The Present Status of Casualty Care in Japan and The Role of Anesthesiologists

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(Key words: "Kyumei-kyukyu" (casualty critical care) Centers, medical economy, protease inhibitors, transfusion and infusates, anesthetic techniques)

This paper is an introduction of the present status of casualty care in Japan and the role of anesthesiologists. These data were based on our inquiries to the network of casualty critical care "Kyumei-Kyukyu" centers, all over Japan. This network system has been established on financial support by the Ministry of Health to cover regional areas on the thirtial critical care since 1970s. They are numerated to 102 institutes in 1989.

I. Statistical analysis of trauma care in Japan

In a general survey of trauma in Japan, based on published data by the Ministry of Health[1], a total of 527,600 cases of various causes of trauma were treated and 120,700 of them, 22.9%, were hospitalized in 1984 (table 1).

The whole cases included minor trauma such as those of laceration of skin, bruise and broken teeth. Naturally, the more grave the trauma, the higher hospitalization rates were observed.

In 1986, 57,825 cases died by trauma and/or accident, while 39.5 percent of them died in hospital, the rest died before hospitalization (table 2).

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Majority of the patients were found dead by suffocation and drowning, occuping 37.1 percent of the total death by casualties. The highest mortalities in hospitalized cases were brain and/or spinal injuries, thorax and abdominal ones and multiple fractures, in respective order.

The survey on the causes of death in table 3 are as follows; in various accidents including falls and during sports, 32,561 died out of 226,700 cases. Due to traffic accidents 13,588 were killed and 96 thousand were injured.

By occupational accidents, 5,921 died out of 55,000. The rates of death in these three accidents were same, and more than half of them died in hospital.

On the contrary, majority of the cases of suicide and victims of murder found dead were not hospitalized, and the number of survivors obscured as well.

Refering to the major triad causes of death in various age group, accidents occupied the primary position upto 24 years old (table 4). Suicide was the second major cause of death in age group between 15 and 24 years. In the age range of 25 to 29, suicide became the primary cause followed by accident. Over the age of 30, neoplasm became the primary cause of death followed by suicide and accident. Over the age of 45, the numbers of suicide and accident were not reduced but both were withdrawn from the major triad causes of death.

The total death rate in Japan was reduced to a quarter in 1955 from the

Table 1. Patients treated for trauma in a year (1984)
Total cases 527,600

Classification	① Whole cases	② Hospitalized	Ratios of hospitalized
Soft tissue injury	171,000	23,300	13.6%
Fx. of extremities	109,800	47,300	43.1%
Laceration & broken teeth	101,800	6,500	6.4%
Fx. of the skull	35,400	17,800	50.3%
Brain/spinal injury	19,800	10,900	55.0%
Burn	17,300	1,900	11.0%
Foreign body	6,700	300	4.5%
Others	65,800	11,700	17.8%
Total	527,600	120,700	22.9%

Table 2. Death by casualties in a year (1986)

Causes	① Death	② Hospitalized	Ratios of hospitalized
Fx. of skull	6,063	2,850	47.0%
Brain/spinal injury	7,311	5,858	80.1%
Thorax & abdominal injury	4,281	2,873	67.1%
Burn	2,541	755	29.7%
Suffocation	15,443	1,527	9.9%
Drowning	6,024	874	14.5%
Multiple Fxs.	2,963	1,682	56.8%
Others	13,181	6,449	48.9%
Total	57,825	22,868	39.5%

Table 3. Causes of trauma in a year (1986)

Causes	Total cases	Total No. of death (Death rate to total cases)	Death in hospital (Death rate in hospital)
Accident (includes Falls)	183,400 } 226,700	32,561 (14.4%)	19,881 (61.0%)
sports	43,300 }		
Traffic accident	109,600	13,588 (12.4%)	9,198 (67.7%)
Occupational accident	55,000	5,921 (10.8%)	3,335 (56.3%)
Suicide	8,200	25,667	4,852 (18.9%)
Murder	—	1,029	291 (28.3%)

