

## Brief Communication

# A system of delivering medical staff members by helicopter to manage severely wounded patients in an area where medical resources are limited

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**Aim:** We review the case of a severely injured patient to evaluate the system of delivering medical staff by helicopter in areas with limited medical resources.

**Methods:** The patient's chart was reviewed, summarized, and presented.

**Results:** A 22-year-old woman attempted a suicidal fall after using a knife to stab herself. She was transported to a local hospital. A radiological study revealed fractures to the patient's face and the base of her skull, pneumocephalus, traumatic subarachnoid hemorrhage, stab wounds to the neck and chest, pneumothorax, unstable pelvic fracture, and right femoral shaft fracture. Her circulation status became unstable. We sent medical staff members to the local hospital by doctor helicopter. The patient underwent tracheal intubation and the insertion of a chest drain, and was evacuated by doctor helicopter. After aggressive intensive treatments in our hospital, the patient finally obtained social rehabilitation.

**Conclusion:** In an area where medical resources are limited, sending trained physicians to a referring hospital to appropriately prepare a severely wounded patient for transportation might be the key for the patient to maximize his or her chance of survival.

**Key words:** Doctor helicopter, medical resource, prehospital, shock, trauma

## INTRODUCTION

THE AVERAGE NUMBER of physicians per 1000 population in Shizuoka Prefecture was 1.93 in 2012, the fifth lowest among the 47 prefectures of Japan (Report from Ministry of Health, Labor and Welfare in Heisei 24).<sup>1</sup> Medical resources, including physicians, are unevenly distributed, predominantly in the western and central areas.

A physician-staffed helicopter emergency medical service (termed doctor helicopter [DH] in Japan) was introduced in western Shizuoka in 2001. In March 2004, a service was introduced in eastern Shizuoka. Two helicopters cover the whole prefecture, with an arrival time of within 20 min. Our facility (Juntendo University Shizuoka Hospital, Izunokuni,

Japan) serves as the base hospital and is responsible for eastern Shizuoka (population of approximately 1,100,000). With the inclusion of Izu Peninsula,<sup>2</sup> the combined area is approximately 4,090 km<sup>2</sup> and the terrain is mountainous; only a few hospitals serve approximately 250,000 people. The journey from the southern tip of the peninsula to the critical care medical center of our hospital takes 1.5 h by ambulance but only 15 min by helicopter.<sup>2</sup> We herein introduce the case of a severely injured patient who obtained social rehabilitation after the delivery of medical staff members to a local hospital by DH.

## CASE

A 22-YEAR-OLD FEMALE, who became depressive because she suffered from chronic myelogenous leukemia, attempted a suicidal fall from the fourth or fifth floor of a building after using a knife to stab herself in the chest and neck early in the morning. She was found unconscious on the road by a passerby and an emergency medical technician transported her, under triage, to a nearby local

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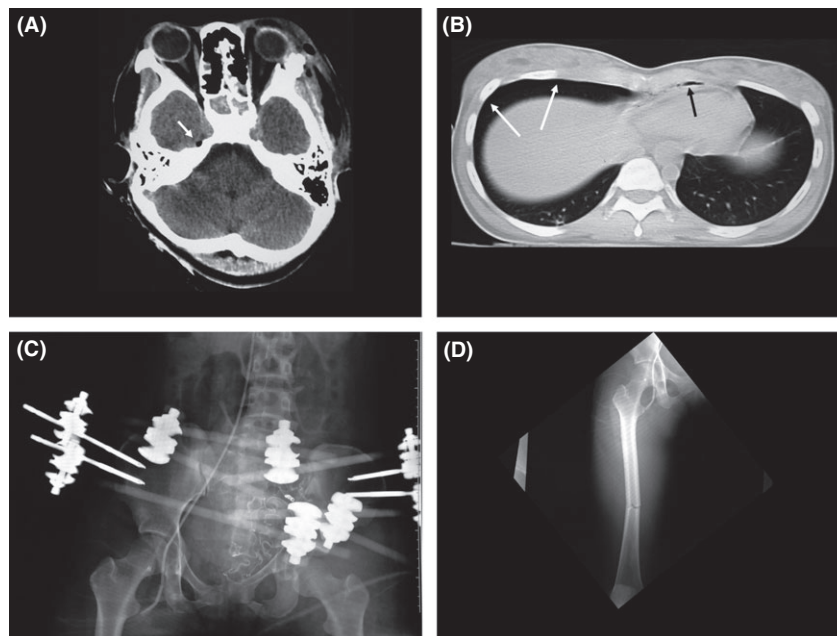
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hospital at 11:35. At the local hospital, a radiological study revealed fractures to the patient's face and the base of her skull, pneumocephalus, traumatic subarachnoid hemorrhage, stab wounds to the neck and chest, pneumothorax, unstable pelvic fracture, and right femoral shaft fracture (Fig. 1). Her circulation status became unstable and the local hospital requested that she be transferred to our department at 12:15. The journey between the local hospital and our own would take approximately 1 h by ambulance, but only 7 min by DH. Tracheal intubation and the insertion of a chest drain were required for her to be transported by DH; however, there were no physicians with the skills required to carry out these procedures at the local hospital. Accordingly, we decided to send medical staff members (one trained physician and one nurse) to the local hospital by DH. The DH took off from our hospital at 12:38 and landed at a rendezvous point at 12:46. The DH can usually take off within a few minutes from the receipt of a dispatch call. The main cause of a delay in dispatching the DH was the time taken to share precise information about the patient's condition between the two hospitals and arrangements that were necessary to deliver medical staff members using ambulances belonging to local fire departments. As there was no heliport at the local hospital, the staff members were transported by the ambulance after landing at the rendezvous point. The two members of our DH medical staff arrived by ambulance at the local hospital at 12:53. When

