Original Article

Validating the trauma care system developed by Yokohama City local government

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Background: Since becoming the city with the first government-designated major trauma center in 2014, Yokohama has been striving to centralize care for extensive trauma patients. Hence, in this study, the Yokohama City Major Trauma Care Advisory Committee tested the efficacy of the centralization of care for trauma patients.

Methods: This investigation included all cases of deaths due to road traffic accidents that occurred in the 2-year period following the establishment of the major trauma center. The probability of survival was calculated using data provided by the police and fire departments. Cases that died despite having a probability of survival of 50% or more were included in the survey undertaken by physicians recommended by the Japanese Association for the Surgery of Trauma, who visited the hospitals.

Results: Of those surveyed, preventable trauma death accounted for 1 case (1.7%) and potentially preventable trauma death accounted for 7 (11.9%), compared with 5 (9.8%) and 11 (21%) cases, respectively, in the period 2009–2010.

Conclusions: Comparing the survey conducted before establishment of the major trauma center, those results support the benefits of centralizing care for severe trauma cases. We aim to continue improving trauma care provided through the center along with the Yokohama Medical Control Council and to overcome challenges that were identified through the peer review.

Key words: Medical control, prehospital care, preventable trauma death, trauma, validation

INTRODUCTION

DESPITE THE RECENT dramatic drop in the number of deaths due to traffic accidents in Japan, accident-related traumatic death remains the leading cause of death in the young population[1,2]; thus, providing prompt treatment to trauma patients and improving therapeutic outcomes remain important challenges. The Japanese Association for the Surgery of Trauma has proposed the concept of preventable trauma death (PTD) and has been endeavoring to improve therapeutic outcomes through activities, such as gathering and analyzing data for the Japanese Trauma Data Bank[2] and promoting the application of trauma care procedures, such as Japan Prehospital Trauma Evaluation and Care,[3] Japan Advanced Trauma Evaluation and Care,[4] Japan Nursing for Trauma Evaluation and Care,[5] and Japan Expert Trauma Evaluation and Care.[6]

The nation's first major trauma center was established in Yokohama city, which has been striving to centralize traumatic patient care under a consolidated care system.[7] Foreign studies have reported that therapeutic outcomes improve when major trauma patient care is centralized,[8,9] but similar data are yet to be reported in Japan.

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The Yokohama City Major Trauma Care Advisory Committee and Yokohama City Healthcare Department jointly investigated the therapeutic outcomes of trauma patients since establishing the trauma center with the cooperation of the Kanagawa Prefectural Police Department, Yokohama City Fire Department, and various medical institutions in the city. Few studies have tested the efficacy of the centralization of care for trauma patients. Thus, we herein report on the results of this investigation and the implied challenges faced by trauma care in Japan.

METHODS

Data resources

THIS INVESTIGATION INCLUDED all cases of deaths due to road traffic accidents that occurred in the 2-year period following the establishment of the major trauma center. The probability of survival (PS) was calculated using data provided by the police and fire departments. Cases that died despite having a PS of 50% or more were included in the survey undertaken by physicians recommended by the Japanese Association for the Surgery of Trauma, who visited the hospitals.

Yokohama city undertook the Yokohama City Trauma Care Survey in 2009–2010 and designated two medical institutions as major trauma centers in 2014, based on the outcomes of the survey.[7] Yokohama is a large city with a population of 3.78 million and area of 437.4 km^2 (north to south, approximately 40 km; east to west, approximately 20 km). Of nine emergency centers in Yokohama, the two designated as major trauma centers are Yokohama City Medical Center, located in the middle of the city, and Saiseikai Tohbu General Hospital, located in the far east of the city. The Yokohama medical protocol for severe trauma recommends that emergency medical service paramedics transfer severe trauma patients to these major trauma centers within 45 min. If longer than 45 min, it is recommended that patients are transferred to the nearest emergency medical center. The current investigation aimed to assess the effects of establishing the trauma center and included all deaths related to road traffic accidents (RTA) that occurred in Yokohama city during a 2-year period between 2015 and 2016. In the new protocol, patients who met the criterion were transported to trauma centers, and the remaining trauma patients were transported to secondary or tertiary care hospitals. Before the utilization of two trauma centers, trauma patients had been transported to the closest available secondary or tertiary care hospital. We compared distributions of PTDs before and after the designation of trauma centers with Fisher's exact test. Statistical analysis was undertaken with IBM SPSS Statistics for Windows, version 25.0 (IBM Corp.).