Table 4. Main causes of death rates in ages (per 100,000)

Ages	I	II	III
0–4	Accident (16.7)	Cong. Abonormality	Neoplasm
5–9	Accident (8.6)	Neoplasm	Cong. Abnormality
10–14	Accident (4.1)	Neoplasm	Heart Failure
15–19	Accident (25.2)	Suicide (5.1)	Neoplasm
20–24	Accident (20.8)	Suicide (14.4)	Neoplasm
25–29	Suicide (16.8)	Accident (14.0)	Neoplasm
30–34	Neoplasm (16.9)	Suicide (16.6)	Accident (1.18)
35–39	Neoplasm (30.3)	Suicide (18.0)	Accident (13.0)
40–44	Neoplasm (54.8)	Suicide (25.1)	Heart Failure
45–49	Neoplasm (93.2)	Heart Failure	CVA
50–54	Neoplasm (170.8)	CVA	Heart Failure

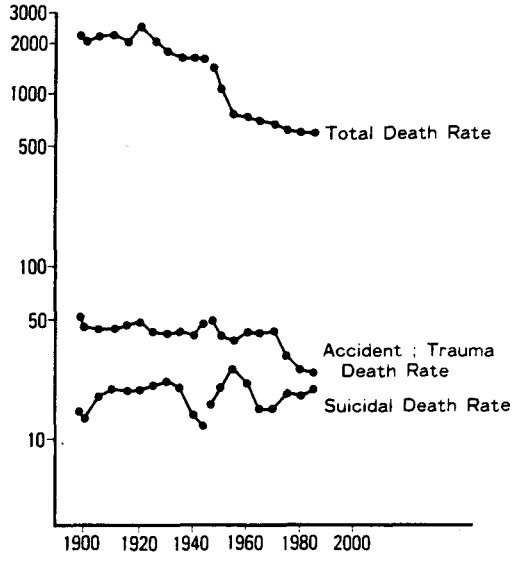

Fig. 1. Trends of death rates (Per population of 100,000) in Japan

peak in 1925 on a chronological survey as illustrated in the figure 1.

The death rate due to trauma, however, was not changed by 1970 until the network of casualty critical care centers became well organized. The death rate was reduced to half in 1985.

Regarding suicide, the death rate, however, remained almost the same for the last 90 years.

II. An introduction of the network of casualty critical care centers in Japan

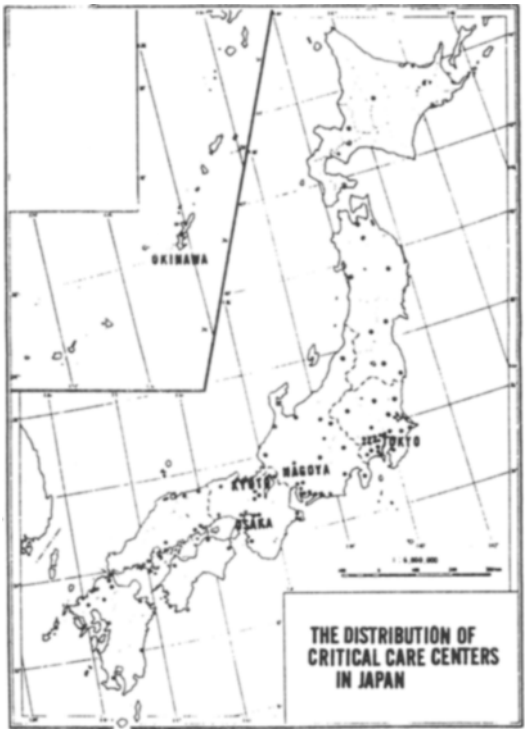

Fig. 2.