the two staff members checked her, she was comatose and in a profound state of shock (heart rate was 130 b.p.m., her radial artery was impalpable, and SpO<sub>2</sub> was unmeasurable). She underwent tracheal intubation, the insertion of a chest drain and the attachment of a SAM Pelvic Sling (SAM Medical Products, Tualatin, USA). The ambulance carrying the patient escorted by the DH staff left the local hospital at 13:30 and arrived at the rendezvous point at 13:35. After transporting the patient from the ambulance to the DH, the DH took off from the rendezvous point at 13:44 and arrived at our hospital at 13:51. Our hospital staff members received information about the condition of the patient and her treatment, and were placed on standby to administer radical treatment.

Upon arrival, the patient had a total Glasgow Coma Scale score of 6, isocoric and reactive pupils, her blood pressure was 58/30 mmHg, her heart rate was 136 b.p.m., her respiratory rate was 40 breaths/min, and her body temperature was 38.8°C. A physical examination revealed bloody rhinorrhea, otorrhea, bleeding from mouth, deformity of the pelvis, and stab wounds to her neck and chest. The findings of an arterial blood gas analysis (FiO<sub>2</sub> 1.0) revealed a pH of 7.348, a PaCO<sub>2</sub> level of 22 mmHg, a PaO<sub>2</sub> level of 282 mmHg, an HCO<sub>3</sub><sup>-</sup> level of 13.3 mEq/L, BE -10.9 mEq/L, and a lactate level of 24 mg/dL. The major laboratory results on arrival were as follows: hemoglobin, 2.8 g/dL; platelet count,  $5.4 \times 10^4$ /L; aspartate



**Fig. 1.** Radiological imaging of a 22-year-old woman who attempted a suicidal fall after using a knife to stab herself. Radiological studies revealed pneumocephalus (A, white arrow), pneumothorax (B, white arrows), pneumomediastinum (B, black arrow), pelvic fracture (C, after initial treatment), and right femoral shaft fracture (D).

aminotransferase, 140 IU/L; alanine aminotransferase, 89 IU/L; prothrombin time (international normalized ratio), 1.83 s; and activated partial thromboplastin time, 69.8 s (control, 26.3 s). A massive transfusion with type O blood and plasma was carried out emergently, arterial embolization was undertaken by interventional radiology, gauze packing was carried out in the retroperitoneal space, the pelvis was externally fixated, and skeletal traction was applied to the femur shaft fracture. After obtaining stable circulation two days after being transferred to our hospital, tracheostomy, and internal fixation of the femur, pelvis, and face were undertaken on different days. The patient finally obtained social rehabilitation.

## DISCUSSION

**D**URING INTERHOSPITAL AIR evacuations where both the supplying and receiving hospitals have their own heliport, the DH staff typically undertake critical intervention to stabilize the patient's condition and ensure safe transportation to the receiving hospital. However, to our knowledge, this is the first instance of directly sending the DH staff from the rendezvous point to the receiving hospital, despite the supplying hospital not being affiliated with the receiving hospital.

