The efficacy of comprehensive post-cardiac arrest care including therapeutic hypothermia and immediate coronary angiography following out of hospital cardiac arrest due to ventricular fibrillation

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ABSTRACT

Purpose: This is a retrospective comparative study about neurological outcomes of comatose patients after out of hospital cardiac arrest (OHCA) due to ventricular fibrillation (VF) who presented before and after implementation of comprehensive post-cardiac arrest care including therapeutic hypothermia (TH) and immediate coronary angiography (CAG) in a community hospital.

Subjects and Method: We evaluated 26 comatose survivors with reactive pupils or spontaneous breathing (Before April 2008 when we have started to implement the TH and immediate CAG, we defined Pre-TH patients and assigned 14 patients. Thereafter, we defined Post-TH patients and assigned 12 patients) among 52 consecutive OHCA due to VF cases from December/1/2003 to May/31/2011. In Post-TH patients, an immediate CAG was always performed to decide the indication of percutaneous coronary interventions (PCI) followed by active surface cooling to achieve a rectal temperature of 34°C. The primary outcomes were length of stay, mortality, the neurologic outcome after 1 month, the rates of hospital procedures (CAG, PCI, etc) and complications. The secondary outcomes were the comparison of the frequency of acute coronary syndrome, interventions and complications between the favorable (CPC: Pittsburgh cerebral performance category 1-2) and non-favorable neurologic outcomes (CPC 3-5). All data were compared using Fisher's exact test or Student's t-test.

Results: The rate of favorable neurologic outcome significantly improved in the Post TH patients ($p < 0.05$), the mortality rate was not significantly different ($p = 0.13$). The rates of CAG performance and intra-aortic balloon pumping (IABP) use were higher in the Post-TH patients ($p < 0.05$). The rate of pulmonary edema alone was lower in the Post-TH patients ($p < 0.05$) among complications. As for neurological outcomes, the frequency of TH and immediate CAG was higher ($p < 0.05$) and that of pulmonary edema was lower ($p < 0.01$) in the favorable outcome.

Conclusions: The comprehensive post-cardiac arrest care including TH, CAG and IABP could be associated with a significant improvement in neurologic outcomes and reduction of the complication of pulmonary edema in comatose survivors whose initial rhythm was VF.

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Introduction

An estimated 110,000 people in Japan undergo sudden cardiac arrest yearly and the rate of survival after an out-of-hospital cardiac arrest has increased as improvements are made in connecting the links in the "chain of survival," but recovery without residual neurologic damage after cardiac arrest with global cerebral ischemia is still

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low¹⁾. Although early defibrillation and high quality cardiopulmonary resuscitation (CPR) play key roles in the chain of survival, aggressive post-resuscitative care has been recognized as an important link in the cardiac arrest chain of survival²⁾. Both the International Liaison Committee on Resuscitation (ILCOR) and the American Heart Association (AHA) recommend the use of therapeutic hypothermia (TH) in the treatment of persistently comatose survivors resuscitated after out-of-hospital cardiac arrest (OHCA) due to ventricular fibrillation (VF)^{3,4)}. Since April 2008, we have begun to implement the mild TH following coronary angiography (CAG) and percutaneous coronary intervention (PCI) for the comatose survivors after return of spontaneous circulation (ROSC) due to out of hospital VF. This provided a unique opportunity to explore the benefit of our comprehensive protocol including TH, CAG and PCI by comparing outcomes of patients with a historical control period about 4 years before the implementation of this protocol in the same hospital.

Methods

This study was approved by the Research Ethics Board of our hospital, and the requirement for informed consent was waived according to Japanese government guidelines.

Subjects

We conducted a non-randomized observational study of clinical outcomes of all patients resuscitated after OHCA due to VF between December 1, 2003 and May 31, 2011. During the 40-month period from December 1, 2003 to May 31, 2007, Pre-TH period, no attempts were made to cool comatose survivors with reactive pupil or spontaneous breathing, who were assigned to the Pre-TH patient group. Since April, 2007, Post-TH period, the comprehensive post-cardiac arrest care including TH and CAG has been initiated for comatose survivors, who were assigned to the Post-TH patient group. During the pre-TH period, 378 OHCA patients were brought to the emergency department, of whom 170 (45%) were presumed cardiac etiology and 26 (7.1%) were presented with VF. 16 patients with ROSC survived to hospital admission and 2 regained consciousness. 14 comatose survivors were assigned to the Pre-TH patient group (**Fig. 1a**). During the Post-TH period, 352 OHCA patients were brought to the emergency department, of whom 140

(45%) were presumed cardiac etiology and 26 (7.7%) were presented with VF. 17 patients with ROSC survived to hospital admission and were eligible for TH protocol but 5 of them were not cooled for the following reasons: 1 died shortly after admission, and 4 regained consciousness. 12 comatose survivors actually achieved TH and were assigned to the Post-TH patient group (**Fig. 1b**).

