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Original Contribution

# A comparison between evacuation from the scene and interhospital transportation using a helicopter for subarachnoid hemorrhage

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ABSTRACT

*Purpose:* We investigated the changes in the vital signs and the final outcomes subarachnoid hemorrhage (SAH) patients who were evacuated from the scene using the doctor-helicopter (Dr. Heli) service and those who only underwent interhospital transportation using the doctor-helicopter Dr. Heli service to investigate safety of this system.

*Methods:* We retrospectively investigated all of the patients with non-traumatic SAH who were transported by a Dr. Heli between January 2010 and March 2016. The subjects were divided into two groups: the Scene group included subjects who were evacuated from the scene by a Dr. Heli, while the Interhospital group included subjects who were transported by a ground ambulance to a nearby medical facility and then transported by a Dr. Heli to a single tertiary center.

*Results:* The systolic blood pressure, ratio of cardiac arrest, and Fisher classification values of the patients in the Scene group were significantly greater than those in the Interhospital group. The Glasgow Coma Scale in the Scene group was significantly lower than that in the Interhospital group. After excluding the patients with cardiac arrest, the Glasgow Coma Scale scores of the patients in the two groups did not differ to a statistically significant extent during, before or after transportation. There were no significant differences in Glasgow Outcome Scores or the survival ratio of the two groups, even when cardiac arrest patients were included.

*Conclusion:* The present study indirectly suggests the safety of using a Dr. Heli to evacuate SAH patients from the scene.



## 1. Introduction

Previous studies have reported the survival benefits of air ambulances in the evacuation of trauma patients from the scene [1-5]. However, there have been few reports on the usefulness of air ambulances in the inter-hospital transportation of non-trauma patients, especially those with acute coronary syndrome or stroke, in which time-dependent management is required in order to obtain a favorable outcome [6-11]. In the case of stroke, recent reports have focused on ischemic stroke patients who were candidates for tissue plasminogen activator infusion [7,8]. We herein report the results of a retrospective analysis to investigate the change in patients' vital signs during transportation and the outcomes of evacuating subarachnoid hemorrhage (SAH) patients from the scene using a government-funded medical helicopter service known as "doctor-helicopter" (Dr. Heli). The purpose of the current study was to determine whether SAH patients could be safely transported from the scene based on their clinical condition during transport and their outcomes.

## 2. Methods

The protocol of this retrospective study was approved by our institutional review board, and the examinations were conducted according to the standards of good clinical practice and the Helsinki Declaration.

We retrospectively investigated all of the patients with non-traumatic SAH who were transported by a Dr. Heli between January 2010 and March 2016, during which time hospital medical charts were preserved according to Japanese law, using the registry data of the Dr. Heli control room of our hospital. We did not include the SAH patients who were transported to our hospital directly, either by self-transport or ground ambulance. The exclusion criteria were as follows: 1) patients with trauma; 2) patients who did not use a ground ambulance; 3) patients who were delivered to other medical facilities; 4) cases in which SAH was ruled out based on the results of a computed tomography (CT) examination that was performed after arrival at our hospital. The diagnosis of SAH was determined by CT. In our institute, patients

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with sudden-onset headache without visible SAH on the CT undergo magnetic resonance imaging (fluid-attenuated inversion recovery) and magnetic resonance angiography, or CT angiography.

The subjects were divided into two groups: the Scene group included subjects who were evacuated from the scene by a Dr. Heli, while the Interhospital group included subjects who were transported to a nearby medical facility by a ground ambulance and then transported to our hospital by a Dr. Heli after the diagnosis of SAH. The primary outcome measures were safety during air-transportation, including changes of vital signs, which were examined in order to investigate the safety of the Dr. Heli system. The secondary outcome measure was the final outcome in terms of the Glasgow Outcome Score at discharge and the survival rate in the patients of the two groups. The subjects in the Scene group were diagnosed by CT after arrival at our hospital. The decision to access Dr. Heli on scene was made by emergency medical technicians, based on the subjects' complaints or symptoms, such as severe headache with sudden onset, unconsciousness or hemiparesis. The patients' age, sex, Glasgow Coma Scale, systolic blood pressure, heart rate (at first contact, when it was checked by the Dr. Heli staff), the presence/absence of cardiac arrest, percentage of tracheal intubation, Fisher scale, Glasgow Outcome Score at discharge and the survival rate were investigated in the two groups [12]. In the Scene group, the reason for calling for a Dr. Heli was investigated. In addition, we performed a further analysis of the two groups after excluding subjects with cardiac arrest. Concerning the analyses, the proportions of patients using anti-hypertensive or sedative agents and the changes in the vital signs before and after transportation in a Dr. Heli were also analyzed in each group.

The data were analyzed using the unpaired or paired Student's *t*-test for variables displaying normal distribution, the Wilcoxon test for non-parametric variables, and the chi-squared test or contingency table analyses for categorical variables. Sample size calculations were not performed. The data were expressed as the mean ± standard deviation (SD) or median (interquartile range) for continuous variables, and the number (percentages) for categorical variables. p values of $<0.05$ were considered to indicate statistical significance.