Data on the location of all 149 RTA cases provided by the Kanagawa Prefectural Police were compared with the transport data obtained from the Yokohama City Fire Department. In addition, the Yokohama City Trauma Investigation Committee carried out a peer review on all cases that resulted in death despite a PS of 50% or more to determine whether any of the cases were PTDs. We then qualitatively evaluated the validity of the trauma care system established by the City.

RESULTS

ACCORDING TO THE transport data held by the Fire Department, we excluded 90 cases in cardiorespiratory arrest on site and without vital signs at the time of arrival of the emergency crew. The PS was calculated from the transport data and initial medical assessment carried out at the hospital that the 59 cases with vital signs confirmed on site were transported to. Of these, 20 had partially missing data. For these cases, the PS was calculated assuming a maximum Abbreviated Injury Scale (AIS) value, following the methods used at the last investigation. The PS for all 59 cases were calculated in this manner, which resulted in ≥50%; nonetheless, 24 cases died after being transported to the hospital. Of the 24 cases, the PS of 21 was calculated based on complete data, and the PS of the remaining three were calculated by substituting data with the maximum AIS value (Fig. 1).

Peer review evaluation

The 24 cases were transported to seven hospitals in Yokohama city; hence, the Yokohama City Healthcare Department requested cooperation of these hospitals in the study, and all hospitals accepted the peer review.

A team of two physicians recommended by the Japanese Association for the Surgery of Trauma, two government staff from Yokohama City, and one of the members of the Yokohama City Trauma Investigation Committee visited the hospitals to conduct a third-party evaluation of medical records and held a discussion with the physician who provided trauma care for each case while reviewing the actual initial care and surgical records. The physicians recommended by the Japanese Association for the Surgery of Trauma gave an overall evaluation of whether the case was a PTD, or potential PTD, that is, a borderline PTD who could possibly have been saved had emergency surgery or other care been provided.

Of the 24 cases that underwent a peer review, erroneous AIS coding was identified through an evaluation of the