§ Study Setting and Population

This study was conducted at a tertiary care suburban community hospital with over 3,000 ED visits annually and nearly 400 inpatient beds, which has become only emergency and cardiovascular care center in Nobeoka City, located at the northern region of Miyazaki Prefecture in the southern part of Japan, with a population of over 130,000 and an area of 86,800 km². EMS (emergency medical service) system in Nobeoka, Japan, existed at fire station with dispatch center and is provided by municipal governments. All EMS providers perform cardiopulmonary resuscitation (CPR) according to the Japanese CPR guidelines⁵⁾ and are not permitted to terminate resuscitation in the field. All OHCA due to VF cases in Nobeoka City over this period were brought to our hospital and routinely reviewed by some physicians in charge, in collaboration with the emergency medical service (EMS) personnel.

§ TH protocol

This protocol, especially the practical method of therapeutic hypothermia, was based on the finding of some previous reports⁶⁻¹⁰⁾. Unconscious patients with reactive pupil or spontaneous breathing, resuscitated from OHCA due to VF and brought to the emergency department were eligible for the TH protocol; however, the ultimate decision for implementation was at the discretion of the treating physicians. Patients were excluded from the TH protocol if there was evidence for no light reflex with dilated pupil, significant active bleeding, severe infection (sepsis or pneumonia), recent burn or if skin was injured, or if the patient was in a preexisting persistent vegetative state. All comatose victims resuscitated after OHCA due to VF are recognized to be eligible for PCI. Initially, an urgent CAG were performed for every candidate and, if indicated, coronary intervention should be ensued and then an mild therapeutic hypothermia using cooling blankets was followed. The goal was to achieve a rectal temperature of 34°C as soon as possible and maintain it for 24 hrs. Cooling blankets, using circulating cold water, were adjusted manually to keep temperatures close

Fig. 1. Study dates, patient treatments and overview of EMS-treated cardiac arrests with an abridged Utstein template in Nobeoka City.

The study has two distinct periods: (a) the Pre-therapeutic hypothermia (TH) period (December 1, 2003, to March 31, 2008) and (b) the Post-TH period (April 1, 2008 to May 31, 2011). During the Post-TH period, active cooling with cooling blankets were used and rectal temperatures were measured.

EMS: emergency medical service, OHCA: out of hospital cardiac arrest, ROSC: return of spontaneous circulation, CPC: cerebral performance category, TH: therapeutic hypothermia

to the goal of 34°C. All unconscious patients were mechanically ventilated via endotracheal tubes. Shivering was prevented with sedative medications, such as propofol, midazolam, fentanyl and, if necessary, paralytics (pancuronium/rocuronium). This protocol (from CAG) was initiated as soon as possible after arrival at the hospital. Efforts to cool the patient were temporarily suspended if the temperature dropped <32°C, or if the patient was transported out of the emergency department or intensive care unit for procedures. The protocol was discontinued if the patient regained consciousness before TH at ICU entry. Otherwise, the protocol was continued and no attempts were made to wean sedatives and paralytics, unless clinically indicated. After 24 hrs of cooling, the patient was managed to be slowly rewarmed every 0.5–1.0°C per day. When the rectal temperature was reached above 36.5°C, sedatives and paralytics were discontinued and patient was attempted to be weaned from ventilator.

§ Patient data collection and baseline characteristics

All patient data were abstracted from medical records and a linked first-responder database. Information abstracted included times from call to first shock and ROSC; whether the arrest was witnessed, whether bystander CPR was performed within 5 mins, and whether ROSC was achieved (Pre-hospital or following advanced cardiovascular life support).