The Dr. Heli service was first implemented in Japan by the Kawasaki Medical School. The service was called "Dr-Heli" to emphasize the fact that doctors are onboard the helicopter and fly to the patients to provide treatment as quickly as possible. The crews of physician-staffed helicopters generally consist of 1 pilot, 1 mechanic, 1 doctor, and 1 nurse. Our hospital in eastern Shizuoka prefecture began to provide a Dr. Heli service in 2004. Since then, the service has been used to directly transport patients with suspected stroke, including patients with subarachnoid hemorrhage (SAH), from the scene to a medical facility [1]. The helicopter used by the Dr. Heli service in Eastern Shizuoka, which is jointly produced by Messerschmitt-Bölkow-Blohm in Germany and Kawasaki in Japan, is known as the BK 117; the Eurocopter EC 145 is based on this design. Eastern Shizuoka is a mountainous region of approximately 4090 $km^2$ in size, which has a population of approximately 2 million and few hospitals [1]. The journey from the southern tip of the peninsula to the critical care medical center of our hospital takes 1.5 h by ambulance using a windy road that crosses over mountain passes. In contrast, this trip only takes 15 min by helicopter [1]. The road often becomes congested because eastern Shizuoka is a sightseeing resort area that is located near Tokyo. Only the fire department and doctors in hospitals that have a heliport can request the dispatch of a Dr. Heli for critically ill patients including trauma patients.

In Japan, local governments have established the emergency medical system (EMS) as a public service, and anyone can call an ambulance free of charge by dialing 119. Most local governments use a one-tier emergency system. Usually, the fire department dispatches the EMS team (three emergency medical technicians) in an ambulance after receiving a 119 call. Recently in Japan, emergency medical technicians, who can secure a venous route, secure an airway with instruments and inject adrenaline for patients in cardiac arrest, have been allowed to inject adrenaline for patients with anaphylactic shock, infuse glucose to patients with hypoglycemia and to secure a venous route for patients with unstable circulation. When emergency medical technicians cannot decide how to treat patients, they can consult a doctor in a hospital by telephone. However, until April 2016 in Shizuoka Prefecture, emergency medical technicians were not allowed to secure a patient's airway using instruments, establish a venous route, or prescribe drugs for patients who are not in cardiac arrest [13]. They could only administer oxygen, provide supportive ventilation using a self-inflated bag-mask and manage the patient's position (sitting, supine or lateral position). Of note, they still cannot administer anti-hypertensive agents to patients with hypertension. Accordingly, the changes in the patients' vital signs have been controlled by Dr. Heli staff, as opposed to emergency medical technicians (who would be providing care for patients transported in a ground ambulance).

## 3. Results

There were 108 cases in which SAH was diagnosed in patients transported by a Dr. Heli during the investigation period. The following cases were excluded from the study: cases in which the patient was transported to another medical facility by a Dr. Heli (n = 15); and cases in which SAH was found to have been induced by trauma (n = 3). After excluding these cases, the 90 remaining cases were enrolled in the present study. There were no cases in which SAH was invisible on CT, but visible on MRI. The Scene and Interhospital groups included 46 subjects and 44 subjects, respectively. All subjects in the Interhospital group had SAH diagnosed by CT and transported to local hospital by ground ambulance.

Table 1 shows the results of an analysis of the two groups. There were no significant differences between the two groups with regard to the age, sex, heart rate, ratio of tracheal intubation and change of condition. Seven subjects in the Interhospital group had already received tracheal intubation by the staff at their local hospital. However, the systolic blood pressure, percentage of cardiac arrest, and Fisher classification values of the patients in the Scene group were significantly greater than those in the Interhospital group. The Glasgow Coma Scale and the percentage increase of systolic blood pressure during transportation in the Scene group than in were significantly lower than those in the Interhospital group.

The reasons for calling for a Dr. Heli in the Scene group are as follows: unconsciousness (n = 35), severe headache (n = 22), hemiparesis (n = 2), dysarthria (n = 1), and convulsion (n = 1). Among them, a total of seven subjects in the Scene group had hemiparesis confirmed by the staff of the Dr. Heli.

As the percentage of cardiac arrest in the Scene group was significantly greater than that in the Interhospital group, we excluded the subjects who had cardiac arrest prior to Dr. Heli transportation, since all of

**Table 1**
The results of the analysis of the whole study population.

| | Scene (n = 46) | Interhospital (n = 44) | p-Value |
|---|---|---|---|
| Age | 68.7 ± 13.5 | 68.3 ± 12.8 | n.s. |
| Male/female | 15/31 | 9/35 | n.s. |
| Glasgow Coma Scale | 7 (11) | 14 (11) | $p < 0.05$ |
| Systolic blood pressure | 151.5 ± 62.4 | 140.4 ± 35.3 | $p < 0.05$ |
| Heart rate | 78.4 ± 31.6 | 81.0 ± 14.5 | n.s. |
| Proportion of cardiac arrest | 7 (15.2%) | 1 (2.2%) | $p < 0.05$ |
| Tracheal intubation | 19 (30.7%) | 12 (25.6%) | n.s. |
| Change of condition | 22 (47.8%) | 25 (56.8%) | n.s. |
| Vomiting | 10 (21.7%) | 6 (13.6%) | n.s. |
| Increase of blood pressure | 9 (19.5%) | 19 (43.1%) | $p < 0.01$ |
| Decrease of blood pressure | 0 | 2 (4.5%) | n.s. |
| Decrease of respiratory rate | 1 (2.1%) | 1 (2.2%) | n.s. |
| Deterioration of consciousness | 1 (2.1%) | 0 | n.s. |
| Fisher classification | 3.5 (3) | 3 (3) | $p < 0.05$ |

n.s.: not significant.