doi: 10.1016/j.resuscitation.2015.10.004

Are regional variations in activity of dispatcher-assisted cardiopulmonary resuscitation associated with out-of-hospital cardiac arrests outcomes? A nation-wide population-based cohort study.

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Word count: 2993

Number of Figures: 3

Number of Tables: 3

Supplementary Table: 1

Abstract

Aim: Dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) impacts the rates of bystander CPR (BCPR) and survival after out-of-hospital cardiac arrests (OHCAs). This study aimed to elucidate whether regional variations in indexes for BCPR and emergency medical service (EMS) may be associated with OHCA outcomes.

Methods: We conducted a population-based observational study involving 157,093 bystander-witnessed, resuscitation-attempted OHCAs without physician involvement between 2007 and 2011. For each index of BCPR and EMS, we classified the 47 prefectures into the following three groups: advanced, intermediate, and developing regions. Nominal logit analysis followed by multivariable logistic regression including OHCA backgrounds was employed to examine the association between neurologically favourable 1-month survival, and regional classifications based on BCPR- and EMS-related indexes.

Results: Logit analysis including all regional classifications revealed that the number of BLS training course participants per population or bystander's own performance of BCPR without DA-CPR was not associated with the survival. Multivariable logistic regression including the OHCA backgrounds known to be associated with survival (BCPR provision, arrest aetiology, initial rhythm, patient age, time intervals of witness-to-call and call-to-arrival at patient), the following regional classifications based on DA-CPR but not on EMS were associated with survival: sensitivity of DA-CPR [adjusted odds ratio (95% confidence intervals) for advanced region; those for intermediate region, with developing region as reference, 1.277 (1.131–1.441); 1.162 (1.058 – 1.277)] ; the proportion of bystanders to follow DA-CPR [1.749 (1.554–1.967); 1.280 (1.188–1.380)].

Conclusions: Good outcomes of bystander-witnessed OHCAs correlate with regions having higher sensitivity of DA-CPR and larger proportion of bystanders to follow DA-CPR.

Word counts: 250

Key words: Cardiopulmonary resuscitation; Dispatcher-assisted; Cross-regional comparison; Out-of-hospital cardiac arrest; Survival; Pre-Arrival Instructions

Introduction

Regional variations in the rate of survival after out-of-hospital cardiac arrests (OHCAs) have been reported [1–4]. These variations are likely due to uneven distribution of high-grade management of OHCAs in both prehospital and in-hospital settings [4].

Rapid initiation of cardiopulmonary resuscitation (CPR) is an important determinant of survival after OHCA [5, 6]. Nevertheless, laypersons who witness OHCAs rarely start bystander CPR (BCPR) on their own initiative [2, 3]. Dispatcher-assisted CPR (DA-CPR) increases the rate of BCPR performance and may improve survival after OHCAs [7, 8]. The impact of DA-CPR on survival may depend on the dispatcher's experience [8] and quality of the DA-CPR [9, 10].

Therefore, regional variations in the provision of high-quality DA-CPR may be one of the causes for variations in the rates of BCPR and OHCA outcomes. The quality of DA-CPR should be measured in terms of early and proper recognition of savable cardiac arrests [7, 8,10] . This study was conducted to elucidate whether regional variations in indexes related to DA-CPR and BCPR may be associated with better outcomes of OHCAs.

Methods

Data collection

We obtained permission from the Fire and Disaster Management Agency (FDMA) of Japan to analyse the FDMA data prospectively collected for 388,221 OHCAs that occurred from January 2007 to December 2011. The FDMA database was created by a prospective, nationwide, population-based registry system of OHCAs according to the Utstein style [11]. This study was designed by a group comprising members of the Ishikawa Medical Control Council and their collaborators, and it was approved by the review board of Ishikawa Medical Control Council.

FDMA databases include the following information recommended at the Utstein International Conference [11]: patients backgrounds, arrest witness, aetiology of OHCA (presumed cardiac or non-cardiac), derivation of BCPR (with or without DA-CPR instruction), type of BCPR (conventional or compression-only), initial cardiac rhythm, estimated time of collapse, times of CPR initiation by bystander and emergency medical technician (EMT), and times of EMT arrival on the OCHA site and in the hospital, one-month (1-M) survival, and neurologically favourable 1-M survival (cerebral performance category, 1 or 2). The times of collapse and BCPR initiation and type of BCPR were estimated from the EMT's interview of the bystander. Cardiac or non-cardiac origin was clinically determined by EMTs in collaboration with physicians. The fire departments obtained information on 1-M survivals and neurological outcome from the hospital records. The FDMA logically checked data integrated in the registry system and, if necessary, requested the respective fire department to correct and complete the data.

Population, geography, emergency medical service (EMS) and basic life support training

Japan is composed of 47 prefectures. Population and geographic data in each prefecture were collected from the 2007‑2012 Japan Census data [12].

