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Introduction of A Unique Medical Co-Operative System for Decompression Sickness in Izu Peninsula

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Original Research Article

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Abstract: We describe our attempts to form a co-operative system for patients with decompression illness (DCI). We selected the narrative method concerning the distribution of fire departments, medical control systems, the coast guard, diving shops, physician-staffed emergency helicopters (HEMS) in eastern Shizuoka; the time trend in DCI patients transported by HEMS and described our attempts to form a co-operative system for patients with DCI. In 2011, we began to hold meetings concerning how to manage patients with DCI in our hospital. As a result, all representatives of these organizations joined the meeting. This meeting has been regularly held once a year since 2011. In this meeting, we hold lectures concerning new topics of DCI, review the management of patients with DCI at the scene using videos, discuss how to share information on the diving profile using a diving check list, and review the proper, prompt management of patients with DCI. This report describes a unique medical co-operative system to cooperate in preparation for managing patients with DCI with a mutual understanding of how to improve the outcomes of patients with DCI.
Keywords: Izu; decompression illness; helicopter; medical control.

INTRODUCTION

Emergency medical services (EMS) are provided by the fire defense headquarters of local governments in Japan. The EMS system is single-tiered, with ambulances staffed by three crew members trained in rescue, stabilization, transport, and advanced care of traumatic and medical emergencies.

There are three levels of care provided by ambulance personnel, including a basic-level ambulance crew (First Aid Class One), a second level (Standard First Aid Class), and the highest level (Emergency Life-saving Technicians, ELSTs). ELSTs are trained in all aspects of basic life support (BLS) and some advanced life support (ALS) procedures relevant to pre-hospital emergency care, such as tracheal intubation, securing a route, and the administration of adrenalin for patients with cardiac arrest after receiving orders from physicians [1]. However, there are no physicians in the fire department. As a result, each local government establishes a medical control council (MC) consisting of members of the Japanese Medical Association, acute critical care hospitals and the fire department to develop a command system. In this way, ELSTs can receive direct orders from physicians via cellular phone whenever they need. In addition, the MC can check on the activity of the ELSTs, plan and change prehospital protocols (guidelines for the activity of the ELSTs), correct the activity of the ELSTs if they do not follow the protocol, and help ELSTs maintain their skills in a hospital in order to ensure a high quality of care.

Izu Peninsula is a popular recreational scuba area located near Tokyo (Figure 1). For patients with decompression illness (DCI), search and rescue is mainly conducted by professional divers belonging to local dive shops and/or the coast guard. After reaching shore, transportation is overseen by the fire department and physician-staffed helicopters (HEMS) in order to transport patients to a hospital for recompression treatment; the helicopter is necessary for such cases because there are no suitable hospitals on the Izu Peninsula[2,3]. However, these organizations operate outside of the regular MC system. In addition, there have been few reports concerning the prehospital management of patients with DCI.

We herein report our attempts to form a co-operative system for managing patients with DCI.

METHODS

This review was approved by the review board of Juntendo Shizuoka Hospital, and the examinations were conducted according to the standards of good clinical practice and the Declaration of Helsinki.

We selected the narrative method concerning the distribution of fire departments, medical control systems, the coast guard, diving shops, HEMS in eastern Shizuoka; the time trend in DCI patients transported by HEMS and described our attempts to form a co-operative system for patients with DCI. .

RESULTS

Eastern Shizuoka has six fire departments: Fuji-Fujinomiya, Gotenba-Oyama, Fujisan Nanoto, Atami, Sunoto Izu and Shimoda. Among them, Atami, Sunto Izu and Shimoda have jurisdiction over shores. The MC system of eastern Shizuoka comprises Fuji, Sunto Tagata, Atami-Ito and Kamo; this distribution is not the same as that of the fire departments (Figure 2) and can be attributed to irregular mergers of local fire departments. Accordingly, reviewing the activity of ELSTs can be complicated. Furthermore, two coast guards control the Izu peninsula: one at Shimoda and the other at Shimizu (Tagonoura is part of Shimizu). There are also many diving shops that are managed by professional divers (Figure 3).

