the management of trauma victims during their Japan visit. They were also able to gain valuable insights on the importance of strict laws and the magnitude of investment in healthcare required for the effective care of the injured. At the same time, they felt that Japan could be a suitable place for doctors, nurses, and paramedical staff from the AIIMS to learn about the optimum use of advanced technology to help patients. Furthermore, they were thrilled to learn about trauma care training courses and excited to create similar courses in India with support from the JAAM and JAST joint association.

Outcomes

Communication amongst doctors, nurses, and medical staff; mutual exchange of ideas and shared experiences; and training programmes adapted to each country's needs are expected to contribute to improving trauma care in each country.

Chapter 1

Trauma Care in India and Japan

1. Trauma Care in India

With improving infant mortality rates, death rates, and quality of healthcare, India's developing economy has seen a sharp increase in life expectancy from 41 years in 1960 to 68 years in 2015. There has also been increased economic and urban development, especially in terms of the development of high-quality roads, highways, improved infrastructure, and advancements in the automobile industry. All this has happened at a rate much faster than the implementation of strict motor-vehicle and road safety laws, resulting in a significant increase in the number of high-velocity road traffic accidents. Even though the country has seen a sharp increase in the number of trauma centres to deal with this problem, India's healthcare system has not kept pace with the increase in these accidents.

Unlike developed countries where many patients are brought to hospitals in private vehicles, police vehicles, and three or two-wheelers, India faces problems in bringing the victims of accidents to hospitals in a timely manner because of overcrowding in cities and lack of proper centralised infrastructure to respond critical accidents. Due to the lack of prehospital care, combined with delays in bringing patients to hospitals due to overcrowded roads, prehospital care remains a challenge. The government has come up with stricter laws, especially pertaining to traffic violations and drunk driving, to manage the incidence of such accidents but it remains to be seen whether these laws will make a significant impact.

Surgeons in India see a large number of trauma victims and hence are well versed with the management of such victims. However, patient care protocols vary greatly throughout country, given its size and diversity. With close to 10 years since the inception of Advanced Trauma Life Support (ATLS) courses in India and an increase in the number of sites where these courses are conducted, surgeons in India are increasingly applying common and uniform management methods for trauma patients across the country. However, many more of such courses and simulation-based learning activities need to be implemented over the coming years to equip surgeons across the country with important skills.

A trauma registry is a database of the trauma patients, with information on the causes of injury, severity, and patient outcomes. It is useful for improving the quality of trauma care

in developed countries. India has not had a central trauma registry to date, making it difficult to produce exact statistical data on trauma victims in the country. Although many efforts have been made not just by private individuals but also by the government, a trauma registry has yet to be fully established across the country.

The unequal distribution of health resources across villages and cities has also been detrimental to victims of trauma in far-flung areas from even though the government has taken several steps to establish not just primary but also tertiary level hospitals across the country. In recent years, the government has also created stricter laws and established more and more health facilities which have improved survival rates and life expectancies but there remains much more to be done in a developing country like India to be able to catch up to the health standards in developed nations.

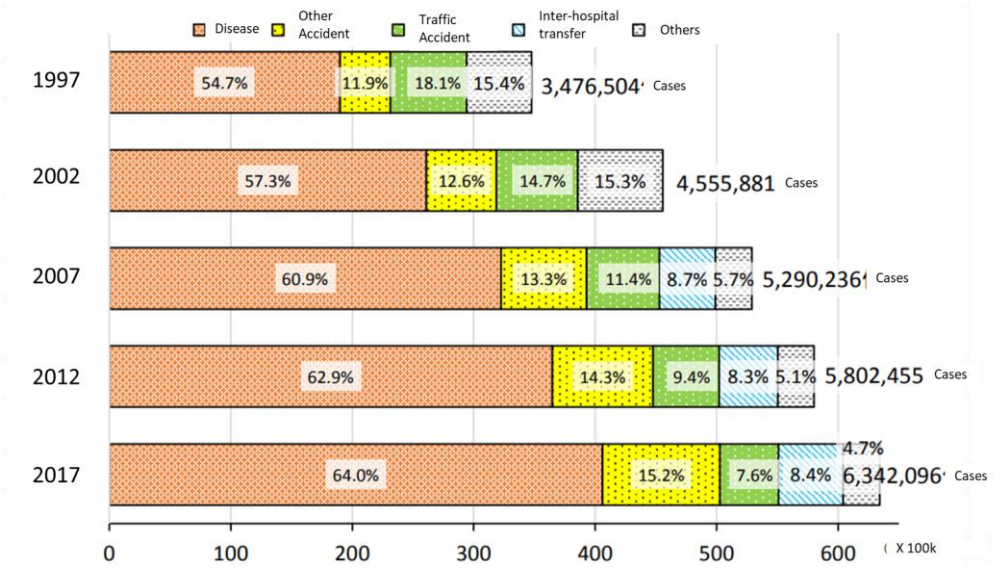
2. Trauma Care in Japan

2.1. Trauma Features in Ageing Countries

In developed countries such as Japan, the United States (US), and European countries, demographic ageing is proceeding rapidly due to extended longevity and low birth rates. Japan, in particular, is currently the world's top country for longevity. In such ageing societies, mild injuries caused by a minor external force (such when falling while walking) are increasing due to the decreased physical function of individuals, while traffic accidents amongst young people that could cause severe traumas are on a downward trend. The number of traffic accidents in recent years has been decreasing as a result of improvements in road environments, the introduction of severer penalties for traffic law violations such as drunk driving and dangerous driving, and the development and commercialisation of vehicle safety technology such as pre-crash systems and/or automatic and emergency braking.

With such changes, the type of patients seeking emergency medical care in Japanese institutions is also changing. Since 1963, the number of nationwide emergency transport cases has increased every year. From 1996 to 2016, the number increased from approximately 3.4 million to 6.2 million. The main contributing factor to this surge was the increase in the number of elderly emergency patients as a result of a rapidly ageing society. While general injuries amongst the elderly, such as falls, have increased, the number of traffic accident patients has decreased from 634,000 (18.8% of all ambulance dispatches) in 1996 to 491,000 (7.9% of all ambulance dispatches) in 2016 (Figure 1.1).