Since 1970s, the network of 102 casualty critical care centers, supported by the Ministry of Health, has been established to cover all parts of Japan as illustrated on the map (fig. 2). In addition to them, some 60 medical school hospitals are associated

Table 5. Equipments in overall critical care centers

I.	Over 81% equipped ECG, BP-monitor, Blood gas analyser, Electrolytes analyser, Portable X-P, Echocardiograph, Hemodializer, DC-defibrillator, Fiberscope, Anesthesia machine.
II.	61–80% equipped C.O. computer, Resp. monitor, ICP monitor, Bed scale, CT-Scan X-p, Cine-angio X-P, Plasma exchanger, IABP, Auto-hypothermia, EEG, Osmometer, Emergency bioch-lab.
III.	41–60% equipped Core-temp. monitor, CO-Oxygen-meter, Exp. CO_2-monitor, Clotting analyser, ABR (Evoked EEG) monitor.
IV.	Less than 40% equipped $\dot{V}_{O_2}$-meter, Auto-urimeter, Lactate-meter, Drug analyser, Power spectrum EEG, R.I. stethoscope, Hyperbaric oxygen chamber, Clini-system (for burns), Medispect.

Table 6. Kinds of respirators in critical care centers

Kinds / Numbers	Siemens servo	Engstroem	Bennett MA	Bear	Others
0	16.7%	77.7%	40.7%	79.6%	20.4%
1	11.0%	18.5%	18.5%	9.3%	7.4%
2	18.5%	1.9%	11.0%	3.7%	7.4%
3	13.0%	—	7.4%	—	9.3%
4	13.0%	—	1.9%	1.9%	13.0%
5	7.4%	1.9%	—	1.9%	7.4%
6 & Over	16.8%	—	20.0%	3.6%	35.1%

to the network.

On average, each center has 32.6 ± 17.6 beds, with a maximum of one hundred, and 548 ± 654, a maximum of 2,500 cases of trauma have been treated yearly by 10.9 ± 15.7, a maximum of 76 doctors.

These centers are affiliated to major hospitals but their organizations are independent. Therefore, the facilities and medical equipments are not consistent.

Upon our inquiry to all centers about their equipments, authors have graded them arbitrary into four groups as shown on the table 5.

The first group includes the minimum requirements that all centers should be equipped with.

The second one is the essentials required for critical care, with which more than 61% of centers are equipped. The third one is preferentially equipped and the last one is fully facilitated.

Apart from authors' grading point, each center is unevenly equipped in detail items; clotting analyser, auditory evoked and power spectrum EEG monitor are essentials, however, these are available in less than 60% of the centers.

It is noteworthy that many centers are not equipped with a lactate analyser which should belong to the first group as well as an osmometer and EEG. This indicates that blood lactate is not enough regarded as an important index to treat shocked patients by many clinicians in Japan.

The number of respirators in each center are 11.6 ± 4.1 in average, with a maximum of 27. One sixth of them has less than six

Table 7A. Scoring of clinical signs, symptoms and laboratory data

Items \ Score	0	1	2	3
Systolic blood pressure (BP, mmHg)	$100 \leqq BP$	$80 \leqq BP < 100$	$60 \leqq BP < 80$	$BP < 60$
Pulse Rate (PR, $r \cdot min^{-1}$)	$PR \leqq 100$	$100 < PR \leqq 120$	$120 < PR \leqq 140$	$140 < PR$
Base excess (BE, $mEq \cdot l^{-1}$)	$-5 \leqq BE \leqq +5$	$\pm 5 < BE \leqq +10$	$\pm 10 < BE \leqq +15$	$\pm 15 < BE$
Urinary output (UO, $ml \cdot h^{-1}$)	$50 \leqq UO$	$25 \leqq UO < 50$	$0 < UO < 25$	$UO = 0$
Mental State	Alert	Restlessness	Apathy	Comatosc

respirators, while some centers have more than 21.

Concerning the types of respirators, there are various kinds including Japanese makes (table 6). Among them, the most widely available is expensive Siemens servo and Bennett MA the next.

