Case report

Rapid response doctor cars for cases of severe trauma in remote locations: A life saved owing to cooperation between a doctor car and a physician from a local medical facility

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Abstract

Objective: Rescuing severe trauma patients who are injured far from a trauma center is challenging for rural emergency systems. We report a severe trauma case that occurred at a remote location, in which the patient’s life was saved by a dispatched doctor car and a physician from a local medical facility.

Patient: A 31-year-old man experienced a left femur injury due to a fallen tree. The fire station requested a doctor car from our center, approximately 56 km away. Meanwhile, a paramedic team reported that the patient was in a state of shock. The doctor car docked over 1 h after the accident. Pressure hemostasis, rapid intravenous infusion, and tracheal intubation were performed en route. After arrival at our hospital, an emergency blood transfusion was administered; the injured blood vessel was sutured and the wound closed. On day 22, the patient was transferred to another hospital for rehabilitation.

Discussion: Rapid response-type doctor car is often considered ineffective for distant severe trauma cases. However, this case demonstrates the benefits of a doctor car working with local medical facilities.

Conclusion: The rapid response-type doctor car is effective even in remote severe trauma cases.

Key words: pre-hospital care, medical control, trauma, rural emergency system

Introduction

For rural emergency systems, rescuing severe trauma cases that occur in remote locations presents a complex challenge. Miyazaki Prefecture is a rural prefecture located in Southwest Japan, with an area of approximately 6700 km² and a population of approximately 1,100,000. The Faculty of Medicine of the University of Miyazaki Hospital Trauma and Critical Care Center (hereinafter referred to as our center) commenced its rapid response-type doctor car services (hereinafter referred to as doctor car) in April 2014. Doctor cars have been introduced as alternatives in situations where a helicopter emergency medical service (HEMS) cannot be dispatched owing to poor visual flight conditions. A doctor car is presumed to be ineffective for emergencies occurring far from a base hospital because of delayed medical intervention. In this report, we present a case of severe trauma that occurred at a remote location, in which the patient’s life was saved by close coordination between the dispatched doctor car and a physician from a local medical facility.

Patient

A 31-year-old man was logging trees in the westernmost mountains of the prefecture in June 2014 when a tree collapsed and injured his left femur. He sought first aid at the nearby fire station, but because the trauma was suspected to be severe, the station requested a HEMS from our center, which was approximately 56 km away. However, the HEMS could not be dispatched because of bad weather, and a doctor car was sent instead. Soon after the doctor car was dispatched to the scene, the same fire station also requested Kobayashi Municipal Hospital, which was the nearest hospital from the scene, to send a physician to the scene (Figure
A team of paramedics arrived 34 min after the accident. His radial artery had a weak pulse; his blood pressure was 84/48 mmHg, and his pulse rate was 120 beats/min. There was continuous hemorrhage from a contusion of approximately 15 cm on the medial side of his left femur. Direct and indirect compression was applied to the injured and proximal areas, respectively, to achieve hemostasis. The physician from Kobayashi Municipal Hospital arrived at the accident scene 49 min after the accident and established a peripheral intravenous line.

The doctor car from our center docked at the halfway point between the scene of the accident and the municipal hospital at 1 h 6 min after the accident. Although pressure hemostasis was achieved with gauze, the patient subsequently went into hemorrhagic shock. He was transported to our center for resuscitation via blood transfusion, as emergency blood transfusion was not possible and complete hemostasis was not obtained at the municipal hospital. Because his state of shock was prolonged, tracheal intubation was performed en route. During that time, the wound began hemorrhaging again, suggesting coagulopathy, and pressure hemostasis using gauze continued to be applied. Photographs of the injury were transmitted to our center, along with the patient’s information, through the image transmission system to prepare blood transfusions and summon the surgeons.