Figure 1.1. Trends in Numbers and Causes of Ambulance Dispatches, 1997–2017



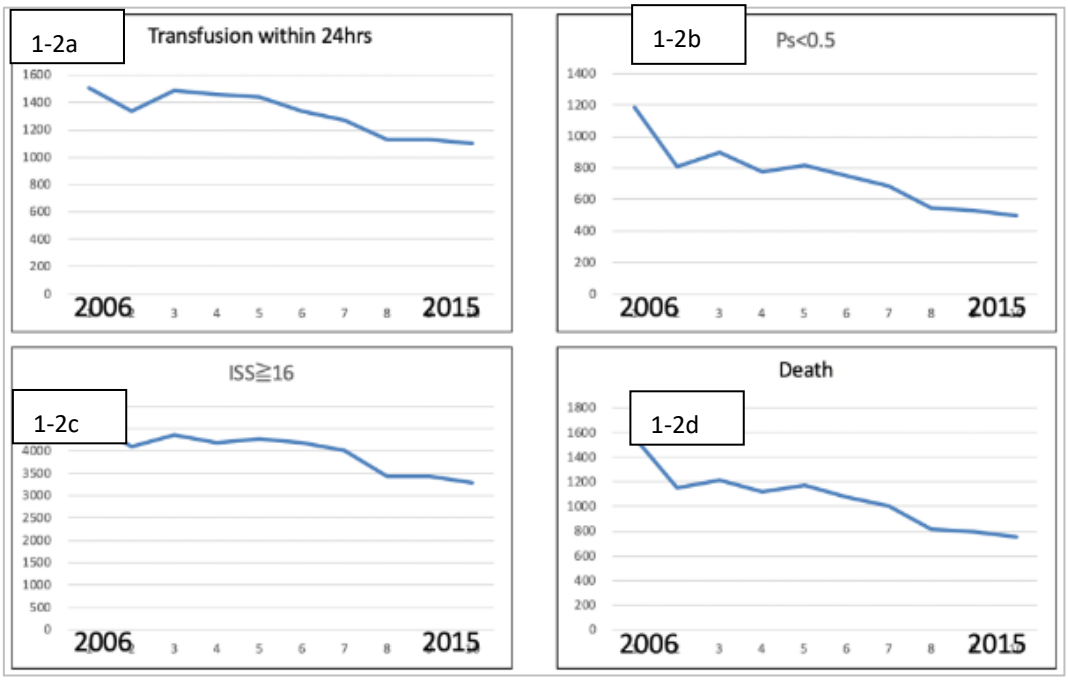
Source: Fire and Disaster Management Agency (2018), 'Report on Ambulance and Rescue' (Trans.).

Along with the decrease in severe trauma cases such as those due to traffic accidents, the number of trauma cases at advanced emergency medical care institutions such as emergency and critical care medical centres (ECCMCs) where severe trauma cases are treated, is also shrinking.

Japan Trauma Data Bank (JTDB) is a nationwide database where every case of trauma received by 264 institutions nationwide (as of March 2017) is registered. To investigate the changes in life-threatening severe trauma cases, we looked at the time courses for cases receiving emergency blood transfusion within 24 hours, cases with an Injury Severity Score (ISS)[2] of 16 or above, cases with a prognostic survival rate of less than 50%, and the total number of deaths (Figure 1.2). Our time courses show that from 2006 to 2015, all these cases were on a declining trend. As the number of severe trauma cases decreases nationwide, trauma surgeons working at ECCMCs are becoming less and less experienced.

[2] The Injury Severity Score (ISS) assesses the combined effects of the multiply-injured patients and is based on an anatomical injury severity classification, the Abbreviated Injury Scale (AIS). The ISS is an internationally recognised scoring system that correlates with mortality, morbidity, and other severity measures.

Figure 1.2. Trends in Severe Trauma Cases, 2006–2015



ISS = Injury Severe Score, Ps = probability of survival. Notes: These figures present the elements of severe trauma cases. Figure 1-2a indicates the number of patients transfused during the first 24 hours. Figure 1-2b represents cases where the probability of survival for the injured patient is over 50%, calculated using their ISS, the trauma type, and the patient's age. Figure 1-2c refers to patients with at least two serious or one severe injury. Figure 1-2d concerns the number of fatalities.

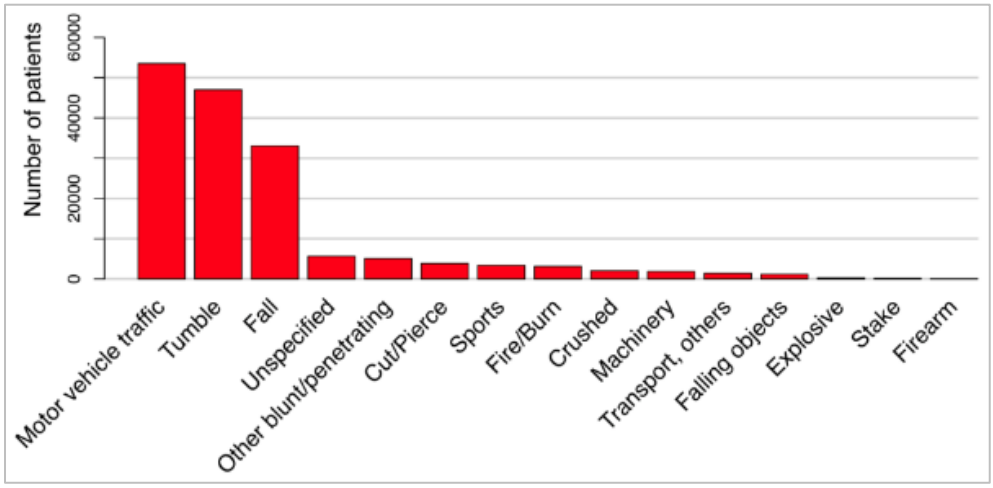
Sources: Japan Trauma Data Bank (JTDB).

2.2. Gunshot and blast injuries

In Japan, traffic accidents and falls (both from a height and from slipping or tripping) account for most cases of the trauma, while penetrating trauma such as a stab wounds, incision wounds, and impalement injuries account for only approximately 4% of all trauma injuries (Figure 1.3). Possession and carrying of guns is highly restricted so gun-related crimes are rarely seen. Physical trauma due to explosive accidents is also rare. Thus, trauma surgeons in Japan have limited experience in handling gunshot and blast injuries.

Random shootings and terrorist bombings, such as the Boston Marathon bombing in 2013, are becoming more frequent around the world. In preparation for possible terrorist attacks at large-scale events such as the Osaka Universal Exposition scheduled for 2025, ECCMCs are required to establish and secure an adequate medical care system.

Figure 1.3. Mechanisms of Injury (2010–2014)



Note: Mechanism of injury refers to the method by which damage or trauma is inflicted on the human body.
Source: Japan Trauma Data Bank (JTDB).

