—**Case Reports**—

Effectiveness of a Doctor Dispatch System Activated by an Advanced Automatic Collision Notification after a Single-Vehicle Accident: A Case Report

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A 79-year-old woman collided with a cliff in a passenger automobile. The fire department acknowledged an automated collision notification from the D-Call Net (DCN) at 1 min after the accident and called for doctors by helicopter ("Doctor-Heli" [DH] in Japan) 9 min after the injury. The DH reached the victim 28 min after the injury, and examination revealed pain in the right side of her chest, tachypnea, and a weak radial artery pulse (indicating shock). The DH arrived at the hospital 49 min after the injury. Thoracic drainage was performed for right-sided tension pneumothorax. She recovered from shock but was diagnosed with flail chest and placed on a respirator. She was extubated on postoperative day 6 and transferred to a rehabilitation hospital on postoperative day 57. Because of the DCN, the patient received treatment 15 min earlier than she would have with the conventional system. Emergency response task forces must develop strategies for connecting DCN warnings to rapid medical response systems. (J Nippon Med Sch 2023; 90: 465–469)

Key words: emergency medical services, air ambulances, emergency medicine, accidents, automobiles

Introduction

The survival rate in patients with severe trauma (including victims of traffic accidents) can be improved by shortening the interval between injury and medical treatment, especially definitive hospital-based treatment[1]. The D-Call Net (DCN) was launched in Japan in November 2015 with this aim. The DCN is an advanced automatic collision notification (AACN) system that is unique to Japan and dispatches doctors to accident scenes as promptly as possible. This is the first system in the world to use engineering data as a basis for dispatching doctors by helicopters ("Doctor-Heli" [DH] in Japan) and other means[2,3]. We present a case in which the DCN effectively facilitated optimal care for a patient with severe trauma due to a single-vehicle accident.

Case Presentation

The patient was an otherwise healthy 79-year-old woman. Written informed consent was obtained from her for the anonymized publication of her clinical findings and associated images.

History of Current Illness

In December 2020, the patient sustained injuries when her automobile collided with a cliff; she was seated in the front passenger seat. The DCN set the collision at Δ57 km/h, and the predicted risk of passenger death or severe traumatic injury was 84% (**Fig. 1**). The Fire Department Command Headquarters with local jurisdiction received the DCN data 1 min after the injury. Additional time was required to file an official dispatch request for a DH. Thus, the DH application was not filed until 9 min after the injury. At the time of filing, the DH was engaged in another case. It departed the site of the other

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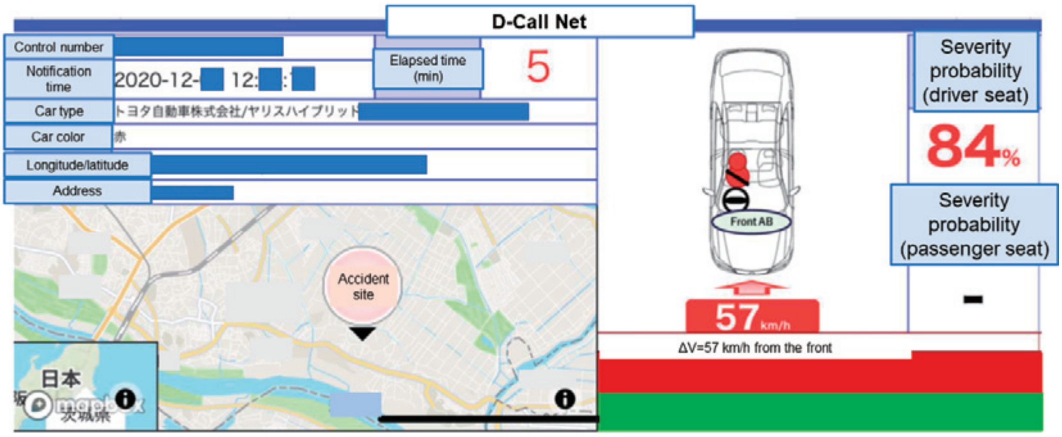