Outcome

Our primary outcomes were hospital length of stay, in-hospital mortality, neurological outcomes after 1 month or on hospital discharge, the rate of hospital procedures other than TH, which included CAG, PCI, and intra-aortic balloon pumping (IABP). The incidence of pre-determined complications during the first 72 hours, which included significant bleeding (requiring transfusion, or surgical or gastroenterological consultation), sepsis (meeting systemic inflammatory response syndrome criteria plus documented infection or positive culture), pneumonia (infiltrate on chest radiograph or clinical diagnosis recorded on chart), renal failure (new use of dialysis or continuous renal replacement therapy), pulmonary edema due to heart failure (requiring medical or mechanical supportive therapy such as ventilator, IABP), seizures and recurrent VF (requiring medical or electrical therapy) were also evaluated. Since an individual patient might have more than one complication at a time, the occurrence of at least one complication of any kind per pa-

tient was also documented, and all of which were compared between Pre-TH patients and Post-TH patients. We also evaluate the ratio of acute coronary syndrome (ACS) in the causative diseases, which was diagnosed with electrocardiographic criteria for an acute ST segment elevation myocardial infarction (STEMI), serum troponin-T, or CAG findings. Favorable neurologic outcomes were defined as a Pittsburgh cerebral-performance category (CPC) of 1 (good recovery) or 2 (moderate disability) on a five category scale; non-favorable neurologic outcomes were 3 (severe disability), 4 (a vegetative state), and 5 (death). Secondary outcomes were the comparison of the frequency of acute coronary syndrome, hospital interventions (TH, CAG, PCI, IABP), and complications described as before between the favorable and non-favorable neurologic outcome patients.

§ Patient exclusions

Every outcome was based on an intention-to-treat analysis including all patients presenting to the emergency department, where patients occasionally required prolonged stabilization if beds were not available for patient admission. Because patients who died early in the emergency room would not likely have benefited from TH, we conducted our TH indication limited to those patients who could be admitted to an in-patient service; we recognize the potential selection bias of restricting our analysis to these patients.

§ Statistical analyses

Continuous variables are expressed as mean ± standard deviation. Categorical data are shown as frequencies and percentages. Continuous variables were tested by the Kolmogorov-Smirnov test for normal distribution and compared between groups using unpaired student t-test (for normally distributed variables). Fisher's exact probability test were used for the comparison of categorical variables as appropriate.

Based on the findings of a previous study¹¹⁾, it was determined that a sample of 36 patients (18 in each group) would be required to show a change in the rate of a good outcome (CPC1-2) from 15 percent to 50 percent, with a power of 80 percent and a significance level of 0.05. We could collect only 26 cases so that our study would most likely be underpowered to detect a difference. All analyses were performed, using with JMP PC software, version 8 (SAS Institute Inc., Cary, NC). A P-value of 0.05 was considered statistically significant.

Table 1. Baseline characteristics and primary outcomes of Pre- and Post-TH patients.

Baseline characteristics	Pre-TH patients (n=14) n or mean	% or SD	Post-TH patients (n=12) n or mean	% or SD	Fisher's exact test/ t-test Significance, p
Mean age (year : SD)	69.9	10.6	67.6	10.4	0.58
<u>Gender, male</u>	7	50.0%	11	91.7%	0.036
Presentation					
Mean call to first shock (mins : SD)	11.9	10.2	14.3	7.2	0.50
* Bystander CPR<5mins	8	57.1%	10	83.3%	0.22
Witnessed arrest	8	72.7%	8	66.7%	0.70
prehospital ROSC	4	28.6%	7	58.3%	0.23
ACS	9	64.3%	8	66.7%	1

TH: therapeutic hypothermia, CPR: cardiopulmonary resuscitation, ROSC: return of spontaneous circulation, ACS: acute coronary syndrome

* Bystander CPR within 5mins denotes CPR initiated within 5mins since the witness of collapsing or last signs of life by lay persons (excluding health care professionals).

Results

Baseline characteristics between the Pre-TH and the Post-TH patients, there were no significant statistical differences in baseline mean age (69.9 year vs. 67.6 year, $p=0.58$), time interval of call to first shock (11.9 mins vs. 14.3 mins, $p=0.50$), and the rate of bystander CPR (57.1% vs. 83.3%, $p=0.22$), witness (72.7% vs. 66.7%, $p=0.70$), pre-hospital ROSC (28.6% vs. 58.63%, $p=0.23$) and ACS (64.3% vs. 66.7%, $p=1$). Bystander cardiopulmonary resuscitation (CPR) within 5mins denotes CPR initiated within 5mins since the witness of collapsing or last signs of life by lay persons (excluding health care providers). Males are more common in the Post-TH patients compared with the Pre-TH patients (91.7% vs. 50.0%, $p<0.05$) (**Table 1**).