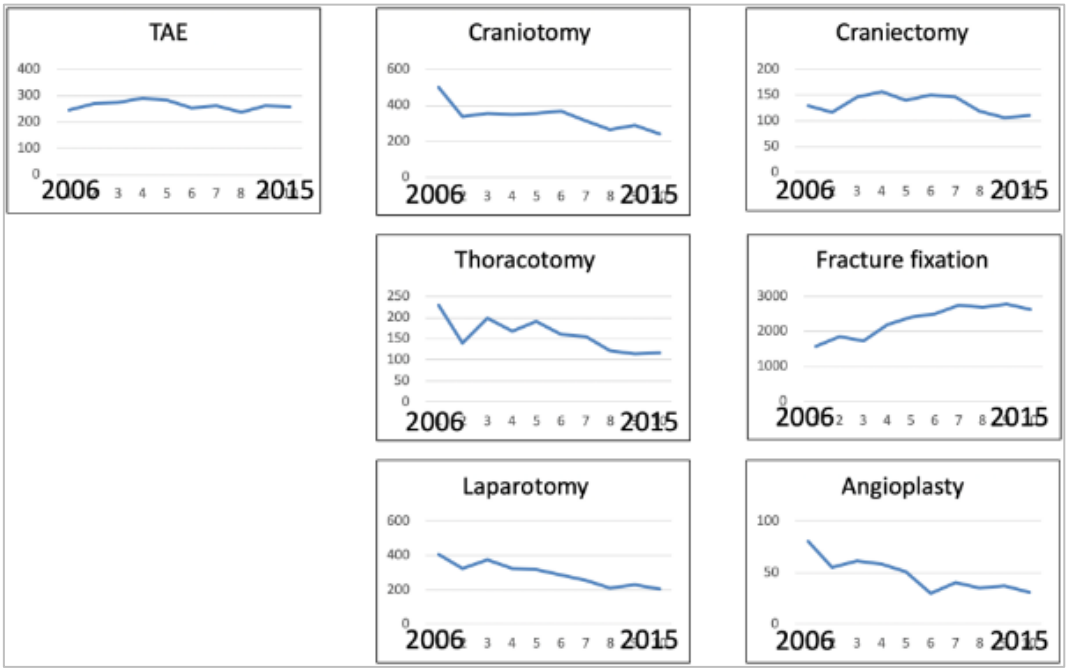
2.3. Features in the treatment of trauma patients in Japan

In addition to the decreased number of severe trauma cases at advanced emergency medical care institutions, the features of trauma treatment have changed.

The widespread use of computed tomography (CT) scans have enabled accurate and reliable diagnosis of chest and abdominal organ injuries. Many organ injuries that would have been treated with surgery are now treated with non-invasive therapies or endovascular treatment. According to JTDB, amongst the operative methods first performed after arrival, craniotomy, craniectomy, thoracotomy, laparotomy, and angioplasty were all on the decrease except for transcatheter arterial embolisation (TAE) which has not changed in the last 10 years (Figure 1.4).

Japan's trauma surgeons are experienced with interventional radiology in the treatment of severe trauma patients. In fact, Japan's trauma surgeons were among the first to recognize the effectiveness of TAE for severe trauma cases. This is something that can be shared worldwide. Of course, some severe trauma patients are unable to survive without surgical operation so the need to train trauma surgeons to perform trauma surgeries promptly and accurately remains.

Figure 1.4. Trends in Surgical Cases, 2006–2015



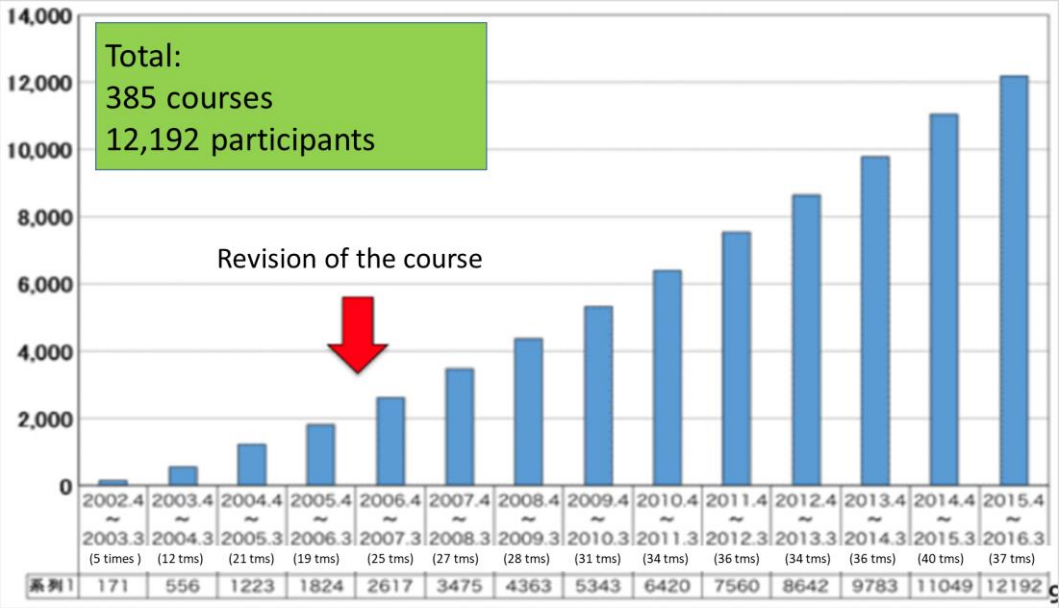
TAE = transcatheter arterial embolisation.

Sources: Japan Trauma Data Bank (JTDB).

2.4. Preventable trauma death and training for trauma care

Preventable trauma death refers to trauma death that could have been avoided if appropriate trauma treatment was provided. Otomo et al. (2002) reported that amongst 1553 trauma deaths at ESCCMs nationwide in 2000, 661 cases (38.6%) were preventable trauma deaths. The same survey was conducted the following year and 38.1% of all trauma deaths were considered potential preventable trauma deaths, similar to the previous year. To help mitigate these preventable deaths, the Japanese Association for the Surgery of Trauma (JAST) compiled and released 'Japan Advanced Trauma Evaluation and Care (JATEC)' to serve as a set of guidelines for primary trauma care, while the Japanese Association for Acute Medicine (JAAM) developed and disseminated off-the-job training courses on JATEC. JATEC courses are now being held more than 30 times per year, and more than 10,000 doctors have taken the course in the 20 years since its commencement (Figure 1.5).