Respiratory care in each center is the share responsibility half and half by anesthesiologists and other physicians.

III. The role of anesthesiologists in casualty care in Japan

On medical economy[1], for the 677,383 cases of trauma treated in 1985, the total expenses amounted to 920 million US dollars. Surgery was performed on 190,198 cases and surgical fees were charged to 100 million US dollars, along with an anesthesia fee of 10 million US dollars.

Thus, anesthesia fees occupy just one percent of the total expenses. This indicates that very little attention has been paid to the anesthesiologist's work in casualty care, though their activities are extensive.

In authors' survey, the average number of house anesthesiologists in each center is 1.5 ± 2.2, with a maximum of 10. Beyond the shortage of man power, they participate actively on the care of trauma as well as all kinds of CPR in more than half of the centers. In 5.6% of the centers, anesthesiologists have been responsible for primary care.

In a quarter of the centers, however, anesthesiologists' work was limited to administer anesthesia only.

Table 7B. Shock scores of various types of shock

Shock	Total	Alive	Died
Hemorrhagic	(21) 8.3 ± 0.6	(15) 8.2 ± 0.7	(6) 8.5 ± 1.0
Septicemic	(21) 7.9 ± 0.5	(8) 6.5 ± 0.5*	(13) 8.8 ± 0.6*
Cardiogenic	(12) 7.8 ± 0.6	(5) 8.6 ± 0.8	(7) 7.1 ± 0.9
Others	(8) 7.5 ± 1.0	(7) 6.6 ± 0.9	(1) 11.0

*: $P < 0.05$

In smaller centers, because of shortage of anesthesiologists, full coverage of even respiratory care has to be shared by other physicians as mentioned before.

Regarding the respiratory management for thoracic trauma or frail chest, 60% of them are treated with unilateral lung ventilation with bronchocath and/or application of HFV by anesthesiologists, and the rest is managed by a conventional method.

IV. Specific trends in trauma care in Japan

There are some defferences in the treatment of the trauma in Japan from other countries.

Firstly, evaluation of the patient's physical status in casualty, Ogawa's scoring system[2] as shown in the table 7A has been widely accepted. This scoring system is easily checked even by medical students,

Table 8. Comparative effects of protease inhibitors

	Ulinastatin	Aprotinin	Gabexate	Nafamstat
Trypsin	◎	◎	◎	◎
α-chymotrypsin	◎	◎	×	×
Pancreatic elastase	△	○	△	×
Enterokinase	△	△	△	–
Kallikrein	×	◎	×	△
Thrombin	×	△	◎	○
Plasmin	△	◎	△	△
Urokinase	×	△	◎	–
Complement ($C1_r^-$)	×	×	×	○
Complement ($C1_s^-$)	×	×	×	◎
Lipase	○	×	×	×
Phospholipase A_2	×	×	×	×
Hyaluronidase	○	×	×	–
Leukocyte elastase	◎	△	×	–
Leukocyte cathepsin G	○	◎	×	–
Leukocyte collagenase	○	○	○	–

	Aprotinin & Ulinastatin ($\mu \cdot ml^{-1}$)	Gabexate ($\mu g \cdot ml^{-1}$)	Nafamstat ($\mu g \cdot ml^{-1}$)
◎	~ 10	~ 1.0	~ 0.1
○	~ 100	~ 10	~ 1.0
△	~ 3000	~ 100	~ 10
×	3000 ~	100 ~	10 ~

and reflects the patient's condition as well.

It consists of five variables; systolic blood pressure, pulse rate, base excess, hourly urinary output and consciousness. On each variable, four grades from zero to three are rated. Thus, the patient's condition is scored in range of zero to 15 points.

The table 7B presents his scoring system being applied to various kinds of shock in authors' hospital. The scored points per se can not tell the prognosis as Baker's ISS[3] (Injury Severity Score) can, however, over six points indicates the critical situations.