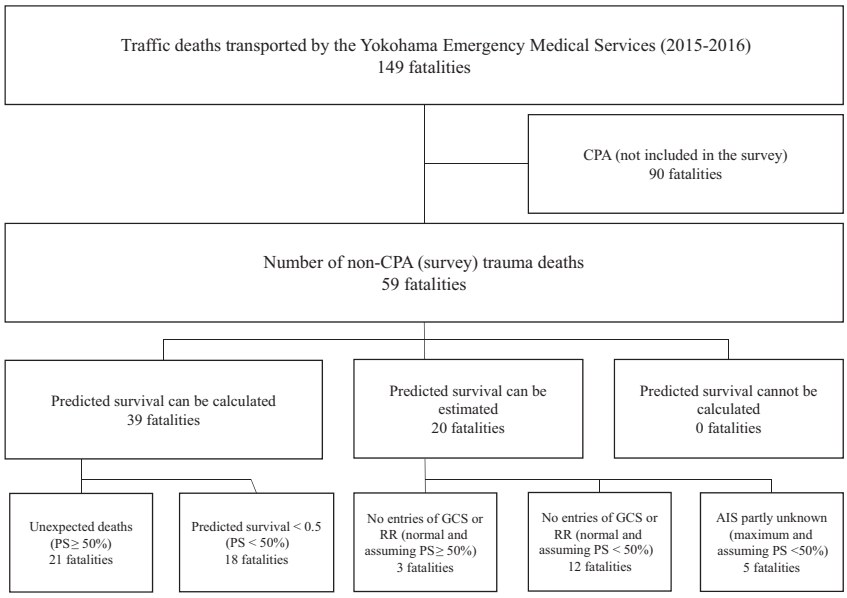

Fig. 1. Response status from hospitals surveyed to test the efficacy of the centralization of care for trauma patients in Yokohama, Japan. AIS, Abbreviated Injury Scale; CPA, cardiopulmonary arrest; GCS, Glasgow Coma Scale; PS, probability of survival; RR, respiratory rate.

actual medical record. When the PS was recalculated based on correct values, six cases were found to have PS < 50%. One (1.7%) was determined as indisputable PTD during the peer review; seven others (11.9%) were evaluated as potential PTD who could have been saved had emergency treatment, such as trauma surgery, been provided, but was not due to patient age or mental or social factors, such as presence of dementia, or lack of support, as observed in patients who lived alone and had no family. Ten cases clearly could not have been saved (Fig. 2).

Yokohama City undertook another investigation in 2009–2010 following the same methodology, before establishing the major trauma center, to investigate the therapeutic outcomes of trauma in Yokohama city as a whole.[7] This survey resulted in 5 (9.8%) of 51 cases being determined as PTD and 11 (21%) as potential PTD. All PTDs were observed in seven other hospitals that provide secondary or tertiary care. The distributions of PTDs before and after the designation were not statistically significant ($P = 0.1895$).

Revising the trauma protocol based on investigation

The Yokohama City Medical Control Council (Yokohama MC) discussed the outcomes of this survey on traumatic injuries at the Yokohama MC Protocol Committee and Investigation Committee meetings. Previously, cases that were transported to the major trauma center required adherence to the following two criteria: (i) cases of suspected hemorrhagic shock due to trauma to the neck, trunk, or bilateral upper legs, (ii) cases that could arrive at the major trauma center within 45 min of dispatch. The discussions on the outcomes of the survey resulted in the decision to eliminate the criterion regarding time restrictions, associated with the conclusion of the investigation results that further effort should be made to centralize major trauma patients in high-volume centers. The new trauma protocol that eliminated the time restriction has been in effect since January 2020 and has led to an increase in the number of cases transported to the major trauma center, from 48 in the previous year to 92 in the 1-year period since its implementation, to January 2021. Yokohama City plans to continue working with the Yokohama City MC to investigate the cases of traumatic injury.

DISCUSSION

Effect of centralization of severe trauma

IN THIS STUDY, the Yokohama City Major Trauma Care Advisory Committee validated the efficacy of the centralization of care for severe trauma patients. This investigation revealed that PTD and potential PTD both decreased through the establishment of the major trauma center in