Figure 1.5. Number of Japan Advanced Trauma Evaluation and Care (JATEC) Courses and Participants, 2002–2016

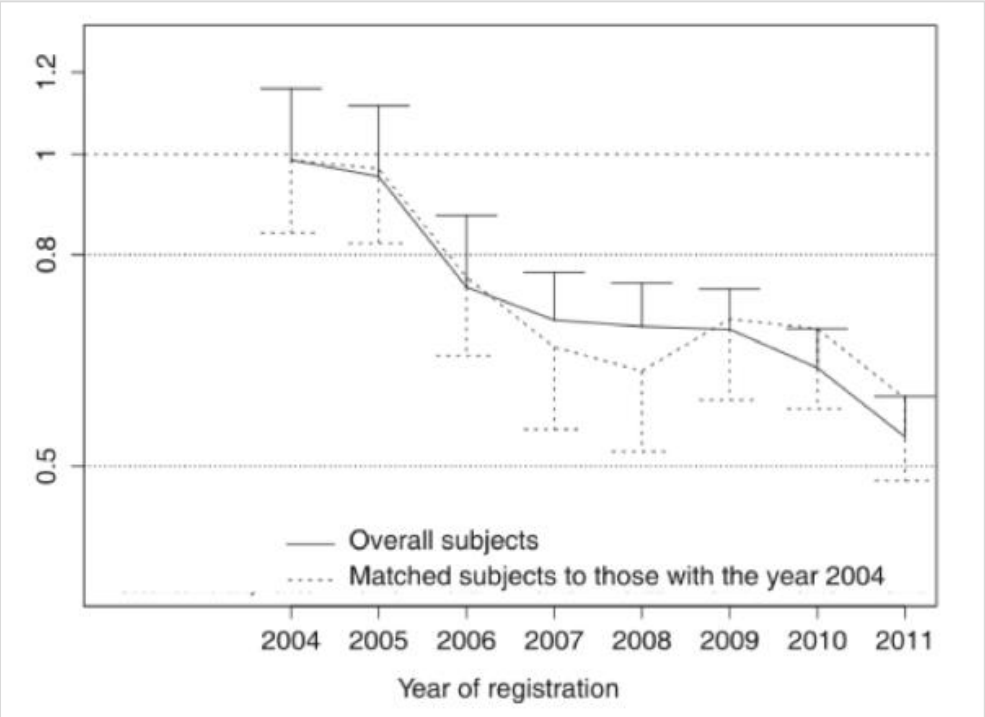


JATEC = Japan Advanced Trauma Evaluation and Care, tms = times.

Source: Japan Trauma Care and Research (JTCR).

To evaluate the impact of the JATEC training, a time course of actual death rate to predicted mortality was analysed. When actual death rate against predicted mortality was set at 1 in 2004 (the year JATEC was implemented widely), actual death rate declined gradually up to 2011 (Figure 1.6). The degree of decline has been growing greater, confirming that the quality of trauma treatment in Japan is improving every year because of JATEC training and other factors. The analysis yielded the same results when only those cases that had the same severity as the cases in 2004 were considered.

Figure 1.6. Trends in Case Fatality Adjusted by the Trauma Injury Severity Score (TRISS) Probability of Survival, 2004–2011



Notes: This table presents the odds ratio and confidence interval of observed survival rate relative to the TRISS probability of survival, plotted against the year of registration in the Japan Trauma Databank. The model was adjusted for logit value estimated using the TRISS method. The TRISS method refers to the Probability of Survival (PS) of each patient calculated from the Revised Trauma Score, Injury Severity Score, age and method of injury (blunt or penetrating), first used in 1984.

Source: Hondo K., A. Shiraishi, S. Fujie, D. Saitoh, and Y. Otomo (2013), 'In-Hospital Trauma Mortality has Decreased in Japan Possibly Due to Trauma Education', *Journal of the American College of Surgeons*, 217(5), pp.850–57.

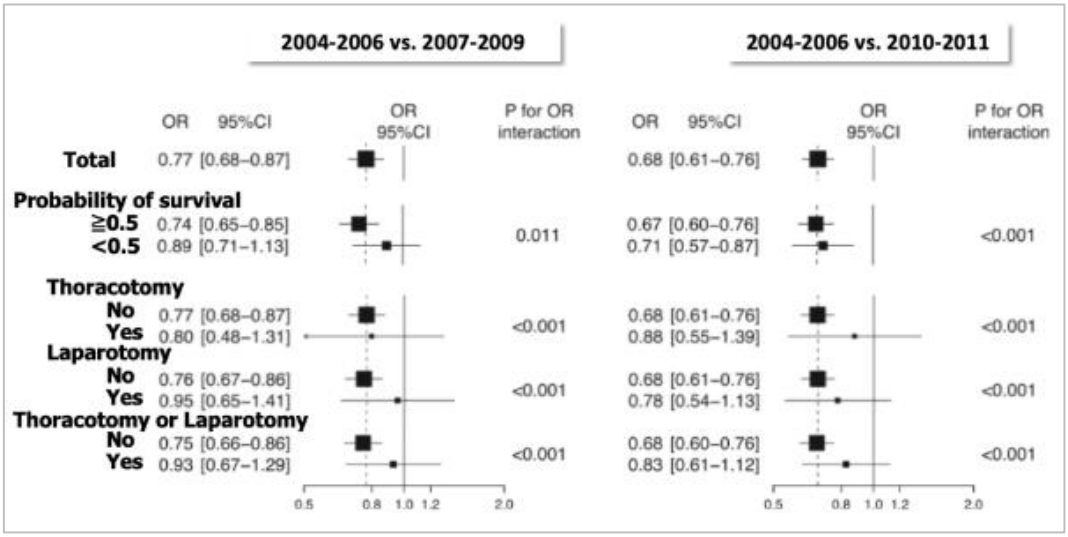
Furthermore, multivariate subgroup analysis was conducted to investigate the types of cases where treatment was improved and how the quality of treatment was improved. The results showed that the subgroup with a probability of survival[3] of 0.5 or

[3] Probability of survival (PS) is calculated for each injured patient and entered into the Trauma Audit and Research Network (TARN) database. This allows researchers to perform comparative outcome analyses of hospitals and groups of trauma patients. Early Outcome Prediction Models using TRISS

In 1984 the Probability of Survival (PS) of each patient was originally calculated from the Revised Trauma Score, Injury Severity Score, age and method of injury (blunt or penetrating). This was known as the TRISS method. There were a number of reasons to develop a European model from this early method. The Revised Trauma Score incurred a high number of cases with unrecorded data (respiratory rate, systolic blood pressure and

higher with mild trauma or not requiring thoracotomy or laparotomy showed a significant decrease in mortality within the time of treatment. On the other hand, the subgroup with a probability of survival of less than 0.5 with severe trauma or requiring a thoracotomy or laparotomy did not show a decrease in mortality (Figure 1.7).

