Effect of Admission Glasgow Coma Scale Motor Score on Neurological Outcome in Out-of-Hospital Cardiac Arrest Patients Receiving Therapeutic Hypothermia

Toru Hifumi, MD; Yasuhiro Kuroda, MD; Kenya Kawakita, MD; Hirotaka Sawano, MD; Yoshio Tahara, MD; Mamoru Hase, MD; Kenji Nishioka, MD; Shinichi Shirai, MD; Hiroshi Hazui, MD; Hideki Arimoto, MD; Kazunori Kashiwase, MD; Shunji Kasaoka, MD; Tomokazu Motomura, MD; Yuji Yasuga, MD; Naohiro Yonemoto, PhD; Hiroyuki Yokoyama, MD; Ken Nagao, MD; Hiroshi Nonogi, MD; the J-PULSE-Hypo Investigators

Background: Because the initial (on admission) Glasgow Coma Scale (GCS) examination has not been fully evaluated in comatose survivors of cardiac arrest (CA) who receive therapeutic hypothermia (TH), the aim of the present study was to determine any association between the admission GCS motor score and neurologic outcomes in patients with out-of-hospital CA who receive TH.

Methods and Results: In the J-PULSE-HYPO study registry, patients with bystander-witnessed CA were eligible for inclusion. Patients were divided into 3 groups based on GCS motor score (1, 2–3, and 4–5) to assess various effects on neurologic outcome. Univariate and multivariate analyses were performed to identify independent predictors of good neurologic outcome at 90 days. Of 452 patients, 302 were enrolled. There was a significant difference among the 3 patient groups with regard to neurologic outcome at 90 days in the univariate analysis. Multiple logistic regression analyses showed that the GCS motor score on admission, age >65 years, bystander cardiopulmonary resuscitation, the time from collapse to return of spontaneous circulation, and pupil size <4 mm were independent predictors of a good neurologic outcome at 90 days in cases of CA (GCS motor score, 4–5: odds ratio, 8.18; 95% confidence interval: 1.90–60.28; P<0.01).

Conclusions: GCS motor score is an independent predictor of good neurologic outcome at 90 days in patients sustaining out-of-hospital CA who receive TH. (Circ J 2015; 79: 2201–2208)

Key Words: Cardiac arrest; Glasgow Coma Scale; Neurological examination; Therapeutic hypothermia

In 2002, 2 randomized clinical trials (RCT) reported that therapeutic hypothermia (TH) improved survival and neurologic recovery of comatose survivors of cardiac arrest (CA)1,2 and since then, the use of TH has rapidly emerged as the principle as well as the standard post-resuscitation therapy. However, a recently published RCT concluded that in comatose survivors who have sustained out-of-hospital CA, normothermia management resulted in the same benefit as TH.3 One of the reasons for this discrepancy may be that there is no standardized definition of coma.4 The actual severity of brain injury varies among studies because of the absence of an established modality that enables evaluation of brain injury...
selected patients who met the following inclusion criteria: bystander-witnessed CA, target core temperature of 32–34°C and a cooling duration of 12–72 h.

GCS Evaluation
The initial GCS score was defined as the score observed immediately after admission to hospital by nurses and/or emergency physicians. Sedatives and paralytics were not administered before admission to hospital, and therefore, the GCS score was not influenced by any drugs.

Treatment
Patients received standard cardiopulmonary resuscitation (CPR) and post-CA care according to the 2005 American Heart Association guidelines. If hemodynamic instability persisted after ROSC, despite adequate fluid resuscitation and intravenous infusion of noradrenaline, adrenaline and/or dopamine, intra-aortic balloon pumping and/or cardiopulmonary bypass was performed as applicable.

Core temperature was immediately monitored by the bladder or rectal temperature upon hospital admission and monitored during the post-ROSC cooling period. A target core temperature of 32–34°C was maintained for 12–72 h, followed by gradual rewarming for 24–72 h. Emergency coronary angiography (CAG) was performed if acute coronary syndrome (ACS) was suspected, and coronary reperfusion therapy with percutaneous coronary intervention (PCI) was performed if necessary.

