Effects of the AutoPulse® used on patients with CPA during transportation in a "Doctor-Heli"

Fig. 1: In Japan, an air ambulance with emergency doctor on board is called "Doctor-Heli" (Photographs: K. Omori)

Can quality and safety be guaranteed for critical patients with cardiopulmonary arrest (CPA) through chest compressions during helicopter transportation? This question is important since the Juntendo University Shizuoka Hospital in Japan – located in an underpopulated rural area called the Izu Peninsula of Shizuoka – is the only hospital in the area taking care of emergency patients. There is no other emergency or critical care center nearby and only few other hospitals take care of emergency patients in general. If the regional emergency medical service (EMS) in Shimoda-city, located at the tip of the Izu Peninsula, has to transport a patient showing a critical state (including CPA), it takes about 90 minutes from the scene to the hospital at Izunokuni-city by surface transport. This is one of the disadvantages for patients to obtain a good outcome. However, if the EMS decides to use the air-ambulance with a "flying doctor", also called "Doctor-Heli", transportation takes only 15 minutes.

Purpose

The "Doctor-Helicopter"-system has recently been introduced as part of EMS in the local area, complementing the inadequate numbers of ambulances and hospitals in Japan. The "flying doctor" was implemented in the area of the Izu Peninsula in order to take care of extremely critical patients with CPA. However, it is not easy to do effective manual chest compressions in the helicopter. The purpose of the study was to evaluate the effect of the automated load-distributing band (LDB) chest compression device, the so-called AutoPulse®, for continuous chest compression during transportation in a "Doctor-Helicopter".

Patients and Methods

The study included adult patients showing signs of CPA at the scene. After initial evaluation and medical care performed by EMS personnel, the medical staff – including the "flying doctor" – joined to take care of the CPA-patient. Standard methods of advanced cardiopulmonary resuscitation (CPR) – including manual chest compression – were performed at the scene or landing point of the "Doctor-Helicopter". When the decision was made to transport the patients with CPA, the AutoPulse® was prepared on the helicopter stretcher. The compression device was applied to the patient after having been moved

Fig. 2: Izu Peninsula is a very mountainous region, where it may take up to 90 minutes to transport a patient from Shimoda-city to the hospital by ambulance car

Fig. 3: The AutoPulse®, an automated LDB chest compression device, prepared on the helicopter stretcher

from the ambulance stretcher to the helicopter stretcher. When the patients arrived at the emergency room (ER) or when they showed return of spontaneous circulation (ROSC), use of AutoPulse® was stopped. If the patients were still in a CPA-state, manual chest compression was then performed immediately.

At a total number of 1,532 missions carried out by the "Doctor-Heli" of Juntendo University Shizuoka Hospital between July 2008 and March 2011, there were 140 patients with CPA conditions. AutoPulse® was used during transportation on 49 patients. These patients were divided into two groups depending on whether they showed ROSC or not (ROSC group and non-ROSC group). There were 15 patients in the ROSC group and 34 cases in the non-ROSC group. Patients were analyzed upon the basis of the following components: demographic data, presence of witness and bystander CPR, the initial electrocardiogram (ECG) rhythm as well as the period regarding manual CPR and CPR carried out using AutoPulse® during pre-hospital procedures until arrival at the ER. Some data showed mean±standard deviation (SD) and statistical significance was assumed for $P<0.05$.

Results

The difference of patients' demographic data such as mean age, sex, cause of onset and presence of witness and bystander CPR, did not indicate any influence on the two groups (see Table 1). In the initial ECG, non-shockable rhythms – including ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT) – were much greater in both groups than shockable rhythms, including pulseless electrical activity (PEA) and asystole. Four cases indicated shockable rhythms, including two cases of VF and one case of VT in the ROSC group as well as one case of VF in the non-ROSC group. 12 cases showed non-shockable rhythms, including two cases of PEA and 10 cases of asystole in the ROSC group. Furthermore, out of 33 cases in the non-ROSC group, six cases showed PEA and 27 cases were asystole.

The time duration from the onset and/or EMS dispatch to the arrival of EMS personnel at the scene was 12.7±6.1 minutes in the ROSC group and 12.9±10.9 minutes in the non-ROSC group ($p=0.2460$). The time duration from EMS personnel arrival to medical staff arrival at the scene and/or landing points of the "Doctor-Helicopter" were 19.1±10.0 minutes in the ROSC group and 20.3±11.1 minutes in the non-ROSC group ($p=0.7069$). The duration of stay at the scene and/or landing points were 16.9±13.8 minutes in the ROSC group and 18.6±8.2 minutes in the non-ROSC group ($p=0.5047$). The mean duration of manual CPR including bystander, EMS personnel and medical staff at pre-hospital setting was 36.6±13.8 minutes in the ROSC group and 42.4±16.6 minutes in the non-ROSC group ($p=0.2472$). However, the mean duration for AutoPulse® CPR were 11.9±6.7 minutes in the ROSC group and 18.1±5.2 minutes in the non-ROSC group ($p=0.0011$). The resuscitation time in the ROSC group was significantly shorter than the non-ROSC group using AutoPulse® CPR (Table 2). At the time of hospital discharge, three cases in the ROSC group had survived, whereas the remaining cases in both groups had died.