Upon arrival at our hospital, the patient’s blood pressure was 62/33 mmHg, pulse rate was 153 beats/min, SpO₂ was 100% (FiO₂: 1.0), and body temperature was 36.8°C; he was administered 3000 mL of extracellular fluids. His level of consciousness under sedation (midazolam 3 mg intravenously) was Glasgow coma scale 3. Blood tests revealed a hemoglobin level of 57 g/L, platelet count of 85 × 10⁹/L, prothrombin time-international normalized ratio of 1.45, and fibrinogen level of 2.03 µmol/L. Blood gas analysis revealed a pH of 7.31, HCO₃ level of 18.0 mmol/L, and a lactate level of 3.8 mmol/L. An emergency blood transfusion was initiated shortly after his arrival. An injury of approximately 2 cm in the left femoral vein was noted (Figure 2). The blood vessel was sutured, and the wound was cleaned and closed. By the following morning, he had received a transfusion of 20 units each of packed red blood cells, fresh frozen plasma, and platelet concentrate. Extubation was performed on day 2 after admission, and artificial respiration was stopped. On day 22, the patient was transferred to another hospital for rehabilitation.
The patient’s incident timeline and vital signs before arrival at our center are shown in Table 1.

**Discussion**

Because vascular injury is rare and occurs in approximately 1–4.4% of external injuries, approximately 30% of which are in the extremities\(^1\), no treatment strategy has been recommended in the guidelines of the Eastern Association for the Surgery of Trauma\(^3\). If injury occurs at a location that is distant from an emergency medical facility, there is a risk of a sudden deterioration in a patient’s condition during transportation, as happened in this case. Treatment for hemorrhagic shock includes resuscitation, blood transfusion, and hemostasis\(^4\), and transporting the patient to a facility that can perform early-stage definitive treatment is essential. In this case, we administered approximately 3000 mL of fluid to resuscitate him from his state of shock. Recent studies have shown that restricting pre-hospital fluid infusion for hemorrhagic shock patients reduces blood transfu-

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**Table 1** Timeline and patient’s vital signs in this case

| Time after accident (min) | Fire station                           | Doctor car                  | GCS  | BP (mmHg) | HR (/min) | RR (/min) |
|---------------------------|----------------------------------------|-----------------------------|------|-----------|-----------|-----------|
| 3                         | Call for first aid, ambulance dispatched|                              |      |           |           |           |
| 6                         | Request for Doctor Car                 |                              |      |           |           |           |
| 8                         |                                        | Dispatch from UMH           |      |           |           |           |
| 34                        | Paramedic team reached accident scene  |                              | 15   | 80/48     | 120       | 30        |
| 41                        | Departure from scene                   |                              |      |           |           |           |
| 49                        | Arrival of physician from Kobayashi    |                              | 15   | 64/51     | 106       | 26        |
|                            | Municipal Hospital                     |                              |      |           |           |           |
| 66                        | Docking of doctor car and ambulance    |                              |      |           |           |           |
| 68                        | Dispatch from docking point            |                              | 14   | 104/70    | 112       | 26        |
| 111\(^a\)                 | Endotracheal intubation                 |                              | 3    | 88/54     | 150       |           |
| 135\(^a\)                | Arrive at UMH                           |                              | 3    | 62/33     | 153       |           |

UMH, University of Miyazaki Hospital; GCS, Glasgow coma scale; BP, blood pressure; HR, heart rate; RR, respiratory rate. \(^a\) The patient was under sedation at these times.

![Figure 2](image.png) Wound appearance. The patient’s left femur had a 15-cm laceration; the femoral vein also had a laceration of approximately 2 cm (arrow). The injured vein was repaired by simple suturing.
sion volumes\(^5\). However, fluid restriction is not amenable during long-distance transport to proper facilities. Therefore, carrying blood products such as packed red blood cells in doctor cars is prudent for remote traumas.