From March 2004, the HEMS began transporting patients with a severe condition, including DCI, from Izu Peninsula to emergency and critical care centers. Our hospital has, which has a HEMS landing pad, has an emergency and critical care center but no large recompression medical equipment for treating DCI. As a result, patients who might have DCI after diving must be transported via HEMS to a medical facility with large recompression equipment. DCI patients encountered on the eastern shore are mainly transported to Tokai University Hospital, while those encountered on the western shore are mainly transported to Shizuoka Saiseikai Hospital (Figure 4). The HEMS can transport patients in 15-20 minutes, while a ground ambulance would take at least 1.5 h to reach the receiving hospitals.

From 2004 to 2017, 119 DCI patients were transported by the HEMS and average was 8.5 per year. The patients were transported via HEMS flying less than 300 m high with the administration of oxygen and fluids. All patients arrived safely at the receiving hospital for re-compression treatment without significant deterioration of their symptoms and signs[2,3]. All cases of DCI were induced by recreational scuba diving (Figure 5). The trend in the occurrence of patients with DCI did not change over time.

In 2011, we began to hold meetings concerning how to manage patients with DCI in our hospital because there is no established medical control council concerning DCI patients. As a result, all representatives of these organizations as fire departments, coast guard and professional divers belonging to local dive shops on the Izu Peninsula joined the meeting. This meeting has been regularly held once a year since 2011. In this meeting, we hold lectures concerning new topics of DCI, review the management of patients with DCI at the scene using videos, discuss how to recognize DCI and share information on the diving profile using a diving check list (Table 1), and review the proper, prompt management of patients with DCI, including their early transportation.

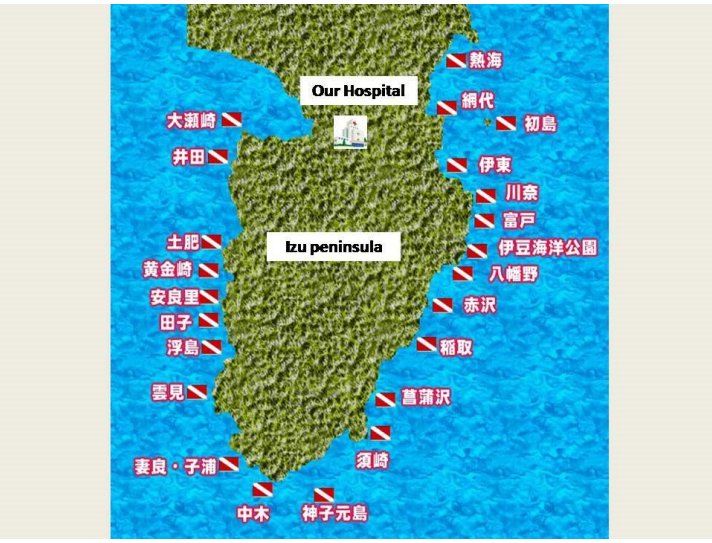

Fig-1: Diving spots on the Izu Penisula. Izu Peninsula is a very popular recreational scuba area, and there are many diving spots. Our hospital is located on the Izu peninsula