Figure 1.7: Subgroup Comparisons Stratified by Baseline Characteristics for Risk of In-Hospital Death in Three Cohorts



CI = confidence interval, OR = odds ratio.

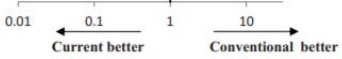
Source: Hondo K., A. Shiraishi, S. Fujie, D. Saitoh, and Y. Otomo (2013), 'In-Hospital Trauma Mortality has Decreased in Japan Possibly Due to Trauma Education', *Journal of the American College of Surgeons*, 217(5), pp.850–57.

The results indicated that the outcome from treatment was improved in non-serious trauma cases which did not require emergency operation. This can be attributed to improved quality of primary care owing to JATEC, which came to be widely used as the standard for early-stage treatment in clinical practice since 2004. However, the results indicated no improvement in severe trauma cases that required a thoracotomy or laparotomy.

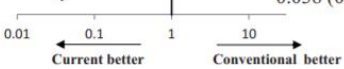
Glasgow Coma Scale). The way that the Injury Severity Score was incorporated into the calculation contradicted some statistical reasoning. Patients who were transferred to another hospital for further care were excluded. Patients who were intubated at scene were excluded. Children were included but not in a statistically acceptable fashion. https://www.tarn.ac.uk/Content.aspx?c=3515

Figure 1.8. Treatment Outcome for 107 Patients with Severe Trauma Treated at the Same Hospital by Date of Admission

In-hospital mortality	Current versus conventional	Current *n* (%)	Conventional *n* (%)	Odds ratio (95% CI)	*P*-value
All patients	48 versus 59	20(41.7)	38(64.4)	0.395 (0.180–0.864)	0.019
FI-surgery	24 versus 22	11(45.8)	8(36.4)	1.481 (0.454–4.833)	0.515
FI-IVR	21 versus 28	6(28.6)	21(75.0)	0.133 (0.037–0.478)	0.001

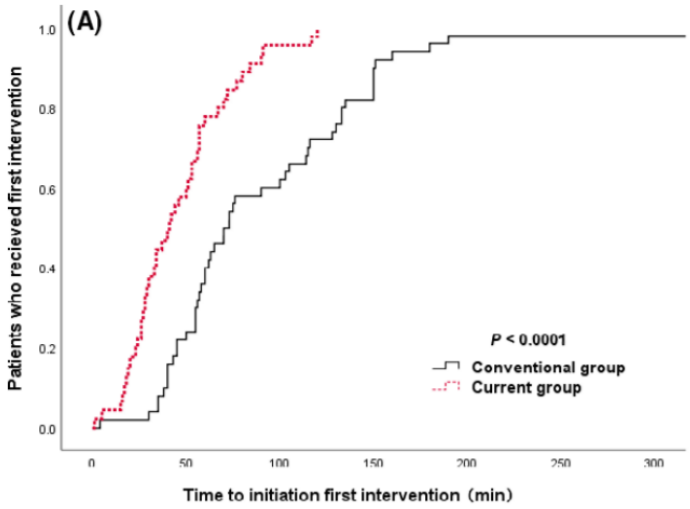


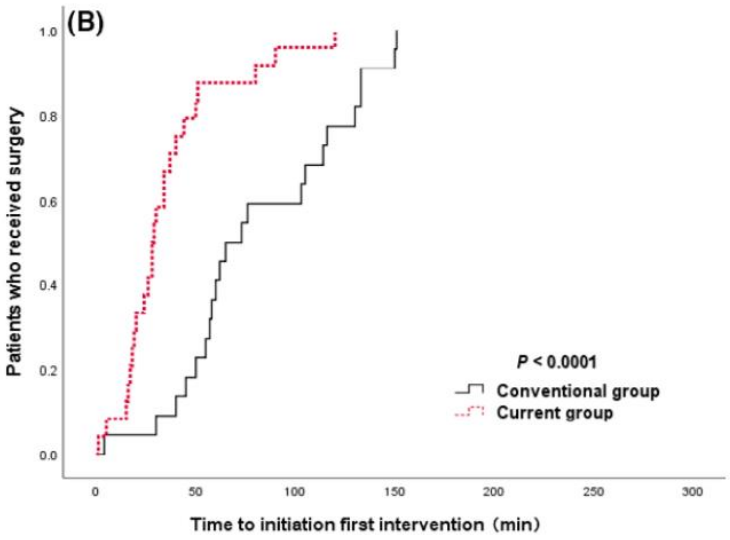
In-hospital mortality SMR	Current versus conventional	Current %	Conventional %	Odds ratio (95% CI)	*P*-value
All patients	48 versus 59	60.0	132.1	0.105 (0.029–0.379)	0.001
FI-surgery	24 versus 22	63.2	133.3	0.415 (0.075–2.295)	0.313
FI-IVR	21 versus 28	46.2	158.3	0.038 (0.004–0.326)	0.003

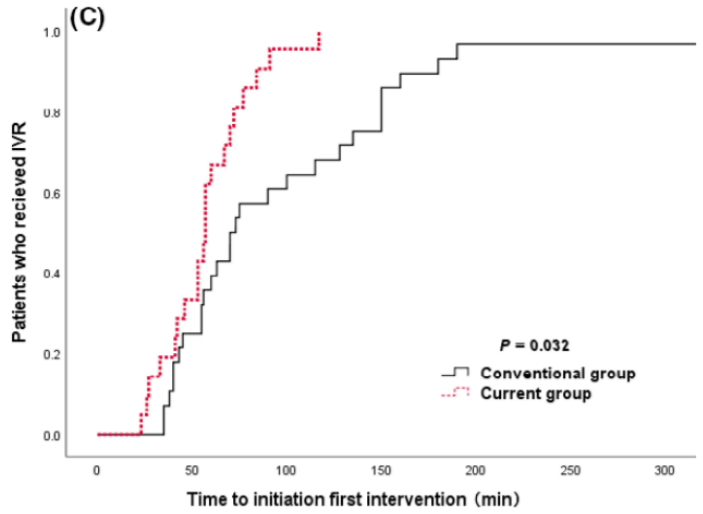


CI = confidence interval; FI = first intervention; IVR = interventional radiology; NA = not applicable; Ps = probability of survival calculated by Trauma and Injury Severity Score; SMR = standardized mortality ratio.
Note: Conventional refers to the period from January 2011 to September 2014, current refers to the period from October 2014 to January 2018.
Source: Otsuka, H. et al. (2018), 'Impact of Emergency Physicians Competent in Severe Trauma Management, Surgical Techniques, and Interventional Radiology on Trauma Management', *Acute Medicine & Surgery,* 5(4), pp.342–49.