We herein present the case of a severely injured patient, whose probability of survival (as calculated by the Trauma Injury Severity Score)<sup>3</sup> was 44%, who was successfully treated in an area with limited medical resources. "Successfully" in this case means that the patient obtained survival discharge. This is our first experience of sending a DH staff member to another medical facility that has no managerial relationship with our hospital to treat a severely injured patient.

We hypothesized that the first key to success was use of the DH to secure safe transportation. This is because the transfer by a mobile intensive care unit staffed by trained physicians imposes less risk to critically ill patients than a transfer by standard ambulance.<sup>4</sup> In addition, the benefits of DH include the highest level of prehospital medical care and transportation.<sup>5</sup> Andruszkow *et al.* reported that helicopter emergency medical services provided an independent survival benefit in multiple trauma patients over the course of a 10-year study in Germany.<sup>6</sup> Furthermore, Hannay *et al.* reported that patients who were transported to an urban trauma center by helicopter were more severely injured and required more interventions, but had improved survival in comparison to those who arrived by other means of transport.<sup>7</sup> Accordingly, in the present case, the use of DH might have led to a favorable outcome.

We hypothesized that the second key to success was the delivery of the trained medical staff members to the local hospital by DH. When interhospital air transport is required but no heliport is available at a hospital, a physician from the referring hospital typically escorts a patient to a rendezvous point. In the present case, there was no trained physician to manage the trauma patient at the referring hospital, who required tracheal intubation due to unconsciousness and unstable circulation, and a chest drain for pneumothorax. These procedures are fundamental skills,<sup>8,9</sup> but incomplete or inappropriate preparation for aeromedical evacuation can result in increased patient discomfort and, in the worst cases, potentially serious or insurmountable in-flight medical problems.<sup>10</sup> For this reason, we decided to send our trained physician to the referring hospital to appropriately prepare the patient for transportation and to maximize her chance of survival. In terms of transfer time, if this patient had been transferred by ambulance car at 12:15 without any intervention, excluding the possibility of death during transportation due to airway obstruction or hypoxia due to the deterioration of pneumothorax, she would have arrived at our hospital at 13:15. In contrast, our DH medical staff arrived at the local hospital at 12:53. Thus, definitive treatments concerning the airway and breathing could be undertaken at an earlier time than if the patient had been transported by ambulance.

Modern helicopter transport teams are equipped with advanced resuscitation measures such as blood products.<sup>11</sup> The patient had already received tranexamic acid at the local hospital. However, the local hospital had no blood products in stock, and the patient underwent a massive infusion without transfusion, leaving her severely anemic on arrival at our hospital. We elected to perform permissive hypotensive resuscitation when the DH staff arrived back at our hospital.<sup>12,13</sup> However, our helicopter also did not have blood products, or expensive prothrombin complex concentrates. The latter have not been approved for use in Japanese trauma patients by the national insurance system due to governmental medical expense controls that are in place due to Japan's super-aging society.<sup>14</sup> If the patient had undergone such treatments, her condition might have been better when she arrived at our hospital. In the future, we will try to be prepared to perform prehospital transfusions in the DH for patients with unstable hemorrhagic shock.

This patient could have been directly transferred to the tertiary care hospital if the emergency medical personnel had properly triaged this patient at the scene. According to Nakahara *et al.*'s report, injury characteristics (severe injuries, and head and pelvic injuries), patient characteristics (middle-aged and conscious), and the time of day (specifically, when patients were triaged at night) were predictive factors for

undertriage.<sup>15</sup> Pelvic fractures are particularly difficult to detect because the assessment of pelvic mobility requires skills and experience, and such assessments at the scene by experienced personnel are still unreliable.<sup>15,16</sup> The patient in the present case also had severe injuries, including pelvic fractures with unconsciousness. In addition, the chief emergency medical technician had not previously evaluated severe pelvic fractures. Moreover, the patient was a young woman; thus the emergency medical technicians were hesitant to expose her, which resulted in missing stab wounds to her chest, pelvic fractures, and a right thigh deformity in their visual examination. As a result, they treated her as patient who was unconscious due to an overdose or for other reasons who had a face contusion that had been caused by falling.

## CONCLUSION

**I**N AREAS WHERE medical resources are limited, sending trained physicians to a referring hospital to appropriately prepare a severely injured patient for transportation might be the key to maximizing the chance of patient survival.

## CONFLICT OF INTEREST

**N**ONE.

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