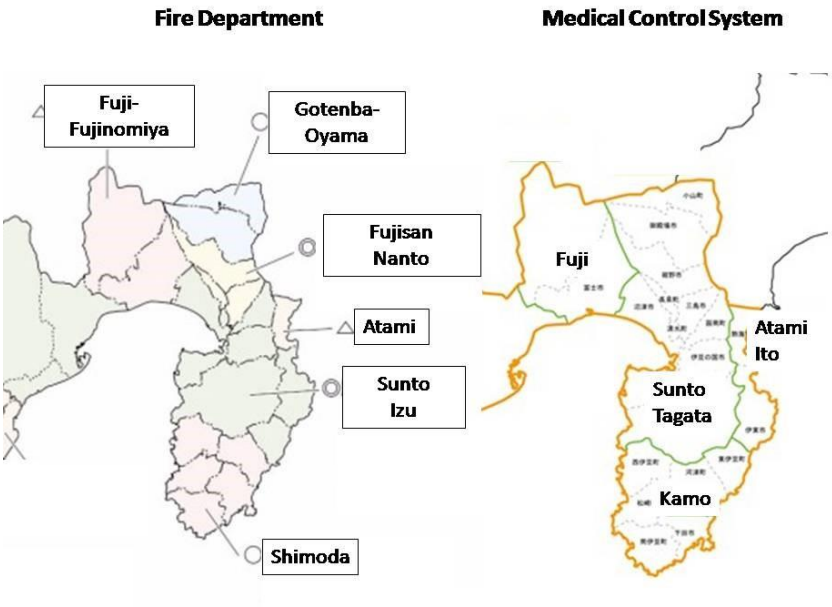

Fig-2: Distribution of fire departments and medical control councils in eastern Shizuoka. Eastern Shizuoka has six fire departments: Fuji-Fujinomiya, Gotenba-Oyama, Fujisan Nanoto, Atami, Sunoto Izu and Shimoda. Among them, Atami, Sunto Izu and Shimoda have jurisdiction over shores. The MC system of eastern Shizuoka comprises Fuji, Sunto Tagata, Atami-Ito and Kamo; this distribution is not the same as that of the fire departments

Fig-3: Distribution of coast guard stations and dive shops on the Izu Peninsula Two coast guards control the Izu peninsula: one at Shimoda and the other at Shimzu. There are also many diving shops that are managed by professional divers

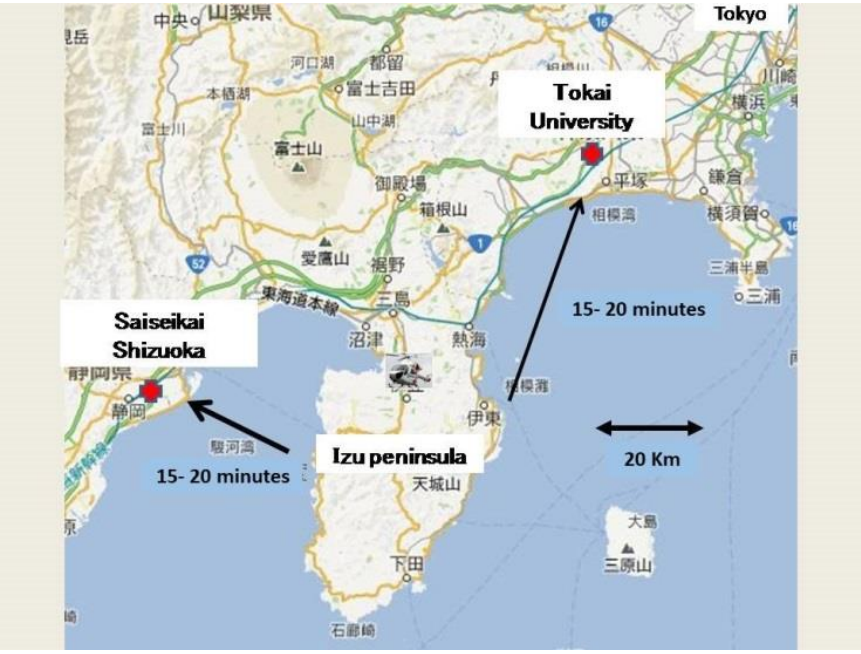

Fig-4: System wherein a helicopter picks up patients who might have decompression illness (DCI) after diving and transports them to a medical facility with large recompression equipment. DCI patients encountered on the eastern shore are mainly transported to Tokai University Hospital, while those encountered on the western shore are mainly transported to Shizuoka Saiseikai Hospital