Fig. 4: Duration of transport of CPA-patients on the "Doctor-Helicopter" and the use of manual CPR as well as of the AutoPulse® [BITTE NACHBAUEN: Omori_Abb4.pptx]

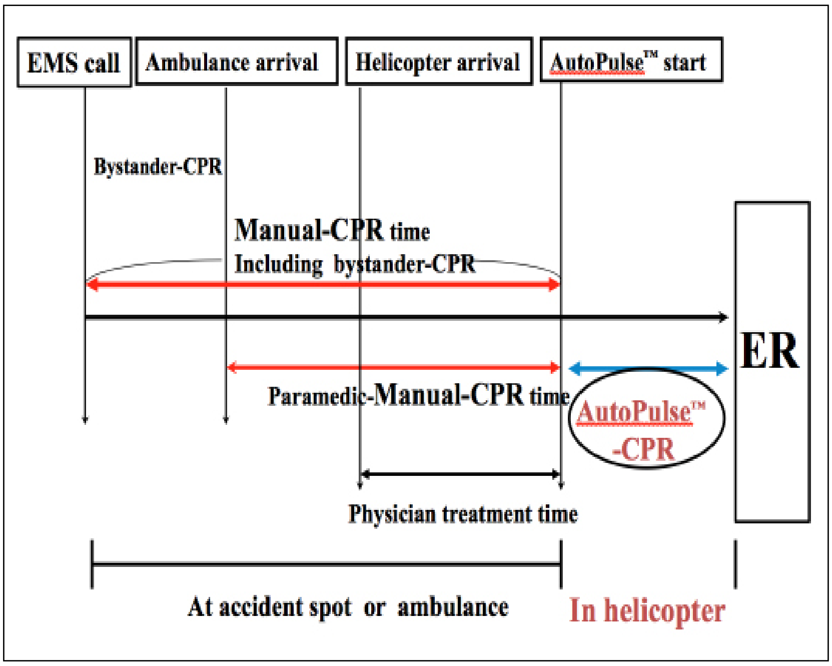

Fig. 5: When not in use, the automated chest compression device is stored in the back of the helicopter (blue bag on the right)

Discussion

The guidelines for advanced life support and CPA emphasize continuous and effective chest compression as one of the main factors of a successful CPR. However, manual chest compression produces coronary and cerebral perfusion that is 10-30% of normal blood supply (1). If the quality of the manual chest compression is inadequate because of incorrect compression rate, depth and interruptions, blood flow to vital organs – including the heart and the brain – may be more reduced and this correlates with a poor outcome. In order to achieve a better survival rate of critical patients, performing adequate chest compressions with optimal depth and rate as well as minimized interruption might be an important factor relating to a good outcome (2). When the "Doctor-Helicopter" transportation had been chosen, there were some problems regarding the efficiency of chest compression and safety for medical staff in the helicopter because it was difficult for them to perform manual chest compressions in the helicopter while being secured to the seat by a safety belt (see Fig. 6).

Juntendo University Shizuoka Hospital introduced the AutoPulse® system – one out of many devices available for automated mechanical chest compression – to its "Doctor-Helis" (3). Data showed that advanced CPR using AutoPulse® performed about 12 minutes might be effective to get the ROSC, if circumstances during a flight make it very difficult to perform manual CPR. The AutoPulse® CPR had several benefits: it was easy to handle, possible to perform continuous and constant quality chest compression, possible to concentrate patient's care without manual chest compressions and feasible to transport patients on a stretcher (4, 5) (Figure 6). Moreover, a relatively stable condition of critical patients with CPA could be maintained without relying on inadequate chest compression during a long mission in rural areas.

Conclusion

Use of the LDB device AutoPulse® during transportation from the landing point of the "Doctor-Helicopter" to the ER might result in a good outcome for introducing aggressive treatment in hospital.

Table 1: Patients' demographic data

	ROSC group	Non-ROSC	group P-value
Age (year old)	55.1 ± 19.3	66.3 ± 18.9	0.062
Gender			
male	12	26	0.9214
female	3	8	
Cause			
endogenous	7	21	0.3249
exogenous	8	13	
witness	7	18	0.6855
unwitness	8	16	
bystander	8	16	0.6856
non-bystander	7	18	

Table 2: Duration from EMS dispatch to CPR

	ROSC group (min)	Non-ROSC (min)	P-value
EMS dispatch ~ EMS personnel arrival	12.7±6.1	16.9±12.9	0.246
EMS personnel arrival ~ Medical staff arrival	19.1±10.0	20.3±11.0	0.7069
Stay at the scene	16.9±7.8	18.6±8.2	0.5047
Manual-CPR	36.6±13.8	42.4±16.6	0.2472
AutoPulse®-CPR	11.9±6.7	18.1±5.2	0.0011

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