Data Collection and Processing
Data were collected following the Utstein Style guidelines for uniform reporting of laboratory CPR research, using software...
designed exclusively for the J-PULSE HYPO study registry. The following parameters were recorded for each study subject: age, sex, presence or absence of bystander CPR, initial rhythm, time from collapse to ROSC, vital signs on admission, mechanical circulation support after ROSC, cooling, CA due to ACS, CAG, PCI, cooling method, interval, overcooling, duration, rewarming duration, and neurologic outcome.

Study Endpoints
The primary endpoints were to assess the effect of GCS motor score on admission and to identify factors associated with a favorable neurologic outcome at 90 days after CA [Glasgow-Pittsburgh cerebral performance category (GP-CPC)] of 1 or 2).

Statistical Analysis
Study patients were divided into 2 groups on the basis of neurologic outcome (GP-CPC 1–2 and 3–5, respectively), and 3 groups on the basis of initial GCS motor score (1, 2–3, and 4–5, respectively). Baseline characteristics were compared using the Mann-Whitney U-test for continuous variables and the Fisher’s test for categorical variables as applicable. Comparisons of GCS motor score among the 3 groups were made using analysis of variance and Wilcoxon test for continuous variables and the $\chi^2$ test in binary data as applicable.

Univariate and multivariate logistic regression analyses were performed for the primary endpoints. Multivariate analysis was adjusted for possible confounders [age, sex, presence or absence of bystander CPR, the time from collapse to ROSC, pupil size <4 mm, initial rhythm (shockable), and GCS motor score on admission]. Variables with a probability (P) value <0.05 in the univariate analyses and variables of clinical significance were included in the model. Statistical analysis was performed using the JMP version 11 statistical software (SAS Institute, Inc, Cary, NC, USA).

Results
Of the 452 comatose adult patients treated with post-ROSC cooling and enrolled in the J-PULSE HYPO study registry, 376 met the inclusion criteria. Of these, 4 were excluded because the collapse-to-ROSC interval could not be determined; 10 patients were not eligible because the GCS motor score on admission could not be determined; another 60 patients were excluded because their neurologic outcome could not be determined (Figure 1). The remaining 302 patients were divided into 3 groups on the basis of the GCS motor score on admission as indicated.

Baseline Characteristics of the Study Population
Of the 302 patients enrolled, 80.8% were male. Analysis of initial (on admission) GCS scores revealed that 97.7% of the patients exhibited an eye score of 1 and 99.7% had a verbal score ≤2 (%).

Comparison of Favorable (GP-CPC 1–2) and Unfavorable (GP-CPC 3–5) Outcome Groups According to Time From Collapse to Arrival in the Emergency Department (ED) by EMS
Comparison of patients in the favorable and unfavorable outcome groups revealed that age >65 years, initial rhythm (shockable), the time from collapse to ROSC, GCS motor score, and pupil size <4 mm differed significantly (Table 2A).

Baseline Characteristics of the Study Population and Comparison of Favorable (GP-CPC 1–2) and Unfavorable (GP-CPC 3–5) Outcome Groups According to the Time Period After Admission
The number of patients with a time interval <4h from induction of cooling to reaching target core temperature was significantly lower among patients with a favorable outcome than among those with an unfavorable outcome (53.4% vs. 71.3%, P=0.02) (Table 2B).

Comparison of GCS Motor Score Groups (Between 1 and 2–3 and Between 1 and 4–5) According to Time From Collapse to Arrival in the ED by EMS
There were significant differences among the 3 groups with regard to the time from collapse to ROSC and pupil diameter <4 mm.