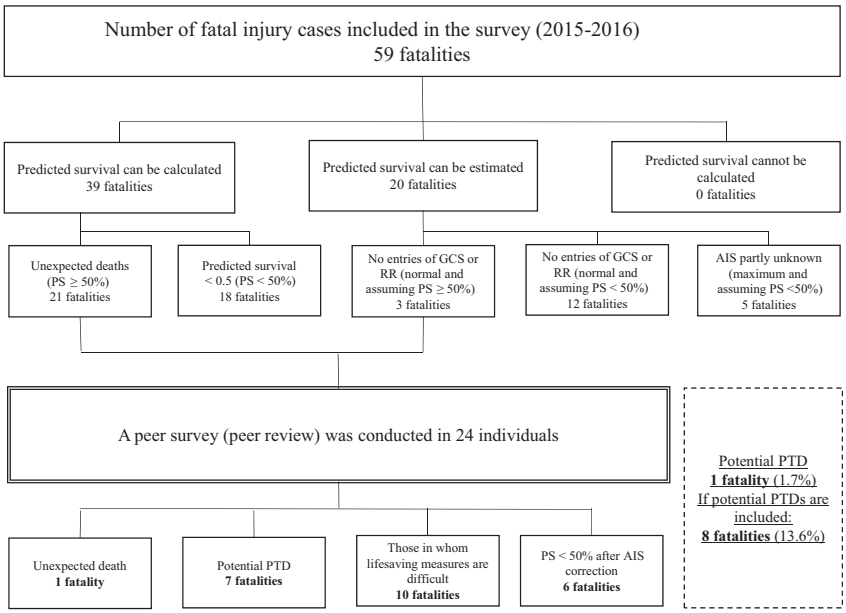

Fig. 2. Summary of results of a survey to test the efficacy of the centralization of care for trauma patients in Yokohama, Japan. AIS, Abbreviated Injury Scale; GCS, Glasgow Coma Scale; PS, probability of survival; PTD, preventable trauma death; RR, respiratory rate.

Yokohama City. Some studies have reported improved therapeutic outcomes due to centralization of severe trauma cases from North America,[8,9] but to the best of our knowledge, this study is the first report from Japan. However, we should be careful in interpreting the results, because the hospital situation in Japan is very different in each area, such as rural and urban areas.

In Japan, social initiatives that aimed to encourage people to stop drinking and driving and increase car safety have helped in considerably reducing RTA deaths: 16,765 deaths recorded in 1970, reduced to 2,839 in 2020.[10] However, according to the Vital Statistics of Japan, falling down, falling from heights, and crashes have increased year by year, in contrast to the reduction in RTA deaths.[1] Trauma is still the main cause of death in young people.

In order to improve therapeutic outcomes further, training trauma care physicians who play central roles in next-generation trauma care is an important challenge. Due to the drop in the number of fatal RTAs, individual hospital-level initiatives to train trauma surgeons and maintain their skills are becoming increasingly difficult. Centralizing severe trauma cases could be one of the solutions for training future trauma surgeons.

In 2021 the Japanese Association for the Surgery of Trauma recommended the establishment of regional trauma care systems to provide abdominal, trunk, and orthopedic trauma care and rehabilitation.[11] To establish and keep the regional trauma care system, validation is essential. In this study, the government played a leading role in investigating therapeutic outcomes in the entire region after establishing the major trauma center in Yokohama. The cooperation of various departments, such as the Kanagawa Prefectural Police responsible for RTAs, the Fire Department that possesses the data on patient transport, the Yokohama City Healthcare Department, which is the core investigative body and coordinates the related institutions, and the medical institutions in the city that accepted the peer review for an investigation

Authors' view for therapeutic strategies

We hereby state our view regarding therapeutic strategies. In the present investigation, physicians appointed by the Japanese Association for the Surgery of Trauma actually visited the hospitals and made an assessment of PTD by reviewing charts and interviewing physicians who provided care for the patient. Therapeutic strategies that should be followed for managing isolated traumatic head injuries in older patients was a topic of discussion with the attending physician at that time. The emergency room physician and neurosurgeon concomitantly decided to forego prompt craniotomy and decompression surgery in older adults with isolated posttraumatic head injury, particularly in patients with activities of daily living impairment, those who were living alone, or those with dementia, even if the surgery might have had the potential to save the patient. There was some

debate between the evaluating physicians themselves as to whether a patient who died as a result of such a decision, despite having a PS ≥ 50%, should be classified as PTD. In the majority of these cases, prognosis in the acute stage was not the major determinant of the therapeutic strategy followed, but the decision was associated with social factors, such as the need to prepare social follow-up support or transfer to a long-term care facility bed. This debate led to the new category of "potential PTD" for patients who could not be immediately classified as PTD, but who had a chance to be saved had emergency surgery been carried out.