Secondly, on evaluation of the impaired consciousness Ohta's nine grade scoring scale[10] has been more popularly accepted by neurosurgeons than the Glasgow coma scale, even if the latter has been widely applied in ICU.

Thirdly, various kinds of protease inhibitors, such as those of ulinastatin, aprotinin, gabexate mesilate and nafamstat have been widely used in the treatment of shock in Japan.

It is well known that the variety of signs and symptoms of shock is induced by activated proteases.

The table 8 exhibits comparative potencies[4] of these inhibitors on various kinds of proteases. Based on this data, one can find that gabexate mesilate is superior to heparin as an anticoagulant when antithrombin III is decreased. Actually, it is applied in hemodialysis instead of heparin because of its transient action and to avoid unpleasant use of protamine sulfate.

Aprotinin and ulinastatin have simillar effects and potencies. Nafamstat mesilate is more potent than gabexate to prevent a triggered activation of a classical pathway of complement cascade in shock.

None of them are effective to inhibit activation of phospholipase A_2, however, corticosteroid is able to cover this. Experimen-

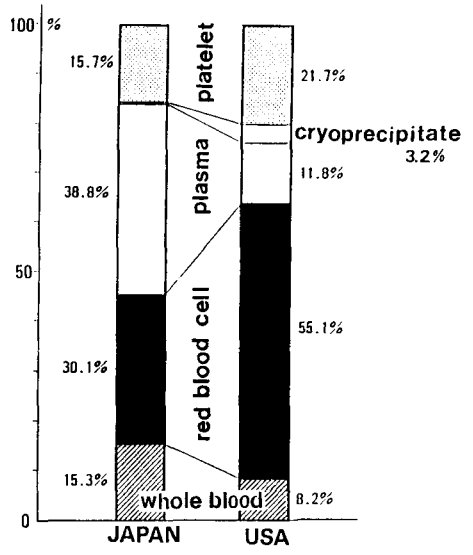

Fig. 3A. Difference of usages in whole blood and various blood components between Japan and USA (1983)

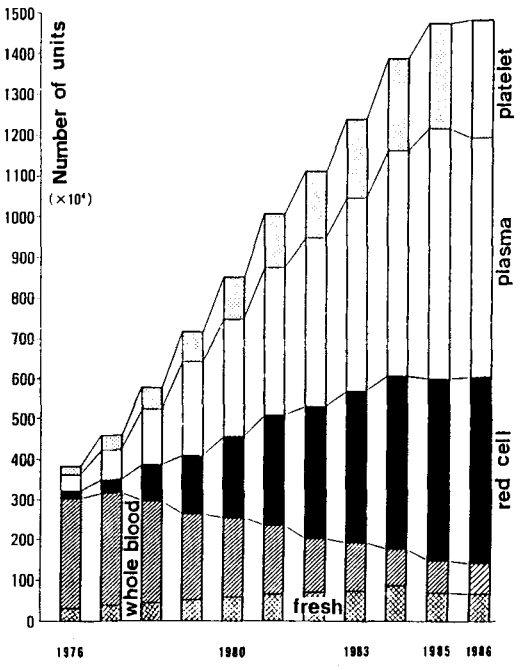

Fig. 3B. Changes of transfused whole blood and various blood components in Japan

tally a weak inhibitory action on it has been reported in clinical doses of nafamstat[12]. Therefore, clinically their use in combination is more effective.

Fourthly, a difference in the use of plasma expanders and blood transfusions is observed in Japan compared to other countries. Regarding the use of whole blood and blood components compared to the USA, a large difference was observed in 1983 especially in the use of plasma and packed erythrocytes[5] (fig. 3A&B).

In Japan, whole blood and its components production have relied on voluntary donors.

On chronological survey of the following supplies on the figure 3B, the use of plasma, albumin and fresh frozen plasma rapidly increased compared to the use of packed erythrocytes by 1983. Consequently, the import of plasma from other countries in the world increased to occupy one third of all blood component production on the earth.

