Original Article

Analysis of consumption of medical resources in terms of intensive care unit/hospital stay and severity using Japan Trauma Data Bank

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Aim: We analyzed the length of intensive care unit or hospital stay of trauma patients to assess the consumption of medical resources using the Japan Trauma Data Bank.

Methods: We classified 60,580 cases registered between 2004 and 2010 in the Japan Trauma Data Bank by hospital ward on emergency admission.

Results: A total of 9,564 intensive care patients could be moved to the general ward before hospital transfer or discharge; 6,217 cases were transferred to another hospital and 9,444 cases were discharged directly from the intensive care unit. The length of intensive care unit or hospital stay correlated with the injury severity score. There were 5,856 patients (68%) from the non-survivors who died within 3 days of admission.

Conclusion: Based on the Japan Trauma Data Bank data for many trauma patients, there are numerous cases of long-term stay ≥ 15 days in intensive care in patients who could not be transferred to a general ward and who consumed the medical resources in the critical care department.

Key words: Additional fee for critical care, diagnosis and procedure combination, intensive care unit, Japan Trauma Data Bank, length of hospital stay

BACKGROUND

EFFECTIVE UTILIZATION OF limited human and material resources is an important issue in emergency medical services, including injury care. Considering that many acute care hospitals provide diagnosis procedure combination (DPC) services, it is expected that patients who survive the super-acute phase are transferred to other hospitals or wards, from the aspect of hospital functional differentiation¹ and the viewpoint of appropriate fees for medical ser-

vice, represented by hospital charges for critical care in the emergency care setting.

Using a simple calculation of length of hospital stay for each sickness and wound, an analysis can be performed to some extent by each Major Diagnostic Category (MDC) code using the DPC data (Form 1, E file, and F file). However, there are limitations in that the MDC code does not reflect severity and that the MDC code of the primary sickness and wound would not be used when more medical resources were spent for complications/accidents. Each trauma severity parameter can also be included for registration in the Japan Trauma Data Bank (JTDB) Appendix *1.

In this study, the occupancy of an intensive care unit (ICU) bed by trauma patients as one form of medical resource consumption and the tendency toward a prolonged ICU stay was determined using the JTDB. The analysis results and trauma severity are described here. There was also prolonged hospitalization of trauma and cerebrovascular disorder patients in a critical care center and therefore these patients were also analyzed.

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METHODS

REGISTERED CASES IN the JTDB from 2004 to 2010 were analyzed ($n = 70,683$).

1. Analysis of the course of inpatient ward (classification) from initial treatment

The ward to be admitted to and the route of change/transfer after hospitalization were classified on the basis of the following JTDB items: ward in which a patient was hospitalized after initial treatment; date of discharge or transfer from an emergency department to another department; date of discharge; and department/hospital transferred to after discharge. Parameters related to trauma severity and prognostic value such as revised trauma score (RTS), injury severity score (ISS), and probability of survival (TRISS Ps) were summed by category and the results are shown as mean values.

2. Analysis of severity and length of hospital stay

The lengths of ICU stay and total hospital stay were summed by ISS.

3. Comparison between length of hospital stay by DPC and actual hospital stay length

The data of patients who underwent cerebral decompression according to the JTDB were compared with the length of hospital stay² defined in the DPC code #2411-2415 “skull injury/intracranial injury – cerebral decompression and others.”

This study was approved by the Institutional Review Board of Tokyo Medical University Hospital (#126) (Tokyo, Japan).

RESULTS

1. Course of inpatient ward hospitalization after initial treatment by severity and outcome

TABLE 1 SHOWS THE severity and length of hospital stay by inpatient ward course after initial treatment. The courses from the emergency room were classified as follows:

- emergency room → ICU → general ward → discharge/hospital transfer/death
- emergency room → ICU → discharge/hospital transfer/death

Table 1. Patient severity and length of stay by ward type of 70,683 cases registered in the Japan Trauma Data Bank between 2004 and 2010