### Table 1. Baseline Characteristics of the Study Population of Out-of-Hospital Cardiac Arrest Patients

| Category                          | Total (n=302) |
|-----------------------------------|---------------|
| Age >65 years (%)                 | 116 (38.4)    |
| Male (%)                          | 244 (80.8)    |
| Bystander CPR (%)                 | 164 (54.3)    |
| Initial rhythm (shockable) (%)    | 238 (78.8)    |
| Time intervals                    |               |
| Time from collapse to ROSC (min)  | 25 (17–39)    |
| Vital signs on admission          |               |
| Glasgow Coma Scale                |               |
| Eye score 1 (%)                   | 295 (97.7)    |
| Verbal score ≤2 (%)               | 301 (99.7)    |
| Motor score                       |               |
| 1 (%)                             | 249 (82.5)    |
| 2–3 (%)                           | 30 (9.9)      |
| 4–5 (%)                           | 23 (7.6)      |
| SBP (mmHg)                        | 130 (110–163) |
| Heart rate (beats/min)            | 99 (84–120)   |
| Core body temperature             | 35.8 (35.0–36.4) |
| Pupil size <4 mm (%)              | 123 (40.7)    |
| Mechanical circulation support    |               |
| Intra-aortic balloon pumping (%)  | 117 (38.7)    |
| Cardiac arrest because of ACS (%) | 185 (61.3)    |
| Cooling                           |               |
| External cooling only (%)         | 72 (23.8)     |
| Time interval from induction of cooling to target core temperature <4h (%) | 193 (63.9) |
| Cooling duration ≤24h (%)         | 134 (44.4)    |
| Rewarming duration, within 2 days (%) | 198 (65.6) |
| Emergency coronary angiography (%) | 62 (20.5) |
| Percutaneous coronary intervention (%) | 142 (47.0) |
| Outcome                           |               |
| GP-CPC 1                          | 158 (52.3)    |
| GP-CPC 2                          | 15 (5.0)      |
| GP-CPC 3                          | 22 (7.3)      |
| GP-CPC 4                          | 33 (10.9)     |
| GP-CPC 5                          | 74 (24.5)     |

Data are presented as median (interquartile range, IQR) for continuous variables and n (%) for categorical variables. ACS, acute coronary syndrome; CPR, cardiopulmonary resuscitation; GP-CPC, Glasgow-Pittsburgh cerebral performance category; ROSC, return of spontaneous circulation; SBP, systolic blood pressure.
Multivariate Analysis
Multiple logistic regression analysis showed that GCS motor score on admission, age >65 years, presence or absence of bystander CPR, the time from collapse to ROSC, pupil size <4 mm, and initial rhythm (shockable) were independent predictors of good neurologic outcome at 90 days in cases of CA (Table 4).

Association Between Pupil Size on Admission (<4 mm or ≥4 mm) and Initial Rhythm (Shockable or Not) and Neurological Outcome in Patients With Initial GCS Motor Score of 1 (Figures 3A,B)
There was a significantly better neurologic outcome in patients with pupil <4 mm compared with those with pupil ≥4 mm (70% vs. 41.4%, P<0.01) (Table 3A).

There was a significantly better neurologic outcome in the group compared with the ≥4 mm pupil group in patients with GCS motor score 1 (60.9% vs. 22.8%, P<0.01) (Table 3B).

Table 2. Comparison of Baseline Characteristics of Favorable (GP-CPC 1–2) and Unfavorable (GP-CPC 3–5) Outcome Groups According to (A) the Time From Collapse to Arrival in the ED by EMS and (B) the Time Period After Admission