Fig. 1 An illustration of a smartphone screen showing "automated emergency alert (D-Call Net) received."
This image shows the screen 5 min after the accident. A head-on collision to the front of the vehicle occurred at Δ57 km/h. The woman in the driver's seat was wearing a seatbelt, and the front airbags were functional. The risk algorithm indicated an 84% chance of death or severe traumatic injury. Data for the front passenger seat were not displayed because of a system malfunction.

case at 18 min after the present injury and made contact with the present patient 28 min after the injury. At the time of emergency contact, another patient was in the driver's seat and was conscious, lucid, and able to walk. He was transported by ambulance.

Pre-hospital Care

An initial examination revealed tachypnea and a weak radial artery pulse. The patient was deemed to be in critical condition. Her respiratory tract was patent, the respiratory rate was 32 breaths/min, and the blood oxygen saturation level was 99% (O_2, 10 L/min). Tenderness was observed on the right side of her chest, but no subcutaneous emphysema and no differences in breath sounds between the left and right sides of her chest were noted. Her blood pressure was 98/50 mm Hg, and her heart rate was 47 bpm. The peripheral regions were cold and wet, indicating shock. A focused assessment with sonography for trauma (FAST) screening was negative for thoracoabdominal fluid retention, and there was no pelvic tenderness suggesting right-sided tension pneumothorax. The transport time was approximately 7 min (by DH). The helicopter departed the site 42 min after the injury and arrived at the hospital 52 min after the injury. This response time was 15 min shorter than the predicted turnaround time (67 min) without DCN installation.

Injury Status at the Time of Hospital Admission

The patient's respiratory tract was patent, and right-sided flail chest and subcutaneous emphysema were confirmed. On hospital arrival, her respiratory rate, blood oxygen saturation, blood pressure, and heart rate were 36 breaths/min, 99% (O_2, 10 L/min), 58/41 mm Hg, and 43 bpm, respectively. Absence of thoracoabdominal fluid retention was confirmed on extended FAST screening. We noted that lung sliding had vanished in the right lung. The patient's consciousness state was registered as "restless" on the Glasgow Coma Scale (score, 13; E3V4M6).

Thoracic drainage (28 Fr) of the right-sided tension pneumothorax was performed through the fourth intercostal space. Tracheal intubation was performed to address the patient's flail chest, and the patient was placed on an artificial respirator (positive-pressure ventilation). Her hemodynamics stabilized rapidly. A contrast-enhanced CT scan revealed right-sided pneumothorax, bilateral pulmonary contusion, bilateral rib fractures (**Fig. 2**), and compression fractures of the 12th thoracic and first lumbar vertebra. Open fracture of the right distal ulna and left ankle fracture/talus bone dislocation were diagnosed. The patient's injury severity score was 34, and her probability of survival was estimated to be 74.5%. External skeletal fixation was performed on her left lower leg fracture, after which she was admitted to the intensive care unit.

Progress After Hospital Admission

The patient's breathing improved rapidly, and she was extubated on postoperative day 6 and transferred to a general care ward on postoperative day 8. On postoperative day 16, open reduction and internal fixation were performed for the right distal ulna and left ankle fractures/talus bone dislocation. On postoperative day 57, she was transferred to a convalescent hospital to continue rehabilitation.