In 1983, the guideline for the usage of blood components was issued by the Ministry of Health, since then the use of packed erythrocytes rapidly increased, and more plasma became available to use for other therapy. Consequently the import of albumin products has been markedly reduced.

This trend to use blood components is also seen in the primary transfusions for casualties, and 77.7% of the centers are using packed erythrocytes.

But whole blood is preserved for massive blood transfusions to treat hemorrhagic shock in 16.7% of the centers with or without supplement of FFP.

Using the plasma expanders in casualties, albumin is own priority. A 6% lower DS (degree of saturation of hydroxyethyl radicals on starch) of HES being manufactured only in Japan, which has some similarity to low molecular weight dextran, has been used more than the latter. They are used not only alone but also supplemented with albumin. Neither high molecular weight dextran nor higher DS of HES is used.

Fifthly, authors should refer to the difference in the use of nutrients.

In hyperdynamic flow state caused by trauma, a high calorie supply is mandatory.

Table 9. Method of anesthesia for trauma

	Emergency surgery	Shocked cases
NLA	16.7%	31.5%
Modified NLA	31.5%	40.7%
GOF	3.7%	—
GOĒ	14.8%	7.4%
Epidural	1.9%	1.9%
Ketamine	1.9%	3.7%
Not specific	27.8%	11.1%

For this purpose glucose is mainly used with or without supplement of fat emulsion. In this use of fat with glucose, a carolimetry based on the R.Q. ratio is preferable to keep it close to 1.0.

As it is well known that glucose tolerance is suppressed by trauma and postoperative condition, some physicians adopt to use fructose and xylitol in combination with glucose.

But many controversy over the use of them have existed for a long time, they have been considered to be rather detrimental by Burch and others[6].

On the contrary, some[7] believe that they help in the metabolism of glucose avert from hyperglycemia.

A combination of glucose, fructose and xylitol, named GFX is reported to reduce negative nitrogen balance postoperatively more effectively than glucose alone[11].

Concerning the use of amino acids, a balanced composition of enriched with branched chain amino acids (BBCA) is widely accepted in combination with a conventional one in 42.6% of the centers.

Since Fishers and others[8] revolutionally challenged the use of this composition of amino acid for treatment of critical care in late 1970s, its use has deserved of the first choice on the liver failure. And it is used in 5.6% of the centers for this purpose.

On multiple organ failures evoked by shock, neither glucose nor lipid can be metabolized as an essential substrate but branched chain amino acid can. Both glucose and glucogenic amino-acid increased lactate production in shock according to Ozawa's experiments[9].

Sixthly, authors will refer to anesthetic techniques used in surgery of trauma.

As isoflurane is not yet available in Japanese market, enflurane has been used as the major inhalation anesthetic.

In emergency surgery of trauma, intravenous anesthesia by conventional neurolept anesthesia (NLA) and its modification has been widely adopted (table 9). In shock cases, this trend is mainly chosen.

A modified neurolept anesthesia consists of a combination of minor tranquilizer, diazepam or fluorazepam and so on, and analgesics as those of morphine, pentazocine or buprenorphine instead of conventional combination of droperidol and fentanyl. These modified NLAs have the advantages of stabilizating the circulation and the quick recovery compared to the conventional neurolept anesthesia.

An epidural anesthesia supplemented by light sedation has been widely accepted for elective general surgeries, except emergencies, in Japan.

Lastly, brain protection using barbiturate after resuscitation has been controversial, and also on its applications.

Majority use it occasionaly, and minority use it routinely but others totally abolish its use.

Monitoring of intra- cerebral- pressure (ICP), together with maintenance of brain circulation assisted with dopamine during protection by barbiturate has been widely accepted.

Use of calcium entry blockers has not been established yet, however, it seems that the choice of blockers is important, because there exists a big difference in specific activities among them.

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