|                      | GP-CPC 1–2 at 90 days (n=173) | GP-CPC 3–5 at 90 days (n=129) | P value |
|----------------------|-------------------------------|-------------------------------|---------|
| A. The time from collapse to arrival in the ED by EMS |                               |                               |         |
| Age >65 years (%)    | 49 (28.3)                     | 67 (52.0)                     | <0.01   |
| Male (%)             | 141 (81.5)                    | 103 (79.8)                    | 0.77    |
| Bystander CPR (%)    | 96 (55.5)                     | 68 (52.7)                     | 0.64    |
| Initial rhythm (shockable) (%) | 153 (88.4) | 85 (65.9) | <0.01 |
| Time intervals       |                               |                               |         |
| Time from collapse to ROSC (min) | 20 (14–30) | 34 (23–50) | <0.01 |
| Vital signs on admission |                               |                               |         |
| Glasgow Coma Scale   |                               |                               |         |
| Eye score 1 (%)      | 167 (96.5)                    | 128 (99.2)                    | 0.24    |
| Verbal score ≤2 (%)  | 173 (100)                     | 128 (99.2)                    | 0.43    |
| Motor score          |                               |                               | <0.01   |
| 1 (%)                | 130 (75.1)                    | 119 (92.3)                    |         |
| 2–3 (%)              | 23 (13.3)                     | 7 (5.4)                       |         |
| 4–5 (%)              | 20 (11.6)                     | 3 (2.3)                       |         |
| SBP (mmHg)           | 132 (110–170)                 | 122 (110–147)                 | 0.18    |
| Heart rate (beats/min) | 100 (85–120)              | 95 (80–120)                   | 0.49    |
| Core body temperature (°C) | 36 (35.1–36.4)               | 35.6 (35–36.2)               | 0.06    |
| Pupil size <4 mm (%) | 87 (50.3)                     | 36 (27.9)                     | <0.01   |

| B. The time period after admission |                               |                               |         |
| Mechanical circulation support after ROSC |                               |                               |         |
| Intra-aortic balloon pumping (%) | 59 (34.1)                       | 58 (44.9)                     | 0.06    |
| Cardiac arrest due to ACS (%)     | 102 (59.0)                     | 83 (64.3)                     | 0.40    |
| Cooling                           |                               |                               |         |
| External cooling only (%)         | 48 (27.8)                      | 24 (18.6)                     | 0.08    |
| Time interval from induction to target core temperature ≤4 h (%) | 101 (58.3) | 92 (71.3) | 0.02 |
| Cooling duration ≤24 h (%)        | 72 (41.6)                      | 62 (48.1)                     | 0.22    |
| Rewarming duration, within 2 days (%) | 111 (64.2)              | 87 (67.4)                     | 0.62    |
| Emergency coronary angiography (%) | 28 (16.2)                       | 34 (26.4)                     | 0.04    |
| Percutaneous coronary intervention (%) | 77 (44.5)                   | 65 (50.4)                     | 0.35    |

Data are presented as median (IQR) for continuous variables and n (%) for categorical variables. ED, emergency department; EMS, emergency medical service; IQR, interquartile range. Other abbreviations as in Table 1.

Significant differences were observed between patients with a GCS motor score of 1 and those with a score of 2–3 with regard to the time from collapse to ROSC and pupil diameter <4 mm. There was also a significant difference in the time from collapse to ROSC between patients with a GCS motor score of 1 and those with a score of 4–5 (Table 3A).

Comparison of GCS Motor Score Groups (Between 1 and 2–3 and Between 1 and 4–5) According to the Time Period After Admission
There was no significant difference between patients with a GCS motor score of 1 and those with a score of 2–3 or 4–5 according to the time period after admission (Table 3B).

Association Between GCS Motor Score on Admission and Neurologic Outcome
There was a significant difference among the 3 groups with regard to favorable neurological outcome (GP-CPC, 1–2) at 90 days [GCS motor score 1, n=130 (52.2%); score 2–3, n=23 (76.7%); score 4–5, n=20 (87.0%); P<0.01; Figure 2].
Table 3. Comparison of GCS Motor Score Groups (Between 1 and 2–3 and Between 1 and 4–5) According to (A) the Time From Collapse to Arrival in the ED by EMS and (B) the Period After Admission