The Japanese population is expected to age at increasingly accelerating rates. Life-saving emergency surgery for patients with post-=traumatic head injury is impractical without ensuring that the patients can be cared for thereafter through rehabilitation and support by the community as a whole.

In the future, as the population continues to age, we need to find answers to questions, such as whether emergency surgery should be carried out if there is even a slight chance of saving the life, even if there is a great chance that the patient will end up in a vegetative state, or whether invasive surgery should be avoided and the patient should be observed quietly if there are no postsurgery support systems for the patient? These issues should be discussed in the society as a whole, rather than having the surgeon singlehandedly coming to a conclusion, to find the appropriate solutions.

Importance of accurate AIS coding

The Japanese Association for the Surgery of Trauma launched the Japanese Trauma Data Bank in January 2004. Analyzing details of traumatic injury cases and changes in therapeutic outcomes over time through the data bank have contributed to the improvement of the trauma care system in Japan.[2] "Accurate coding" is the premise of this analysis. In the present peer review, some cases were found to have AIS coding errors during the process of checking the actual medical charts. When the PS was recalculated with the correct coding, six cases had PS < 50%, which led to their exclusion from subjects of the peer review. Suitable coding is essential for good quality trauma care, which also warrants an educational system. The current peer review highlighted challenges faced by two types of hospitals in Yokohama city: one where physicians undertake the AIS coding and another where the health information manager undertakes it. The benefit of having a physician carry out AIS coding is that they have accurate knowledge of the therapeutic course, which allows coding without any missing data, whereas the shortcoming is that physicians tend to evaluate the condition more critically. The benefit of having health information managers carry out the same task lies in the likelihood of maintaining objectivity as they only pick up data from what is written on the charts, whereas their shortcoming is that the coding could be inaccurate when certain data are not clearly recorded. Accurate AIS coding is the basis for accurate assessment of therapeutic outcomes and centralization of trauma cases in Japan. Routine reviews of data recorded on charts within facilities and improved on-site training systems for health information managers by the Japanese Association for the Surgery of Trauma are warranted.

Initiatives to improve inclusive emergency care systems applying the results of this investigation

It is important to associate the challenges that were identified in this investigation with improvements in the actual on-site emergency care activities. The results of this investigation were shared with the Yokohama City MC and considered in revising the paramedics' protocol for trauma patients. As an outcome of this discussion, the conventional criteria requiring the patient to be capable of being transported to the major trauma center within 45 min of emergency crew arrival on site has been eliminated since January 2020. This can be considered as a more rigorous application of the trauma bypass that centralizes patients with shock caused by trunk trauma from all areas of the city to the major trauma center. At the same time, we have been transporting cases with airway or breathing abnormalities observed on site to the nearest critical care center as has been conventionally done. This change in the trauma protocol has almost doubled the number of trauma patients transported to the major trauma center (unpublished institutional data). The Yokohama City Trauma Advisory Committee is planning to continue evaluating how therapeutic outcomes of trauma in areas across the region will change due to this revision. There are a few caveats on this study. We evaluated the only patients involved in RTAs, however, the number of RTAs has been decreasing in recent years. Thus, the centralization, as well as the traffic system, might affect our results. A future study including all trauma death would be needed to validate our findings.

CONCLUSIONS

COMPARING THE SURVEY conducted before establishment of the major trauma center, those results support the benefits of centralizing care for severe trauma cases. We aim to continue improving trauma care provided through the center along with the Yokohama Medical Control

Council, as well as to overcome challenges that were identified through the peer review.

DISCLOSURE

Approval of the research protocol: N/A.
Informed consent: N/A.
Registry and registration no. of the study/trial: N/A.
Animal studies: N/A.
Conflict of interest: None.

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ETHICAL INFORMATION

THIS RESEARCH WAS not submitted for Ethics Board approval, because the data were provided from a local government and it consisted of only statistical values. The research was conducted in accordance with the Declaration of Helsinki.

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