	Hospital ward		Outcome	Number of patients	RTS	ISS	TRISS Ps	Length of ICU stay, days	Length of general ward stay, days
Emergency room	ICU	General ward	Transfer	3,517	7.4	14.8	0.92	8.0	30.8
			Discharge	5,579	7.6	12.2	0.96	6.2	28.3
			Death	178	5.7	19.5	0.66	5.7	21.0
			(Others, unknown)	290	7.4	12.9	0.93	8.4	34.0
		Transfer	6,217	7.4	14.1	0.93	20.9		
		Discharge	9,444	7.6	8.2	0.97	14.1		
		Death	1,790	4.0	26.0	0.44	17.1		
		(Others, unknown)	512	7.3	12.5	0.92	13.2		
	General ward	Transfer	6,855	7.8	8.7	0.97		25.0	
		Discharge	10,026	7.8	7.1	0.98		17.6	
		Death	226	5.8	13.0	0.73		35.4	
		(Others, unknown)	1,771	7.7	8.2	0.97		9.6	
			Transfer	NA					
			Death	1,925	0.6	32.0	0.10		1.5
Unknown			12,250	7.5	7.0	0.95			
Total			60,580						

ICU, intensive care unit; ISS, injury severity score; NA, not applicable; RTS, revised trauma score; TRISS Ps, probability of survival score.

- emergency room → general ward → discharge/hospital transfer/death
- emergency room → hospital transfer/death as an outpatient
- unknown

Data without missing RTS, ISS, or TRISS Ps values were obtained from 60,580 patients (85.7%) of the study subjects. A total of 9,564 patients were transferred to a general ward after being hospitalized in the ICU following initial treatment. The mean ICU stays were 8.0 and 6.2 days in patients who were transferred from a general ward to another hospital and in patients who were discharged from a general ward, respectively.

After being hospitalized in the ICU, 6,217 patients were directly transferred to another hospital without being transferred to a general ward and 9,444 were discharged (Table 1). The conditions of these patients were not necessarily more severe, but their mean ICU stay was longer than that of the patients who were transferred to a general ward before hospital transfer or discharge.

A total of 18,878 patients were directly hospitalized in a general ward after their initial treatment (Table 1). Of these patients, 226 died. The mean ISS of these patients was lower than that of the patients who were hospitalized in the ICU. A total of 1,925 patients died during the initial treatment. As those patients who were transferred to another hospital after the initial treatment could not be accurately categorized in the JTDB, they were excluded from this study.

Table 2 shows the patients whose length of ICU stay was ≥15 days. The mean ISS tended to be higher than the values of all the subjects (Table 1). The ICU stay was 30–40 days

in each category. The percentage of main injury sites of the patients who were transferred to another hospital or discharged after being transferred to a general ward from the ICU was not significantly different from that of the patients who were transferred to another hospital or discharged from the ICU as follows: head and neck, 19% and 15%; chest, 39% and 36%; abdomen, 13% and 18%; spinal cord, 4% and 5%; extremities, 20% and 24%; and burns, 4% and 2%, respectively.

2. Severity and length of hospital stay

Figure 1 shows a graph with the horizontal axis representing the ISS and the vertical axis indicating the length of ICU

Fig. 1. Injury severity score (ISS) and length of intensive care unit (ICU) stay in 70,683 cases registered in the Japan Trauma Data Bank between 2004 and 2010.

Table 2. Condition severity and length of stay in patients with an intensive care stay >14 days

	Hospital ward		Outcome	Number of patients	RTS	ISS	TRISS Ps	Length of ICU stay, days	Maximum length of ICU stay, days	Length of general ward stay, days
Emergency room	ICU	General ward	Transfer	266	6.9	21.6	0.84	39.0	745	41.6
			Discharge	282	7.2	20.0	0.90	31.2	384	50.8
			Death	15	5.4	24.1	0.59	33.7	86	32.9
			(Others, unknown)	29	6.9	23.1	0.82	30.4	92	49.5
			Transfer	1,538	7.1	19.6	0.87	41.5	1,002	
			Discharge	1,101	7.4	14.6	0.95	45.9	453	
			Death	178	6.5	13.6	0.79	74.9	222	
			(Others, unknown)	84	7.4	17.9	0.91	30.9	103	
					Total	3,493				

Data from 70,683 cases registered in the Japan Trauma Data Bank between 2004 and 2010. ICU, intensive care unit; ISS, injury severity score; RTS, revised trauma score; TRISS Ps, probability of survival score.

stay in days. The number of patients with outcome events increased with severity. Events excluding death shortened the mean hospital stay. There was a correlation between the ISS and the ICU stay ($R = 0.90$). A similar tendency was found for the total hospital stay, including the ICU and general ward stays (Fig. 2).