|                      | GCS: M1 (n=249) | GCS: M2–3 (n=30) | OR (95% CI) | P value  | GCS: M4–5 (n=23) | OR (95% CI) | P value  |
|----------------------|------------------|------------------|-------------|---------|------------------|-------------|---------|
| **A. The time from collapse to arrival in the ED by EMS** |                  |                  |             |         |                  |             |         |
| Age >65 years, n (%) | 99 (40.0)        | 12 (40.0)        | 1.01        | 0.01    | 5 (21.7)         | 0.42        | 0.11    |
| Male, n (%)          | 199 (79.9)       | 24 (80)          | 1.01        | 0.01    | 21 (91.3)        | 2.64        | 0.27    |
| Bystander CPR, n (%) | 110 (44.2)       | 18 (60.0)        | 1.90        | 0.12    | 10 (43.5)        | 0.97        | 1.00    |
| Initial rhythm (shockable), n (%) | 192 (77.1) | 26 (86.7) | 1.93 | 0.34 | 20 (87.0) | 1.98 | 0.43 |
| **Time intervals**   |                  |                  |             |         |                  |             |         |
| Time from collapse to ROSC (min) | 28 (19–43) | 16.5 (12–20) | <0.01 |        | 17 (13–31) | <0.01 | <0.01* |
| Vital signs on admission |          |                  |             |         |                  |             |         |
| SBP (mmHg)           |                  |                  |             |         |                  |             |         |
| Median (IQR)         | 132 (110–162)    | 121 (110–149)    | 0.33        | 0.33    | 143 (110–176)    | 0.43        | 0.43*   |
| Heart rate (beats/min) |             |                  |             |         |                  |             |         |
| Median (IQR)         | 102 (86–129)     | 90 (79–110)      | 0.08        | 0.08    | 100 (86–121)     | 0.92        | 0.19*   |
| Core body temperature (°C) |        |                  |             |         |                  |             |         |
| Median (IQR)         | 35.8 (35–36.3)   | 36.1 (35–36.4)   | 0.30        | 0.30    | 36 (35.1–36.6)   | 0.33        | 0.39*   |
| Pupil diameter <4 mm, n (%) | 92 (37.0) | 21 (70.0) | 3.68 | <0.01 | 10 (43.5) | 1.31 | 0.65 |
| **B. The period after admission** |                  |                  |             |         |                  |             |         |
| Mechanical circulation support after ROSC |          |                  |             |         |                  |             |         |
| Intra-aortic balloon pumping (%) | 100 (40.2) | 8 (26.7) | 1.85 | 0.17 | 14 (60.9) | 1.04 | 1.00 |
| Cardiac arrest due to ACS (%) | 157 (63.1) | 16 (53.3) | 0.67 | 0.32 | 12 (52.2) | 0.64 | 0.37 |
| Cooling              |                  |                  |             |         |                  |             |         |
| External cooling only (%) | 57 (22.9) | 6 (20.0) | 0.84 | 0.82 | 9 (39.1) | 2.17 | 0.12 |
| Time interval from induction of cooling to target core temperature <4 h (%) | 165 (66.2) | 15 (50.0) | 0.51 | 0.11 | 13 (56.5) | 0.66 | 0.37 |
| Cooling duration ≤24 h (%) | 114 (45.8) | 14 (46.7) | 1.08 | 1.00 | 6 (26.1) | 2.35 | 0.10 |
| Rewarming duration, within 2 days (%) | 165 (66.3) | 16 (53.3) | 0.58 | 0.16 | 17 (73.9) | 1.44 | 0.64 |
| Emergency coronary angiography (%) | 199 (80.0) | 22 (73.3) | 1.45 | 0.47 | 19 (82.6) | 0.84 | 1.00 |
| Percutaneous coronary intervention (%) | 129 (51.8) | 19 (63.3) | 1.61 | 0.25 | 12 (52.2) | 1.01 | 1.00 |