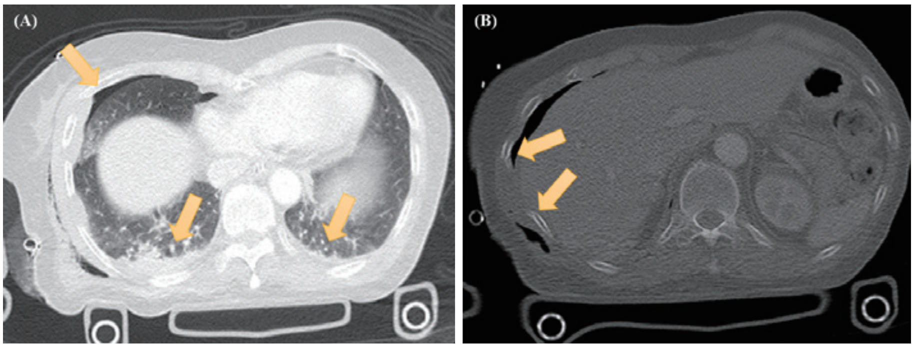

Fig. 2 Findings of thoracic CT scanning.
A: Thoracic CT findings for the lung field. A bilateral pulmonary contusion is noted after thoracic drainage-tube insertion for right-sided pneumothorax. B: Thoracic CT shows multiple rib fractures.
CT, computed tomography

Discussion

The recorded number of traffic accident-related deaths in Japan peaked at 16,765 persons in 1970. This value has been declining; only 2,839 such deaths were reported in 2020. However, an evaluation of cause of death by age group showed that accidents (including traffic accidents) are one of the most frequent causes of death in young people (especially for those younger than 30 years of age). Such deaths are a significant loss to society. Because the absolute number of deaths is decreasing, due attention should be given to this societal concern. Efforts to ensure a prompt response for victims of traffic accidents and a reduction in post-accident complications must be pursued rigorously.

The time between an accident and definitive treatment significantly impacts rates of death and complications among individuals with traumatic injuries[4]. It is vital to begin treatment within the "golden hour" (the first 60 min after injury) to save patients from hemorrhage due to severe traumatic injury[5]. In Japan, response systems have been developed to shorten the time from injury to admission to a medical facility and the start of definitive care.

DH was introduced in 2001 to improve rescue rates and reduce post-accident complications. It has expedited the dispatch of doctors to victims of trauma accidents and has thus greatly improved outcomes[6,7]. However, a 2008 study in Chiba Prefecture reported that it took an average of 67 min from an accident to hospital arrival[8]. Moreover, additional time was required to initiate definitive care after arrival at the hospital. Thus, the golden hour was routinely exceeded, even though DH was effective as a rapid-delivery tool. Therefore, to develop possible strategies for minimizing the interval between an accident and the request for a DH, each phase of the period after an accident was analyzed by an emergency response task force.

The DCN-an updated system that aims to speed up medical treatment-was developed in Japan in 2015 to improve response time. The DCN sends AACN data to fire departments and simultaneously triggers a medical dispatch system. Initially, the AACN was developed at multiple locations worldwide by using engineering data and information on safety devices (e.g., seatbelts) recorded at the time of the accident, to estimate injury severity and send automated reports to local fire departments. In the DCN system, an original algorithm estimates injury severity by using a dataset compiled from data on 2.8 million traffic accidents over the past 10 years. These data include vehicle velocity, direction of impact, number of collisions, and safety device information (seatbelts and airbags). In cases in which the probability of death or serious injury is 5% or higher, doctors are dispatched by DH. Because police data are used in the system, "serious injury" is defined as a case requiring at least 30 days of hospitalization. The DCN trial operations began in December 2015. The annual number of alerts has increased as the number of automobiles equipped with this system has grown. However, for various reasons, such as rejection of passenger alerts and receipt of alerts outside the DH hours of operation, the number of cases for which a DH was dispatched has been fewer than 10 since December 2015[9].

This present case was unprecedented in that the DCN alert was received while a previous case was being handled, and the DH was dispatched from a location other than the base hospital. The interval between the accident and arrival at hospital in the absence of a DCN installa-