The primary outcomes were shown as follows. The mean length of ICU stay (7.14 days vs. 10.25 days, $p=0.29$) was similar in both patients. The rate of mortality in the Pre-TH patients (57.1%) showed higher trend toward than that in the Post-TH patients (25%) without statistically significant differences ($p=0.13$). Favorable neurologic outcomes were significantly evident in the Post-TH patients (58.3%) compared with the Pre-TH patients (14.3%) with statistically significant differences ($p<0.05$). As for the hospital procedures, the rate of CAG performance (35.7% vs. 100%, $p<0.05$), and IABP use (7.1% vs. 50%, $p<0.05$) were statistically higher in the Post-TH patients than in the Pre-TH patients. On the other hand, the rates of PCI in the Post-TH patients (50%)

had greater trend toward than that in the Pre-TH patients (21.4%) without statistically differences ($p=0.22$). The rates of complications except for pulmonary edema were similar between the Pre- and Post-TH patients: bleeding (7.1% vs. 16.7%, $p=0.58$); pneumonia (28.6% vs. 25%, $p=0.65$); sepsis (7.1% vs. 8.3%, $p=1$); renal failure (14.3% vs. 25%, $p=0.63$); recurrent VF (42.9% vs. 41.7%, $p=1$); and seizures (21.4% vs. 8.3%, $p=0.6$). The Pre-TH patients had more complicated with pulmonary edema than the Post-TH patients with statistically differences (78.6% vs. 25%, $p<0.05$) (**Table 2**).

The secondary outcomes were revealed as follows: The frequency of ACS as culprit lesions (55.6% vs. 70.6%, $p=0.667$) were similar between both neurological outcome patients. Among the hospital interventions, the TH (77.8% vs. 29.4%, $p<0.05$) and the CAG (100% vs. 47.1%, $p<0.01$) were more frequently performed in the favorable neurologic outcome patients with statistically significant differences. The use of IABP (44.4% vs. 17.7%) had greater trend toward in the favorable neurologic outcome patients without statistical difference ($p=0.1881$). The PCI (22.2% vs. 41.2%) more frequently showed a tendency toward a non-favorable neurologic outcome patients with no statistical difference ($p=0.4177$). The frequencies of complications except for pulmonary edema were similar between both the neurological outcome patients. The incidence of pulmonary edema alone were higher in the non-favorable neurologic outcome patients with statistically significant differences (11.1% vs. 74.5%, $p=0.003$) (**Table 3**).

Each CAG was performed without any complications,

Table 2. The primary outcomes of Pre- and Post- TH patients.

Primary outcome	Pre-TH patients (n=14) n or mean	% or SD	Post-TH patients (n=12) n or mean	% or SD	Fisher's exact test Significance, p
Mortality after admission	8	57.1%	3	25.0%	0.13
Mean length of stay(days)	7.14	8.38	10.25	5.89	0.29
CPC 1 - 2 after 1 month	2	14.3%	<u>7</u>	58.3%	0.038
Intervention					
CAG	5	35.7%	<u>12</u>	100.0%	0.0007
PCI	3	21.4%	6	50.0%	0.2177
IABP	1	7.1%	<u>6</u>	50.0%	0.0261
Complications					
Bleeding	1	7.1%	2	16.7%	0.58
Pneumonia	4	28.6%	3	25.0%	0.65
Sepsis	1	7.1%	1	8.3%	1
Renal failure	2	14.3%	3	25.0%	0.63
Reccurent VF	6	42.9%	5	41.7%	1
Pulmonary edema	11	78.6%	<u>3</u>	25.0%	0.02
Seizures	3	21.4%	1	8.3%	0.6

CPC: Pittsburgh cerebral-performance category, CAG: coronary angiography, PCI: percutaneous coronary intervention, IABP: intra-aortic balloon pumping, VF: ventricular fibrillation

Table 3. The comparison of the frequency of ACS, interventions, and complications between CPC1-2 and CPC3-5 patients.