(A) P value: Mann-Whitney U-test in upper column, t-test in lower column. *In continuous data, Wilcoxon test among 3 groups for GCS motor scores in upper column, ANOVA in lower column. χ² test among 3 groups for GCS motor scores in binary data. (B) Data are presented as median (interquartile range, IQR) for continuous variables and n (%) for categorical variables. **χ² test among 3 groups for GCS motor scores in binary data. CI, confidence interval; OR, odds ratio. Other abbreviations as in Tables 1,2.
neurologic outcome. Schefold et al demonstrated that simple GCS monitoring on the day after TH is useful for predicting neurologic outcome. However, following TH, neurologic examinations are challenging because of the use of sedative and paralytic agents in TH. Absent or extensor motor responses are no longer reliable predictors of a poor outcome following TH; Greer et al reported that 8.1% of patients with absent or extensor motor responses on day 3 after admission achieved good outcomes. Rossetti et al prospectively evaluated 111 patients treated with TH and observed that a poor motor response on day 3 after admission had a false positivity rate of 24% with regard to predicting poor outcome, but others have reported false positivity rates of 10–17%. Therefore, because sedatives and paralytics were not administered on admission in the current study, it is theoretically reasonable that the admission GCS motor score of these comatose CA survivors may reliably predict neurologic outcome. Schefold et al demonstrated that simple GCS monitoring on the day after TH is useful for predicting neurologic outcome. However, following TH, neurologic examinations are challenging because of the use of sedative and paralytic agents in TH. Absent or extensor motor responses are no longer reliable predictors of a poor outcome following TH; Greer et al reported that 8.1% of patients with absent or extensor motor responses on day 3 after admission achieved good outcomes. Rossetti et al prospectively evaluated 111 patients treated with TH and observed that a poor motor response on day 3 after admission had a false positivity rate of 24% with regard to predicting poor outcome, but others have reported false positivity rates of 10–17%. Therefore, because sedatives and paralytics were not administered on admission in the current study, it is theoretically reasonable that the admission GCS motor score of these comatose CA survivors may reliably predict neurologic outcome. Most of the studies regarding the efficacy of TH in comatose CA survivors did not report the admission GCS motor scores, but 2 did. Greer et al examined 200 comatose

Discussion

In the current study, a favorable neurologic outcome increased in proportion to initial GCS motor score, and the initial GCS motor score was determined to be a factor. Neurologic examinations, such as the FOUR score and the recently published Pittsburgh Cardiac Arrest Category, assist in predicting the outcome of CA survivors; however, such examinations are performed 1–2 days after CA and 6 h after ROSC, respectively, and comprise multiple examinations. Meanwhile, in clinical practice, the decision to initiate TH should not be delayed, so an evaluation of initial (on admission) GCS motor score applicability is valuable. GCS was introduced by Jennett and Teasdale in 1974 and has been shown to be particularly useful for monitoring the severity of consciousness in patients with traumatic brain injury. Because comatose survivors of CA are intubated and eye opening does not always represent intact consciousness (as in a persistent vegetative state), the motor component of GCS is more useful and accurate than the GCS in predicting neurologic outcome. Schefold et al demonstrated that simple GCS monitoring on the day after TH is useful for predicting neurologic outcome. However, following TH, neurologic examinations are challenging because of the use of sedative and paralytic agents in TH. Absent or extensor motor responses are no longer reliable predictors of a poor outcome following TH; Greer et al reported that 8.1% of patients with absent or extensor motor responses on day 3 after admission achieved good outcomes. Rossetti et al prospectively evaluated 111 patients treated with TH and observed that a poor motor response on day 3 after admission had a false positivity rate of 24% with regard to predicting poor outcome, but others have reported false positivity rates of 10–17%. Therefore, because sedatives and paralytics were not administered on admission in the current study, it is theoretically reasonable that the admission GCS motor score of these comatose CA survivors may reliably predict neurologic outcome. Most of the studies regarding the efficacy of TH in comatose CA survivors did not report the admission GCS motor scores, but 2 did. Greer et al examined 200 comatose

![Figure 2. Association between Glasgow Coma Scale (GCS) motor score and neurologic outcome.](image)

Table 4. Univariate and Multivariate Analyses of Favorable Neurologic Outcome at 90 Days After Out-of-Hospital Cardiac Arrest

|                          | Univariate analysis | Multivariate analysis |
|--------------------------|--------------------|----------------------|
|                          | OR 95% CI P value  | Adjusted OR 95% CI P value |
| GCS motor score on admission |                    |                      |
| M1 (reference)           | 1                  | 1                    |
| M2–3                    | 3.00 1.30–7.81 <0.01 | 1.62 0.62–4.64 0.33   |
| M4–5                    | 6.12 2.03–26.36 <0.01 | 8.18 1.90–60.28 <0.01 |
| Age >65 years           | 0.30 0.17–0.53 <0.01 |                      |
| Male                    | 1.03 0.50–2.09 0.94 |                      |
| Bystander CPR           | 1.78 1.00–3.19 0.046 |                      |
| Time from collapse to ROSC (min) | 1.03 1.02–1.05 <0.01 |                      |
| Pupil size <4 mm        | 2.39 1.32–4.40 <0.01 |                      |
| Initial rhythm (shockable) | 3.93 2.01–7.92 <0.01 |                      |