Figure 1.9. Kaplan-Meier Curves of Time to Initiation of First Intervention in 107 patients with Severe Multiple Lethal Trauma







A = all patients; B = those with surgery only; C = those with interventional radiology only; conventional group = admitted January 2011–September 2014; current group = admitted October 2014–January 2018; IVR = interventional radiology; min = minutes.

Sources: Otsuka, H. et al. (2018), 'Impact of Emergency Physicians Competent in Severe Trauma Management, Surgical Techniques, and Interventional Radiology on Trauma Management', *Acute Medicine & Surgery,* 5(4), pp.342–49.

As these sources might indicate, surgical trauma operations may not have been performed promptly or accurately when needed because surgeons who have to deal with these emergencies are not adequately trained due to the low number of severe trauma cases and surgical operations for such cases in recent years.

3. Training for trauma surgery in Japan

In preparation for establishing an emergency medical care system at the Tokyo Olympic and Paralympic Games in 2020, the Ministry of Health, Labour and Welfare (MHLW) deployed the 'Trauma Surgeon Training Program' in 2017. This programme targeted surgeons and nurses who work at ECCMCs and aimed to train them to treat severe trauma cases such as blasts, gunshots, and stab injuries, and to assist medical institutions in establishing hospital functions to receive several trauma patients injured by deliberate detonations. The participants were required to participate in workshops designed and led by trauma care experts in Japan and overseas. These workshops consisted of practical group discussions and group work for team buildings. After the workshop, participants could take two of the off-the-job training courses: the Japan-original Surgical Strategy and Tactics for Trauma; the Surgical Strategy and Tactics for Trauma (SSTT) course, which contains practical training at an animal laboratory and the US Advanced Surgical Skills for Exposure in Trauma; and the ASSET course which included practical training using cadavers. Since then, 30 surgeons and 30 nurses have attended the programme every year and used their learnings to help improve their respective medical institutions' trauma treatment capability. These efforts reflect the recognition in Japan that the training of capable surgeons and trauma treatment teams is an urgent task, and continuous off-the-job training to complement current clinical practice is considered a national project. However, the programme had been suspended halfway because of the COVID 19 pandemic.

Chapter 2

Objectives of the project

According to the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017, injury deaths increased while age-standardised death rates from injuries declined from 1990 to 2017 (James et al., 2020). Trauma constitutes a significant burden on victims as well as on limited critical care resources. This project's end goal is to reduce the social burden posed by trauma victims. To attain this objective, it is vital to efficiently educate trauma experts. This project's initial step is to establish a communication bridge between two countries and its surgeons who could benefit from mutual exchange on the subject of trauma treatment.

The project is divided into several phases. This publication is a report on the first phase which aimed to find a shareable approach to educating trauma surgeons and nurses between two countries. Our goal is to create beneficial effects and synergies in the course of communicating and exchanging perspectives on trauma treatment between the trauma surgeons in India in Japan. During this phase, we focused on consolidating a communication bridge to build a mutual consensus, not only amongst surgeons but also nurses and the other stakeholders. Subsequently, we hope to strengthen the capacity of each country in the field of trauma care and education.

Later on, this project will analyse Japan's trauma surgeons' and nurses' training methods to modify and localise it as an All India Institute of Medical Sciences (AIIMS) model. Therefore, this phase included mutual observation of the realities of trauma care training in each country by following the agreements that had been made. Analysis of the new training courses will be carried out in the next phase of this project during which suggestions for improving the training courses will be gathered.

Through these activities, we intend to make policy recommendations on how capacity building for trauma-care personnel can strengthen the healthcare systems in both countries. Moreover, an international network of trauma care experts will be established along with a trauma data bank in the future. We hope this project will serve as a motivation to enhance international exchanges of personnel such as policymakers and medical doctors in Asia in order to improve the healthcare services in the region.

Chapter 3

Project Activities

1. Personnel exchange programme of key project members

To further extend the cooperation between the All India Institute of Medical Sciences (AIIMS) and Osaka City University in the past 10 years, and to enhance understanding of trauma care situation in India and Japan, AIIMS and the joint association of Japanese Association for Acute Medicine (JAAM) and Japanese Association for the Surgery of Trauma (JAST) have agreed to exchange surgeons and related experts with each other. The Japanese associations dispatched doctors and related staff to the AIIMS, while the AIIMS dispatched doctors and nurses to Japan (See Appendixes A and B).

This project provided opportunities for surgeons from India and Japan to interact actively, determine barriers, and identify potential areas for cooperation. Japanese surgeons gained experience in surgery and learned medical skills needed to cope with the demands of trauma care in India. Indian surgeons were exposed to new methods of strengthening training systems and the fundamentals of a team approach in trauma care.

To consolidate the human network and ensure active communication, the joint association assigned the surgeons at Osaka City University to the role of project leaders. Osaka City University's surgeons have collaborated with the AIIMS in the past and are ready to coordinate and lead this programme. Signing up of a memorandum of understanding between the two parties on 17 March 2019 was the starting point of these series of the programme.

2. Activities of Japanese Trauma Surgeons in India

The programme's participants from Japan were selected through an open call to members of the JAAM and JAST (see Appendix C). Joint committee members of JAAM and JAST then selected six doctors who were divided into two groups. Both groups stayed at AIIMS for about two months and participated in trauma treatment practice there.

2.1. Report from the 1st group

Table 3.1 shows the weekly schedule of the Trauma Surgery Department at Jai Prakash Narayan Apex Trauma Center (JPNATC) of AIIMS. During this time, the Japanese trauma surgeons had many opportunities to join emergency operations day after day besides daily case study conferences and clinical rounds.

Table 3.1. Weekly Schedule of the 1st Group

	Mon	Tue	Wed	Thu	Fri	Sat	Sun
AM	Conference Round Operation	Conference Round Operation	Round Operation	Conference Round Operation	Round Operation	Round Operation	Round Operation
PM	Operation	Operation	Operation	Operation	Operation	Operation	Operation

Source: Authors.

Japanese surgeons were assigned to one of two teams of surgeons at JPNATC. As trauma surgeries are conducted at any given time of the day, the Japanese surgeons joined the team's social media group so that they could be informed of surgeries and participate in emergency operations even at night.

At JPNATC, trauma operations are performed on both hemodynamically stable and unstable patients. Japanese surgeons were involved with both types of cases. They found significant differences between that the therapeutic approach for hemodynamically unstable patients at AIIMS and at their home institutions in Japan. The pros and cons of the approaches of both countries are described in the two cases studies below.