Variables	CPC1-2 patients (n=9) n	%	CPC3-5 patients (n=17) n	%	Fisher's exact test Significance, p
Culprit disease					
#ACS	5	55.6%	12	70.6%	0.667
Interventions					
TH	7	77.8%	5	29.4%	0.0375
CAG	9	100.0%	8	47.1%	0.0094
PCI	2	22.2%	7	41.2%	0.4177
IABP	4	44.4%	3	17.7%	0.1881
Complications					
Bleeding	1	11.1%	2	11.8%	1
Pneumonia	1	11.1%	6	35.3%	0.357
Sepsis	0	0%	2	11.8%	0.529
Renal failure	0	0%	5	29.4%	0.129
Reccurent VF	2	22.2%	9	52.9%	0.217
Pulmonary edema	1	11.1%	13	74.5%	0.003
Seizures	1	11.1%	3	17.60%	1

ACS: acute coronary syndrome, CPC: Pittsburgh cerebral-performance category, TH: therapeutic hypothermia, CAG: coronary angiography, PCI: percutaneous coronary intervention, IABP: intra-aortic balloon pumping, VF: ventricular fibrillation

and in the Pre-TH patients, CAG was limited to survivors with ACS, whereas 33.3% (4/12) of Post-TH patients demonstrated normal CAG. 65.4% (17/26) of survivors after OHCA due to VF were assigned to ACS with electrocardiographic criteria for STEMI (n=4) or with the

coronary angiographic evidence (n=13) of an acute coronary syndrome due to either an acute occlusion (8/13:61.5%) or an irregular lesion suggestive of ruptured plaque or thrombus (5/13: 38.5%). The time to CAG from admission ranged from 28 to 64 (mean 44.8) mins.

Table 4. Results of PCI in the Pre- and Post-TH patients.

Pre-TH patients (n=3)	Coronary lesion	IABP	PCPS	Pulmonary edema +SBP<90mmHg	Cause of death
CPC1-2	LMT 99%	+	-	-	
CPC3-5	#3 100%, #6-7 90%	-	-	+	Severe cardiac dysfunction
	3VD, #1 100% #6 99%, #13 99%	-	-	+	Severe cardiac dysfunction
Post-TH patients (n=6)					
CPC1-2	#2 99%, #7 100%	+	-	-	
CPC3-5	#1 100%, #6 90%, #7 100%	+	+	+	Severe cardiac dysfunction
	#2 99%, #6 99%, #13 99%	-	-	+	Poor neurological outcome due to old cerebral infarction
	#7 100%	-	+	+	Bleeding from PCPS site
	#12 100%	+	-	+	Massive hemothorax due to chest compression
	#7 100%	+	-	+	Severe cardiac dysfunction

PCI: percutaneous coronary intervention, TH: therapeutic hypothermia, CPC: Pittsburgh cerebral-performance category, IABP: intra-aortic balloon pumping, PCPS: percutaneous cardiopulmonary support, LMT: left coronary main trunk artery, 3VD: 3 vessel disease, SBP: systolic blood pressure, +: performed, -: unperformed

Every PCI was performed by proficient PCI operator who had more than 150 annual experience number of PCI cases and 5 years of experience as a PCI specialist. The time to PCI ranged from 48 to 84 (mean 74.8) mins and completed within 120 mins. PCI was deemed successful if it resulted in residual stenosis of less than 50 percent with Thrombolysis in Myocardial Infarction (TIMI) classification grade 3 flow. PCI was attempted in 9 of 17 ACS cases of the total cohort and all PCIs were successfully completed. The non-favorable neurological outcomes reported for 2 of 3 cases in the Pre-TH patients and 5 of 6 cases in the Post-TH patients. All of these cases revealed cardiogenic shock complicated with pulmonary edema and systolic blood pressure lower than 90 mmHg including 4 cases of severe cardiac dysfunction after PCI, 2 cases of hemorrhagic shock due to PCPS insertion site bleeding and massive hemothorax caused by chest compression and one case of exacerbated cerebral ischemia with the previous infarction (Table 4).

Discussion

In 2002, two randomized controlled trials evaluated the effect of mild TH on comatose patients resuscitated after OHCA due to VF and demonstrated improvements in survival and neurological outcome^{11,12}. A number of studies published since 2002 support the use of TH after