Abbreviations as in Tables 1,3.
survivors of CA, but 152 (85%) patients died subsequent to withdrawal of life-sustaining therapies, and the rate of CA patients who received TH was unknown; therefore, any association between initial GCS motor score and neurologic outcome in patients with CA who received TH could not be investigated. A recently published RCT comparing normothermia and TH for comatose survivors of out-of-hospital CA performed by Nielsen et al evaluated GCS motor score on admission. Although they reported similar GCS motor scores in the study groups, the association between GCS motor score and neurologic outcome remains unknown. The results of the present study indicated that GCS motor score monitoring on admission may provide information sufficient to identify patients who are more likely to achieve a favorable neurologic outcome following CA.

Our data do not support early termination of aggressive support, including TH, on the basis of a single test of initial GCS motor score; even patients with the worst GCS motor score (1) may have a 52.2% probability of good neurologic outcome after receiving TH. In patients with initial GCS motor score 1, the pupil size on admission (<4 mm or ≥4 mm) and initial rhythm (shockable or not) are useful information for predicting the neurologic outcome after receiving TH.

Thus, further studies are required to examine the specific benefits of TH for patients with an initial GCS motor score of 1. Initial GCS motor score examination can at least provide baseline objective prognostic data for discussions with surrogate decision makers.

Study Limitations
First, the neurologic outcomes of 60/376 patients could not be obtained because of patient discharge or transfer. Of those 60 patients, 32 were confirmed as cerebral performance category 1 on day 30. We made a comparison of our analyzed data and the missing cases with regard to baseline characteristics and confirmed that there was no significant difference between the 2 groups. Furthermore, we made a comparison of neurologic outcome at 30 days between our analyzed data and the missing cases for each initial GCS motor score 1, 2–3 and 4–5 groups, and there was no significant difference in the neurologic outcomes at 30 days.

Second, our survey did not evaluate GCS following TH; therefore, we did not compare the efficacy of GCS before and after TH. Third, GCS motor scores do not have equal differences. For example, the difference between M5 and M4, and M4 and M3 is not equal. Fourth, the database is relatively old, so patients were not resuscitated according to current guidelines.

Conclusions
GCS motor score on admission is an independent predictor of good neurologic outcome at 90 days for patients who sustain out-of-hospital CA and receive TH. The GCS motor score should be evaluated in the ED when initially examining patients with out-of-hospital CA.

Acknowledgments
This study was supported by a research grant for Cardiovascular Disease (H19-Shinkin-03: a study related to the establishment of a prehospital system in acute myocardial infarction and stroke) from the Ministry of Health, Labour and Welfare of Japan.

Conflict of Interests
We have no conflicts of interest to declare.

References
1. Bernard SA, Gray TW, Buist MD, Jones BM, Silvester W, Gutteridge G, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med 2002; 346: 557–563.
2. Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. N Engl J Med 2002; 346: 549–556.
3. Nielsen N, Wetterslev J, Cronberg T, Erlinge D, Gasche Y, Hassager C, et al. Targeted temperature management at 33 degrees C versus 36 degrees C after cardiac arrest. N Engl J Med 2013; 369: 2197–2206.
4. Greer DM, Yang J, Scripko PD, Sims JR, Cash S, Wu O, et al.
Clinical examination for prognostication in comatose cardiac arrest patients. Resuscitation 2013; 84: 1546–1551.

5. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: A practical scale. Lancet 1974; 2: 81–84.