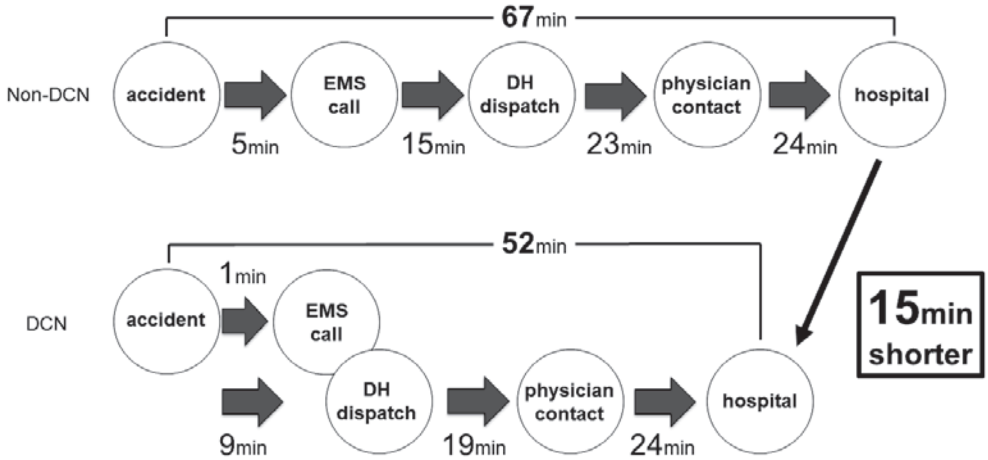

Fig. 3 Actual and estimated times necessary for medical treatment.
The estimated time necessary to provide medical care was calculated based on a 2,008 survey of traffic fatalities in Chiba Prefecture, in combination with the average time required for the use of doctors by helicopter (Doctor-Heli [DH] in Japan) at this hospital and the distance between the accident site and hospital. The interval between the accident and hospital arrival was estimated to be approximately 67 min. The actual time was reduced by approximately 15 min, to 52 min, with the deployment of the D-Call Net system.

tion was estimated to be 67 min, based on the distance between the accident location and the base hospital, as calculated from 2008 survey data provided by the Chiba Traffic Accident Investigating Committee. Despite the delay in dispatch, the DCN alert of severe traumatic injury shortened the time to initiation of medical care by approximately 15 min (**Fig. 3**), which is a remarkable achievement.

When assessing this case, several issues were considered. The first issue was the decision to transport the patient to hospital as soon as possible, which has obvious potential benefits but might have made on-site diagnosis more difficult. In this case, no physical findings suggestive of tension pneumothorax were observed during prehospital treatment, making it difficult to identify the reason for the patient's state of shock. When site dispatches are made based on DCN requests, emergency response teams must consider the early stage of patients' injuries. Moreover, treatment must be provided while considering the difficulty of diagnosis and the risk of worsening the patient's condition.

The second issue was the interval between the DCN alert and DH request. Although both the fire department and base hospital acknowledged the request, the fire department's formal request for the DH took 5 min. The fire department may have been confused because the accident description in the alert ("passenger car, single, injury") was unclear. However, the threshold for DH requests is deliberately set at a low point (i.e., a death/injury rate of <5%) to maintain an under-triage rate of < 10%[10]. Under current conditions (i.e., in which few actual deployments are made), the fire department and base hospital must re-confirm the mutual understanding that, in principle, a DCN alert necessitates a DH request.

The third issue was that the present DCN was received while a previous case was being managed. The present case happened close to the location of the previous case, and pre-hospital treatment for the previous case was almost complete at the time of the alert. Thus, little time was lost. As the number of automobiles equipped with the DCN system increases, previously engaged and duplicate cases are expected to increase concomitantly. Thus, development of a triage policy for these cases is an urgent priority.

In the future, all DH base hospitals will need to understand the issues related to the increase in DCN requests and examine methods to address them in accordance with regional characteristics.

Conclusion

We have presented a case of a patient with severe traumatic injuries resulting from a single-car accident in which a doctor dispatch system involving the DH and DCN enabled a medical response that was more rapid than that possible with DH or DCN alone. Although the DH request was sent while the DH was addressing a previous incident, the time to hospital admittance was considerably reduced. Additional strategies must be pursued to address DH requests swiftly by using the DCN to hasten the start of treatment. The present findings will assist with future research and in the development of effective policy and medical guidelines.

Conflict of Interest: The present DCN system was developed with research funding from the Toyota Motor Corporation and Honda Motor Company.

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