Figure 3 shows the length of hospital stay for all 9,369 deaths. The date of death was unknown in 757 patients. A total of 5,856 patients died within 3 days of hospitalization, which accounted for 68.0% of the 8,612 patients.

Fig. 2. Injury severity score (ISS) and length of hospital stay in 70,683 cases registered in the Japan Trauma Data Bank between 2004 and 2010.

Fig. 3. Number of deaths by length of hospital stay in 70,683 cases registered in the Japan Trauma Data Bank between 2004 and 2010.

3. Comparison between hospital stay for DPC and actual hospital stay in patients with head trauma

A total of 2,844 patients underwent cerebral decompression according to the recorded surgery information code. The ICU stay was 20.4 ± 42.8 days, the total hospital stay was 36.6 ± 53.5 days, and the mean ISS was 26.4.

DISCUSSION

MEASURES TO IMPROVE emergency patient care tend to focus on the development of acceptance rules such as the Tokyo Rules for Emergency Medical Care.³ However, most beds are usually occupied, which is a serious problem for emergency medical centers and one of the main causes of failing to meet patient needs. This makes it difficult to claim that adequate measures have been taken to date. The staff of medical cooperative offices in each institution may not necessarily cope well with daily discharge/hospital transfers. Consequently, physicians belonging to a critical care center must facilitate logistics, which causes a vicious cycle that affects emergency services.

The results of a recent questionnaire showed that trauma and cerebrovascular disorder account for diseases in patients who experienced prolonged (≥ 31 days) hospitalization in a critical care center.⁴ In the case of injury, the results of this analysis revealed that the number of patients who were discharged without being transferred to a general ward was nearly twice that of patients who were discharged after being transferred to a general ward. Regarding hospital transfer, the number of patients who were transferred to another hospital from the ICU was nearly twice that of patients who were transferred to another hospital after being transferred to a general ward. The mean ICU stay of the former patients was at least twice as long as that of the latter patients. Considering that there is no marked difference in severity in terms of the RTS and ISS and that there is no difference in the main location of injury, ICU occupation might be caused by a lack of a mechanism of transfer to a general ward or another hospital. The arrangement of early transfer to a general ward or another hospital and discharge, referred to as an exit problem, may have an immediate effect on improving critical care center capacity.

Regarding the additional fee for critical care that is counted in most critical care centers, both “additional fees for critical care 1” and “additional fees for critical care 2” can be counted only for ≤ 14 days, even if a serious status is continuous for more than 14 days.⁵ For serious trauma cases except extensive burns in an institution in which intensive

Table 3. Diagnosis procedure combination (DPC) code for patients with head injury requiring craniotomy (code definition)

No.	DPC code	Diagnosis	Surgical procedure	Procedure 1	Procedure 2	Coexisting disease/injury	Severity	Period, days			Amount of payment, points/day		
								I	II	III	Hospital days I	Hospital days II	Hospital days III
2411	160100xx0100xx	Cranial/brain injury	Cerebral decompression, others	No	None			13	25	55	2,777	2,023	1,720
2412	160100xx01010x	Cranial/brain injury	Cerebral decompression, others	No	Yes	None		8	23	60	4,248	2,831	2,406
2413	160100xx01011x	Cranial/brain injury	Cerebral decompression, others	No	Yes	Yes		15	35	82	3,876	2,465	2,095
2414	160100xx0110xx	Cranial/brain injury	Cerebral decompression, others	Yes	None								
2415	160100xx0111xx	Cranial/brain injury	Cerebral decompression, others	Yes	Yes			30	60	120	3,836	2,402	2,042

Data from 70,683 cases registered in the Japan Trauma Data Bank between 2004 and 2010. Periods I, II, and III (days) are the hospital periods wherein a patient paid a fee based on Hospital days I, II, and III, respectively. Procedure 1, any other surgery; Procedure 2, intracranial pressure monitoring, central venous catheter, renal replacement therapy, or mechanical ventilation.

care management fees specific to extensive burns can be counted, hospitalization for ≥ 15 days carries very unbalanced medical income versus expenditures. As shown in Table 2, ICU stays exceeding 15 days could not be avoided in many cases. A large number of patients could not be transferred to the general ward and had prolonged ICU stays.

The new medical fee for early transfer (within 5 days) from a tertiary medical center to level 2 facilities, introduced in 2010, may increase the direct transport of emergency patients from the ICU to level 2 hospitals Appendix *2. However, we found that between 9.5% and 11.8% of patients were transferred directly from the ICU to another facility between 2004 and 2009, and that 10.1% of patients were transferred in 2010, which shows no remarkable difference. What we are interested in are additional changes because this system was further improved in 2012.