6. Rossetti AO, Oddo M, Logroscino G, Kaplan PW. Prognostication after cardiac arrest and hypothermia: A prospective study. Ann Neurol 2010; 67: 301–307.

7. Fugate JE, Wijdicks EF, Mandrekar J, Claassen DO, Manno EM, White RD, et al. Predictors of neurologic outcome in hypothermia after cardiac arrest. Ann Neurol 2010; 68: 907–914.

8. Bouwes A, Binnekade JM, Kuiper MA, Bosch FH, Zandstra DF, Toornvliet AC, et al. Prognosis of coma after therapeutic hypothermia: A prospective cohort study. Ann Neurol 2012; 71: 206–212.

9. Shinada T, Hata N, Yokoyama S, Kobayashi N, Tomita K, Shirakabe A, et al. Usefulness of a surface cooling device (Arctic Sun(R)) for therapeutic hypothermia following cardiac arrest. J Cardiol 2014; 63: 46–52.

10. Okamoto Y, Iwami T, Kitamura T, Nitta M, Hiraide A, Morishima T, et al. Regional variation in survival following pediatric out-of-hospital cardiac arrest. Circ J 2013; 77: 2596–2603.

11. Mitani Y, Ohta K, Ichida F, Nii M, Arakaki Y, Ushinohama H, et al. Circumstances and outcomes of out-of-hospital cardiac arrest in elementary and middle school students in the era of public-access defibrillation. Circ J 2014; 78: 701–707.

12. Chest-compression-only bystander cardiopulmonary resuscitation in the 30:2 compression-to-ventilation ratio era: Nationwide observational study. Circ J 2013; 77: 2742–2750.

13. Kobayashi N, Hata N, Shimura T, Yokoyama S, Shirakabe A, Shinada T, et al. Characteristics of patients with cardiac arrest caused by coronary vasospasm. Circ J 2013; 77: 673–678.

14. Yokoyama H, Nagao K, Hase M, Tahara Y, Hazui H, Arimoto H, et al. Impact of therapeutic hypothermia in the treatment of patients with out-of-hospital cardiac arrest from the J-PULSE-HYPO study registry. Circ J 2011; 75: 1063–1070.

15. Soga T, Nagao K, Sawano H, Yokoyama H, Tahara Y, Hase M, et al. Neurological benefit of therapeutic hypothermia following return of spontaneous circulation for out-of-hospital non-shockable cardiac arrest. Circ J 2012; 76: 2579–2585.

16. Cummins RO, Chamberlain DA, Abramson NS, Allen M, Baskett PJ, Becker L, et al. Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: The Utstein Style: A statement for health professionals from a task force of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council. Circulation 1991; 84: 960–975.

17. ECC Committee, Subcommittees and Task Forces of the American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2005; 112: IV1–IV203.

18. Gold B, Puertas L, Davis SP, Metzger A, Yannopoulos D, Oakes DA, et al. Awakening after cardiac arrest and post resuscitation hypothermia: Are we pulling the plug too early? Resuscitation 2014; 85: 211–214.

19. Fugate JE, Rabinstein AA, Claassen DO, White RD, Wijdicks EF. The FOUR score predicts outcome in patients after cardiac arrest. Neurocrit Care 2010; 13: 205–210.

20. Coppler PJ, Elmer J, Calderon L, Sabedra A, Doshi AA, Callaway CW, et al. Validation of the Pittsburgh Cardiac Arrest Category illness severity score. Resuscitation 2015; 87: 122–128.

21. Levy DE, Caronna JJ, Singer BH, Frydman H, Plum F. Predicting outcome from hypoxic-ischemic coma. JAMA 1985; 253: 1420–1426.

22. Schefold JC, Storm C, Krüger A, Ploner CJ, Hasper D. The Glasgow Coma Score is a predictor of good outcome in cardiac arrest patients treated with therapeutic hypothermia. Resuscitation 2009; 80: 658–661.

23. Al Thenayan E, Savard M, Sharpe M, Norton L, Young B. Predictors of poor neurologic outcome after induced mild hypothermia following cardiac arrest. Neurology 2008; 71: 1535–1537.