Case 1

A 28-year-old male patient was presented to the AIIMS trauma centre after he was stabbed in his abdomen with a relative's knife. His blood pressure was unmeasurable, his hands and feet were cold, and his pulses were weak. Focused assessment with sonography for trauma (FAST) revealed massive fluid in the hepatorenal, splenorenal, and suprapubic recesses. Because he was hemodynamically unstable, he was immediately transported to the operating room for emergency laparotomy.

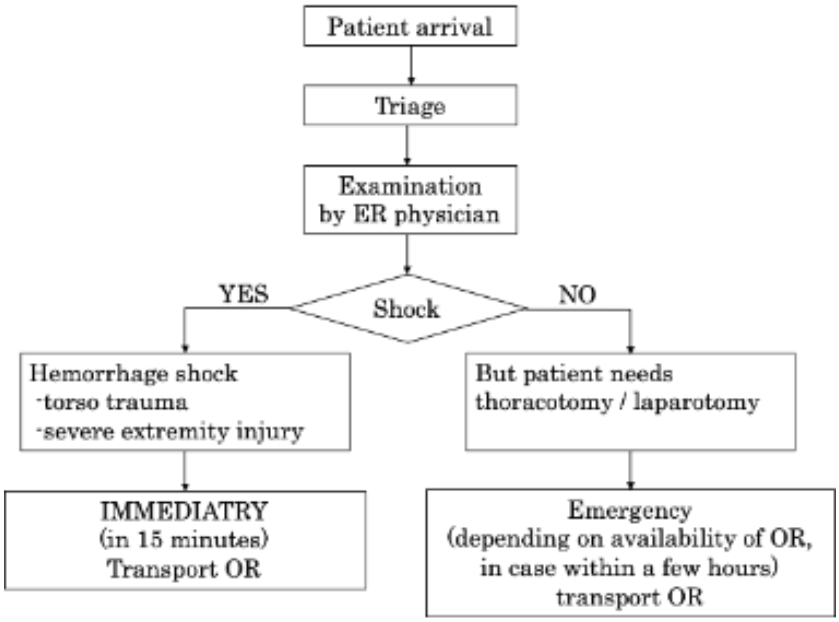
An emergency laparotomy was performed for massive intraperitoneal haemorrhage. The bleeding was from the injured common iliac artery and inferior vena cava. Those injuries were repaired, and the operation terminated as damages of vessels were controlled. After the surgery, the patient was treated in the intensive care unit. Open abdomen management was performed for about one month, after which the patient was discharged to his home.

Case 2

A 28-year-old-male was presented to the trauma centre after a traffic accident. His blood pressure was 70/40mmHg and his heart rate was 140 beats per minute, indicating that he was hemodynamically unstable. Resuscitation was started in the emergency department immediately, and a pelvic x-ray revealed unstable pelvic fractures. He was transported to the operating room for emergency laparotomy. A bilateral internal iliac artery was ligated, and gauze packing was done as damage control for the massive retroperitoneal hematoma.

The key to the success in case 1 was quick transportation to the operating room. The initial management algorithm in the emergency room at JPNATC is shown in Figure 3.1.

Figure 3.1. Algorithm of Initial Management at JPNATC



JPNATC = Jai Prakash Narayan Apex Trauma Centre; OR = odds ratio.

Source: Data collected at the Division of Trauma Surgery and Critical Care, Jai Prakash Narayan Apex Trauma Centre, All India Institute of Medical Sciences.

At JPNATC, a system for severe thoracoabdominal or extremities trauma has been designed for the treatment of patients who are in shock and are transported to operating rooms immediately. Once a surgeon decides to start emergency surgery, anaesthesiologists and nurses work together in order for this to happen. The time it takes to enter the operating room is always measured and strictly verified during case conferences. This is impressive for Japanese surgeons. In many of Japan's hospitals, it is hard to start an operation within 15 minutes after a patient's arrival because of fully scheduled elective surgeries and operative theatres, and because of a shortage in emergency surgical staff. Most hospitals in Japan are unable to keep one operation room open for trauma or emergency cases. In some hospitals, emergency thoracotomy or laparotomy are performed in emergency rooms. From the point of view of Japan's surgeons, rapid transportation to operation rooms is one of the outstanding features of India's trauma care system.

As for case 2, had it occurred in Japan, Japanese surgeons would have likely employed a hemostatic technique called transcatheter arterial embolisation (TAE). However, in India, the TAE procedure is not conducted on patients in shock regardless of the injury.[4] Since TAE is a less invasive technique with fewer complications, it may be worthwhile to promote its use in India. Japan's surgeons are experienced in endovascular treatment and in the concept of damage control interventional radiology. The exchange of human resources through this project may increase awareness and understanding of such treatment amongst Indian surgeons and increase the range of options available to them.

Meanwhile, the prehospital system in India has significant problems. For example, there are no triage systems so a severely injured patient must be transported to regional hospitals which also lack sufficient resources to treat trauma patients. Furthermore, families or friends often have to bring patients in severe condition (e.g. head injury) to a hospital themselves. This causes serious delays in the timely delivery of acute care. Thus it seems the development of a prehospital ambulance system to optimise medical resources and decrease disability and death is urgently needed in India. Japan's prehospital system, including ambulance and triage services, is comprehensive and well-developed. Japan may then be able to contribute significantly to establishing a prehospital emergency system in India.

[4] Non-invasive laparotomy is commonly available in the most medical facilities in Japan because of the availability of equipment such as CT and TAE-relevant modalities. Such equipment is less accessible in India so open surgery has become the preferred option.

Japan's surgeons joined over 100 trauma operations in 2 months. Although penetrating injuries (e.g. stab and gunshot wounds) are rare in Japan, Japan's surgeons experienced 14 penetrating injury cases in the same period. Still, the number of trauma surgeries conducted in India is much higher than in Japan. Trauma surgery experience possessed by surgeons at JPNATC is simply unobtainable for surgeons in Japan. India's trauma surgeons could therefore contribute greatly to strengthening trauma treatments in Japan.

At AIIMS, each individual trauma surgeon is highly capable and skilled in various surgical techniques; their excellent performance is evident in the quality of surgeries conducted. However, there is potential for growth such as by enhancing leadership and team management. The importance of a team approach has in fact gained much attention in Japan recently. There is increased recognition that not only technical skills but also non-technical skills should be honed, especially in trauma care. Thus, training courses such as the Surgical Strategy and Tactics for Trauma (SSTT) course are developed and provided for surgeons and nurses. The purpose of these courses is to build a team and to train personnel on how to manage severe trauma patients in an emergency or operating room as a team. Teamwork techniques are employed in different industries but are especially important in healthcare settings where patients' lives and wellbeing are at stake. From this perspective, the participation of Japanese surgeons in trauma care at AIIMS through this project could also contribute to the level of trauma care in India.