Severity is correlated with length of hospital stay, and the ICU stay may exceed 14 days in cases of an ISS of 15. However, additional fees for critical care can be billed until day 14 only. In this regard, improvements such as establishing the appropriate division depending on each patient's severity and condition might be required. A case in which a patient has to be hospitalized in the ICU despite a status that does not necessarily need ICU management may become an exit problem, thus the appropriate additional fees for critical care should be planned when intensive care ≥ 14 days is required. However, in such cases, the reason for requiring intensive care should be recorded.

According to the score list by the DPC classification, the class number 160100xx0100xx-160100xx0111xx corresponding to "Skull injury/intracranial injury – cerebral decompression and others" appears as in Table 3 (for 160100xx0111xx, yield is used for the calculation of fee-for-service reimbursement). In the case of a patient who underwent cerebral decompression and then received a tracheotomy ("surgical treatment etc. 1") and mechanical ventilation ("surgical treatment etc. 2"; intracranial pressure measurement; central venous injection), this is classified as 160100xx0111xx, as shown in the bottom row of Table 3; hospitalization II as the approximate mean length of hospital stay is 60 days. For cases of cerebral decompression, it is difficult to undertake a simple comparison as the presence or absence of surgical treatment could not be accurately classified. However, the ICU stay was 20.4 ± 42.8 days and the total hospital stay was 36.6 ± 53.5 days. The database revision that enables checking with the DPC data and is expected in the future. Regarding the "additional fee for the critical care", the limit of up to 14 days regardless of the condition does not reflect the actual condition.

Various studies have used the JTDB to analyze many cases, including improving the prognostic value of blunt trauma.⁶ Here, we focused on the possibility of carrying out an analysis of the consumption of medical resources examined on the basis of current social problems, mainly length of hospital stay, using the JTDB. Analysis using the JTDB database may be useful for studies evaluating social aspects of hospitalization, including revising the current fee-for-service, and analyzing and comparing the data obtained with the DPC data.

CONCLUSION

BASED ON THE JTDB data for many trauma patients, there are numerous cases of long-term ICU stay ≥ 15 days in patients who could not be transferred to a general ward and who used the medical resources in the critical care department. There are actual situations in which a long ICU stay cannot be avoided, and improvement in transfer and discharge rates or the provision of additional fees for critical care is required.

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CONFLICT OF INTEREST

NONE.

REFERENCES

- 1 Koinuma N. Review of current health care system. *Byoin*. 1996; 55: 846–50.
- 2 DPC 2014. MDC 160100. Head injury. [Accessed 30 Jan 2012]. Available from: <http://dpc2014.mfeesw.net/dpc/mdc/16-2/438-2>.
- 3 Shimazaki S. Tokyo rule. *Nihon Byoin Kaishi*. 2011; 58: 576–8.
- 4 Shimazaki J, Tasaki O, Shiozaki T *et al*. The nationwide survey of patients admitted to Emergency Medical System Centers in Japan. *JJAAM*. 2011; 22: 793–802.
- 5 Ministry of Health, Labour and Welfare. Medical fee for specific admission. [Accessed 30 Jan 2012]. Available from: http://www.mhlw.go.jp/topics/2008/03/dl/tp0305-1d_0004.pdf.
- 6 Kimura A. Logistic regression models for Japanese blunt trauma victims. *JJAST*. 2010; 24: 321–6.

APPENDIX

*1 JAPAN TRAUMA DATA BANK

JAPAN TRAUMA DATA Bank is a trauma registry system that was established in 2003 by the Japanese Association for the Surgery of Trauma (Trauma Registry Committee) and the Japanese Association for Acute Medicine (Committee for Clinical Care Evaluation) for the purpose of collecting and analyzing trauma patient data in Japan. In 2013, 234 Japanese major hospitals participated in the system.

*2 TERTIARY MEDICAL CENTER/LEVEL 2 HOSPITAL IN JAPAN

IN JAPAN, HOSPITALS are categorized into three levels of emergency care. Primary emergency care is for mildly ill patients who can go home. Level 2 hospitals/facilities are for patients with moderately ill/injured patients who require admission to the general ward. Tertiary medical centers are for severely ill/injured patients who require admission to the intensive care unit.