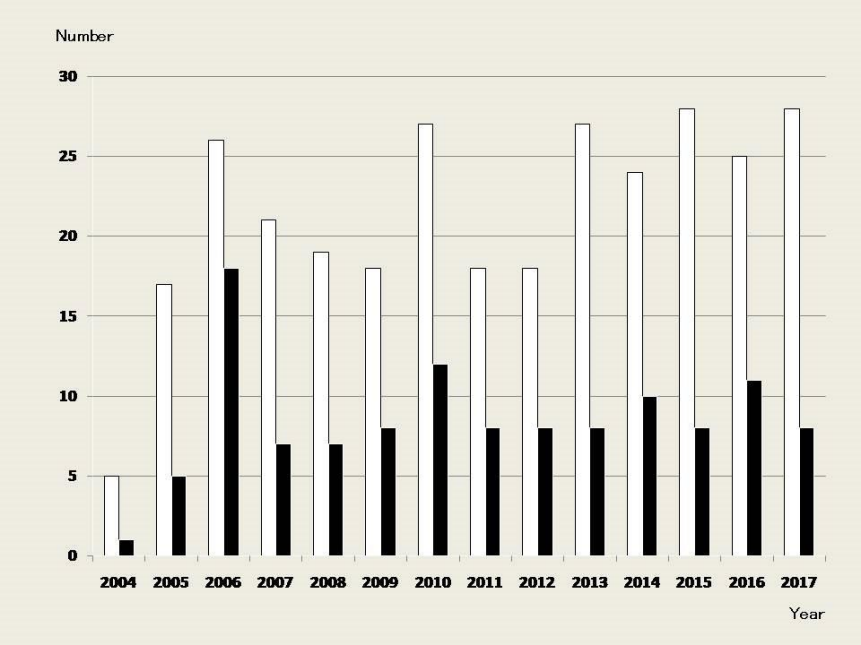

Fig-5: Time trend in the number of patients with sea accidents (white column) and decompression illness (black column) transported by a physician-staffed helicopter. From 2004 to 2017, 119 patients were transported by the HEMS, an average of 8.5 per year. The trend in the occurrence of patients with decompression illness did not change

Table-1: Diving check list

Name ____	
Sex male / female	
Age years old	
Birth day	
Telephone number ( )	
Dive shop representative ____	
Diving start time :	
Diving finish time :	
How many dives have you performed today?	
Diving time in total in today :	
Maximum depth of dive m	
Average depth of dive m	
How many dives have you performed in your entire life? Times	
Condition during ascent	
	No problems
	Sudden ascent without decompression
	Breath held
Sleeping time hours last night	
Did you drink alcohol yesterday? yes / no	
Time of last meal :	
Accompanying person's name ____	
Medical history ____	
Medication ____	
Symptoms ____	
Consciousness clear / unconscious	
Respiration present / absent	
Chest compressions yes / no	
Artificial respiration yes / no	
Oxygenation yes / no	
Automated external defibrillation performed yes / no	

DISCUSSION

This is the first report on the introduction of a new medical co-operative system for patients with DCI on the Izu Peninsula.

The mainstay of treatment of DCI remains hyperbaric therapy, which should be initiated as soon as possible. Estrada *et al*. recently reported a 46-year-old man with shortness of breath and chest pain following an uneventful 4-h SCUBA dive at 100 feet who was transported to a tertiary medical care center [4]. He was diagnosed with DCI based on multiple gas bubbles in his trunk on computed tomography and was subsequently transported to another hospital for recompression treatment by a ground ambulance 7 h after surfacing. However within 24 h, the patient was found to have multiple organ failure, diffuse cerebral edema, and brain death. Based on this unfortunate case, the authors insisted on the importance of the early recognition of DCI by EMS personnel and the appropriate consideration of ground versus flight transportation to the nearest hyperbaric center for such patients. The coordinated and combined use of public servants and civilian resources in response to cases of DCI is beneficial may help reduce patient suffering. All of the participants in our meetings cooperate in preparation for managing patients with DCI with a mutual understanding of how to improve the outcomes of patients with DCI.

One limitation associated with this report is that we were unable to analyze the final outcomes of patients with DCI; we were therefore unable to evaluate whether or not our attempts helped improve the outcome of patients with DCI. Accordingly, we plan to invite members of the receiving hospitals that perform recompression treatment to our meetings in the near future in order to evaluate the final outcomes of patients with DCI.

CONCLUSION

This report describes a unique medical co-operative system established through meetings concerning the management of patients with DCI on the Izu Peninsula in eastern Shizuoka Prefecture in Japan. All of the participants in the meetings cooperate in preparation for managing patients with DCI with a mutual understanding of how to improve the outcomes of patients with DCI.

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