2.2. Report from the 2nd group

The Japanese surgeons in the second group stayed at JPNATC for a month and a half during which they were involved with more than two hundred operative cases and 1,300–1,500 trauma patients per week. They also witnessed five gunshot victims, including non-surgical cases. These patients were remarkably well managed. Management included the initial assessment and resuscitation at the emergency department and the activation of a surgical team in the operation theatre. In discussions between AIIMS surgeons and Japanese surgeons, it was pointed out that the availability of operation theatres and computed tomography (CT) scans is the most significant difference. The availability of the operation theatres is much higher at AIIMS than in Japan, whereas CT scans is almost inaccessible for trauma patients in India because of the large number of CT examination requests from all hospital departments.

The following is one of the cases during the second group's stay at JPNATC. A male patient in his thirties who was shot in the back was taken to the AIIMS trauma centre by a relative. The patient was in a state of shock. A triage officer decided that the patient was

hemodynamically unstable. Trauma surgeons then started initial resuscitation. As the operation proceeded, Focused Assessment with Sonography for Trauma (FAST) revealed that the patient's condition was a pericardial tamponade. Then the patient was shifted to the operation theatre, and an emergency thoracotomy was conducted. The length of time between arrival and thoracotomy was only 16 minutes.

The findings and lessons learned by the second group of Japanese surgeons is as follows:

a. Team cooperation

It is vital to develop a good relationship and maintain communication between trauma experts and the anaesthesiology team in the operation theatre to ensure that emergency operations are performed well. Japan's trauma experts can learn from the excellent teamwork at JPNATC including the flow of initial assessment, resuscitation, operation, intensive care, re-operation, ward management, and so on. Japan's surgeons, anaesthesiologists, and nurses are encouraged to maximise their participation in this programme and contribute to improving trauma treatment in Japan through a strong partnership with the AIIMS.

b. Techniques in trauma surgery

Experience treating vascular injury is essential for the trauma surgeons because quickly repairing vascular damage to restore blood flow through or around blocked arteries (known as reperfusion) is critical for trauma surgery. Compared to trauma surgeons in Japan, trauma surgeons in India are required to cover a wide range of operations including treatment of vascular injuries. Japan's trauma surgeons rarely have opportunities to treat, especially in the field of vascular and limb injuries.

c. Transcatheter arterial embolisation

Transcatheter arterial embolisation (TAE) is a haemostatic procedure widely used by the trauma surgeons in Japan. It does not require open surgery and is therefore less invasive, it is appropriate for either hemodynamically stable or unstable patients, and likely decreases morbidity and improves trauma care outcomes. Currently, it is rarely used at JPNATC. Increased exchanges in treatment experience related to interventional radiology techniques such as TAE could thus contribute to improving trauma management in India.

d. Older patients

Japan is the most aged country in the world and Japan's trauma surgeons are highly experienced in treating older trauma patients. India's trauma surgeons could thus benefit from Japanese surgeons' knowledge of patient management and medical therapy related to older trauma patients.

e. Training for trauma surgeons at JPNATC

In both India and Japan, trauma surgeons conduct daily clinical rounds, weekly case presentations, and semi-weekly surgical and radiology conferences. However, especially in India, the training curriculum for trauma surgeons is designed and created in trauma centres. Trauma surgeon residents rotate through neurosurgery, orthopaedics, cardiovascular surgery, and plastic surgery so they gain practical and well-rounded knowledge and skills. The treatment of trauma patients in emergency departments begins with an initial assessment and resuscitation. Job rotation experience at emergency departments is mandatory for the trauma surgery residents. This clinical training system and its curriculum at JPNATC provide excellent opportunities for trauma surgeons to acquire experience in managing trauma patients from start to finish and in a wide variety of cases.

f. Equipment

Shock is a critical condition brought on by a sudden drop in blood flow through the body. Shock may result from trauma, heatstroke, blood loss, an allergic reaction, severe infection, poisoning, severe burns, or other causes. When a trauma patient is in shock, surgeons need to check the physical condition of trauma patients in a limited amount of time.

CT scans can greatly facilitate quick examinations and potentially reduce the number of invasive therapies using precise information on the patient's condition. In Japan, some hospitals place a CT scan machine in their emergency room (ER) called a hybrid ER system and in their operation theatre (OT) called a hybrid OT system. In India, trauma surgeons have to deal with many trauma cases in the emergency department within a short period of time but CT scans are not readily available. It may be challenging to place CT scan machines in the emergency department in India at the moment, but it will probably be possible in the future.

If trauma centres in India were to have CT scan machines in their OT, a variety of non-surgical management techniques, including interventional radiology and TAE, would be available and contribute significantly to trauma treatment in the country. By utilising a hybrid OT system, surgeons would be able to conduct surgical procedures and interventional-radiological procedures simultaneously. This technique of combining trauma surgery and interventional radiology can improve mortality rates for trauma patients in India.

The possibility of non-surgical management (including interventional radiology) was raised by Japanese trauma surgeons after experiencing a high volume of trauma patients and surgery during their training at JPNATC. Collaboration in this area could contribute to optimising healthcare resources and improving India's healthcare system.

Chapter 4

Conclusions and Prospects

In the course of implementing this project, Japanese associations confirmed that the project can contribute to improving trauma and medical care in both India and Japan. From the point of view of Japanese associations, Japanese surgeons' participation in the treatment of a large number of trauma patients was extremely valuable. They witnessed first-hand how patients in India were quickly brought to operation theatres and surgical treatments started immediately. In most Japanese institution, even in emergency and critical care medical centres, it is very difficult to start operation in such a short time after a patient's arrival. In addition, surgical procedures at All India Institute of Medical Sciences (AIIMS) were highly educational for the Japanese surgeons. Their experiences will be very useful when treating their patients at their institutions in Japan.

Meanwhile, less invasive treatment techniques, such as interventional radiology (IVR) and resuscitative endovascular balloon occlusion of the aorta (REBOA) are still uncommon at AIIMS. Since Japanese trauma surgeons have handled many cases involving IVR, they can share their experiences with AIIMS' surgeons and contribute to widening the treatment options available for trauma patients in India. In addition, Japanese associations have designed off-the-job training courses which include educational materials, management and organisation skills training components, and instructor list that could be very valuable for trauma surgeons in India.

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