Miyazaki Prefecture has employed a HEMS since 2012. However, because helicopters are restricted to visual flight in Japan, our hospital initiated a doctor car system as an alternative to the HEMS in 2014. In the case presented herein, more than 2 h passed before the patient reached the hospital. For an emergency occurring at a location that is distant from the doctor car base hospital, early-stage medical intervention is accomplished by transporting the patient to a local medical facility before the arrival of the doctor car. Had the examination and treatment commenced only in the doctor car, medical intervention would have been delayed by a further 17 min, with possible detrimental consequences. Consistent with the American College of Surgeons guidelines on trauma\(^6\), the Japan Prehospital Trauma Evaluation and Care program\(^7\) also recommends transporting the patient to a higher-level facility while bypassing the nearest emergency medical facility for the sake of a definitive diagnosis during the golden hour (within 1 h after injury). There are only two tertiary trauma centers in Miyazaki Prefecture, including ours. As the prefecture’s jurisdiction is large, trauma bypass alone may not always save lives. In fact, a systematic review conducted by Hill \textit{et al.}\(^8\) revealed no difference in the mortality rate of trauma patients transferred directly to the trauma center compared with that of patients temporarily hospitalized in a non-trauma center before transfer. However, since a nearby emergency medical facility may not be able to adequately treat patients with severe external wounds, it is critical to inform the higher-level emergency medical facility of the patient’s condition at an early stage. A doctor car with an emergency physician dispatched simultaneously while the patient is being transported to a nearby emergency medical facility can serve this purpose. However, a doctor car requires time to arrive at locations that are remote from the base hospital. Therefore, it is essential that fire stations recognize patients with serious illnesses and promptly request a doctor car. According to the guidelines published by American College of Surgeons Committee on Trauma\(^9\) in 2014, the undertriaging rate should be restricted to 5\% of cases or less, whereas an overtriaging rate of 25–35\% is permitted. However, when the accident occurs in a location that is remote from the trauma center, a greater overtriaging rate for the doctor car ought to be permitted.

In our case, the doctor car and the ambulance arrived at the docking point almost simultaneously. In a doctor car, the dispatched physician usually coordinates the docking point with the fire station and the dispatched emergency response team; to reduce the waiting time, it is important to choose a safe docking location that is accessible to both vehicles. To achieve successful docking of the doctor car and ambulance car, the dispatched physician needs to skillfully handle communication tools such as a cell phone or radio. In Miyazaki Prefecture, if the expected docking point was located in the area controlled by another fire station, the fire station that controlled the expected docking area must support the communication between doctor car and ambulance car by relaying the radio transmissions. To arrive at the destination facility as early as possible, the doctor should minimize the time spent at the docking point, because medical intervention is not difficult while traveling to the destination facility. In our case, 2 min elapsed between making patient contact and leaving the docking point, and tracheal intubation was performed in the ambulance en route. Owing to its speedy departure from the site, the ambulance was able to reach the hospital earlier while communicating the patient’s condition to the destination facility for adequate preparation of blood transfusions and surgical personnel. We reemphasize that an early request for a doctor car, reducing the time to reach the docking point, and sending all relevant information to the destination institute are essential for taking full advantage of the abilities of doctor cars.

\section*{Conclusion}

The patient’s life was saved despite the accident occurring at a location distant from the doctor car base hospital. This case, in which an emergency physician was dispatched with the doctor car, illustrates an additional use for doctor cars aside from their effectiveness in early-stage medical intervention.

\section*{References}

1. Gupta R, Rao S, Sieunarine K. An epidemiological view of vascular trauma in Western Australia: a 5-year study. ANZ J Surg 2001; 71: 461–466. [Medline] [CrossRef]
2. Perkins ZB, De’Ath HD, Aylwin C, \textit{et al.}. Epidemiology and outcome of vascular trauma at a British Major Trauma Centre. Eur J Vasc Endovasc Surg 2012; 44: 203–209. [Medline] [CrossRef]
3. \textit{Practice management guidelines for penetrating trauma to the lower extremity.} Chicago: The EAST Practice Management Guidelines Work Group; 2002 [cited 20 Oct 2015]. Available from: \url{https://www.east.org/education/practice-management-guidelines/penetrating-venous-extremity-trauma-management-of/}
4. Kauvar DS, Wade CE. The epidemiology and modern management of traumatic hemorrhage: US and international perspectives. Crit Care 2005; 9(Suppl 5): S1–S9. [Medline] [CrossRef]
5. Feinman M, Cotton BA, Haut ER. Optimal fluid resuscitation
in trauma: type, timing, and total. Curr Opin Crit Care 2014; 20: 366–372. [Medline] [CrossRef]

6. American College of Surgeons Committee on Trauma Resources for optimal care of the injured patient; 2014 [cited 20 Oct 2015]. Available from: https://www.facs.org/quality%20programs/trauma/vrc/resources.

7. Mashiko K. Trauma systems in Japan: history, present status and future perspectives. J Nippon Med Sch 2005; 72: 194–202. [Medline] [CrossRef]

8. Hill AD, Fowler RA, Nathens AB. Impact of interhospital transfer on outcomes for trauma patients: a systematic review. J Trauma 2011; 71: 1885–1900, discussion 1901. [Medline] [CrossRef]