cardiac arrest^{6,7,13-16} and only 4 studies were conducted solely at a community hospital^{8-10,17}. In other studies including all rhythms, much of the survival and neurological outcome benefit was limited to patients presenting with VF/ventricular tachycardia (VT) cardiac arrest^{6,18,19}. In the absence of firm guidelines, approaches to post-resuscitative care are heterogeneous, TH is the only intervention demonstrated to improve neurological recovery in some cardiac arrest survivors. We also did find a non-statistically significant trend towards improvement of survival outcomes and a statistically significant improvement of neurologic outcomes in the TH patients. Since brain injury and cardiovascular instability are the major determinants of survival after cardiac arrest²⁰, and overall the most common cause of cardiac arrest is cardiovascular disease and coronary ischemia²¹, TH and treatment of the underlying cause of cardiac arrest can impact survival and neurological outcomes. So we protocolized the comprehensive post-cardiac arrest care including immediate CAG in order to detect ACS and perform PCI as soon as possible followed by TH with aggressive cardiopulmonary support such as mechanical ventilation and IABP for hemodynamic optimization against all eligible comatose survivors as part of a bundle of care rather than single interventions. Though the ratio of ACS in the comatose survivors after OHCA due to VF was high (>60%: Table 1) and CAG made a positive effect on a fa-

vorable neurologic outcome, PCI did make little difference (Table 3). To explore why 7 of 9 PCI cases resulted in non-favorable neurological outcome, we reviewed the details of all PCI cases. Post-PCI severe cardiac dysfunction due to poor cardiac viability, bleeding complications and previous severe cerebral ischemia could be critical to the non-favorable neurological outcomes after PCI and TH itself could be harmful for these conditions. Pulmonary edema was an only adverse correlate of a favorable neurologic outcome among complications due to the persistent or residual cardiac dysfunction, even if successful PCI was performed. Our data of survival rate and favorable neurologic outcome in the TH patients were similar to the landmark trials by Bernard and the HACA group^{11,12)}. Unlike those trials, we included patients with un-witnessed cardiac arrest. In addition, the mean age of our patients was 2-3 years older^{11,12)}, all of these factors would be expected to lower survival rates and favorable neurologic outcomes. On the other hand, the ratio of male occupied in our study group was high (>50%), especially in the TH patients, higher than 90%, and deflection of the sex was particularly remarkable and our sample size was small, increasing the likelihood of a type 2 error. These factors could limit the ability to compare the outcomes between studies.

Conclusion

The comprehensive post-cardiac arrest care including TH, CAG and IABP could be associated with a significant improvement in neurologic outcomes and reduction of the complication of pulmonary edema in comatose survivors whose initial rhythm was VF. PCI with TH against cardiogenic shock could have some limitations due to poor cardiac viability and potential tendency of bleeding and cerebral hypoperfusion.

This study includes no financial relationship with commercial parties nor no conflicts of interest.

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原著論文

心室細動性心停止後症候群に対する脳低温療法と
迅速冠動脈造影等包括的蘇生後ケアの有用性

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要旨 【目的】1 地方病院での心室細動による院外心停止症例に対する脳低温療法，迅速冠動脈撮影を含めた包括的蘇生後管理導入前後の神経学的転帰の後ろ向き比較検討をする。【対象と方法】2003年12月1日～2011年5月31日に搬送された心室細動による院外心停止患者52例中，自己心拍再開し対光反射または自発呼吸を認めるが昏睡状態であった26例（2008年4月1日の脳低温療法と迅速冠動脈造影導入前の前期群：14例と導入後の後期群：12例）で検討した。脳低温療法（深部温 34℃）導入群では冠動脈造影検査も施行し，適応例に冠動脈インターベンションを施行した。Primary outcomeを入院期間，死亡率，神経学的転帰，冠動脈造影，冠動脈インターベンション等の入院後処置および合併症の頻度とした。Secondary outcomeとして神経学的転帰良好群（CPC: Pittsburgh cerebral performance category 1-2）と不良群（CPC3-5）での脳低温療法等の治療介入および合併症の比較検討を行った。全データはFisher's exact test, Student's t-testで比較検討した。【結果】良好な神経学的転帰は後期群に多く（ $p<0.05$ ），死亡率には有意差（ $p=0.13$ ）はなかった。冠動脈造影，大動脈内バルーンパンピング（IABP）は後期群で有意に多かった（ $p<0.05$ ）。合併症は肺水腫のみ後期群で有意に少なかった（ $p<0.05$ ）。神経学的転帰別にみると脳低温療法および迅速冠動脈撮影が良好群に有意に多く施行され（ $p<0.05$ ），肺水腫の合併も有意に低かった（ $p<0.01$ ）。【結論】脳低温療法，冠動脈撮影，IABPを含めた包括的蘇生後管理は，心室細動による院外心停止蘇生後昏睡患者の神経学的予後を改善し，かつ肺水腫の合併を減らした。

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