In 2011, 791 fire departments had 4,965 ambulance teams. All fire departments principally have a one-tiered dispatch system. Fire departments play a major role in educating citizens regarding basic life support (BLS). Numbers of ambulances, ambulance dispatches, and participants in BLS training courses held by fire departments in each prefecture were collected from a nation-wide database created by the FDMA [13]. In Japan, new driver license applicants are obligated to receive BLS training in qualified driving schools [14]. The number of new driver license applicants in each prefecture was collected from the Statics in Driver License in Japan [15]. The total number of participants in BLS training courses conducted by fire departments and authorized driving schools was calculated in each prefecture.

Unless an OHCA patient is obviously dead or presents post-mortem changes, EMTs must not terminate resuscitation at the scene. In addition to basic life support, EMTs may use airway adjuncts, including suprapharyngeal and laryngeal masks, and may commence a peripheral venous infusion of Ringer's lactate. However, only authorized and specially trained EMTs are permitted to insert tracheal tubes and administer intravenous epinephrine.

At the end of 2006, the Japan Resuscitation Council (JRC) announced similar guidelines to those of the AHA (JRC Guidelines 2005) [16]. Therefore, BLS was substantially performed in accordance with JRC Guidelines 2005 in the period of 2007‑2011. Provision of DA-CPR was encouraged by FDMA in 1999. However, a standard protocol based on the JRC guidelines for DA-CPR and education of dispatcher was released in 2013 (after the study period of this study). Thus, basically each fire department provided DA-CPR instruction on callers according to different protocols during the study period.

Data selection

From the 388,221 OHCAs that occurred from January 2007 to December 2011, we first extracted a dataset comprising 192,794 bystander-witnessed OHCA without any prehospital involvement of physicians, eliminating cases with physician involvement as per the following reasons: 1) some of these cases received prehospital advanced life support (ALS) performed by physicians on duty [17]; 2) most of these OHCAs occurred in medical offices and sanatoriums or during home visit by physicians, and physicians on duty played primary roles in the treatment and transportation of patients; 3) these physicians should not be categorized as bystanders according to the Utstein recommendations [11]. Then, we excluded the following cases lacking the essential information for the analysis: 4,539 cases lacking fundamental time records, 12 cases with unknown patient backgrounds, and 2765 cases with unknown DA-CPR or type of BCPR. Finally, we selected 157,093 bystander-witnessed cases with a complete dataset available (Figure 1).

This study analysed only the bystander-witnessed cases. As stated in the Utstein Recommendation [11], this implies that the bystander was present when the patient went into cardiac arrests before EMT arrival at patients.

Calculation of three indexes related to DA-CPR and BCPR

According to the existence and timing of BCPR and DA-CPR, BCPR was divided into four groups: BCPR following DA-CPR, BCPR on bystander's own initiative (without DA-CPR), no BCPR despite DA-CPR, and no BCPR without DA-CPR. We calculated the following three indexes associated with DA-CPR and BCPR: sensitivity of DA-CPR (= the number of cases for which DA-CPR was attempted divided by the number of cases that did not receive BCPR on bystander's own initiative); proportion of bystanders to follow DA-CPR (= the number of cases that received BCPR following DA-CPR divided by the number of cases for which DA-CPR was attempted); bystander's own performance of BCPR (= the number of cases that received BCPR on bystander's own initiative divided by the number of cases for which DA-CPR was not attempted). These definitions and calculations from the four groups of BCPR are summarised in Table 1. We determined these three indexes and the rate of BCPR in each prefecture.

Calculations of EMS-related indexes

From the data on population, geography, EMS system, and driver license applicants [12,13,15], we calculated the following indexes that may be related to the incidences of BCPR: annual number of BLS training course participants per population and proportion of aged (≧65 years) population [14]. Furthermore, we calculated the following indexes that may be related to EMS response, the transportation of patients and ACLS procedures by paramedics: numbers of emergency hospitals and ambulance teams per 100 km^2 of residential area, annual number of emergency medical dispatches per one ambulance team, and the rates of tracheal intubation and adrenalin administration by paramedics.

Study endpoints and outcomes

The primary endpoint of this study was neurologically favourable 1-M survival (cerebral performance category 1 or 2) [18].

Statistical analysis

Data were analysed using JMP 11 Pro (SAS institute, Cary, NC, USA) and/or a computer software by Preacher [19].

Correlations among prefectural rates of neurologically favourable 1-M survival and calculated indexes were screened by correlation analysis with adjustment of number of OHCAs in each prefecture. Then, we classified the 47 prefectures into the following three groups in each index using entropy splitting with the rate of neurologically favourable 1-M survival as response variable: advanced, intermediate, and developing regions.

Differences across groups for nominal variables were assessed using the $\chi 2$ test with Yates' correction followed by calculation of unadjusted odds ratios (ORs) and 95% confidence intervals (CI). The Wilcoxon rank sum test was applied for nonparametric comparisons of continuous variables.

Multiple logistic regression analysis was used to examine the association between neurologically favourable 1-M survival, OHCA backgrounds, and regional classification based on BCPR- and EMS-related indexes. We sequentially introduced groups of variables into the model: first, basic variables known to be associated with OHCA outcomes, then variables identified as significant in the univariable analysis in a stepwise manner to obtain the lowest Bayesian information criterion (BIC). The generalized R^2 of the final model was computed to measure the fit of the regression model. For each analysis, the null hypothesis was evaluated at a two-sided significance level of p <0.05, with 95% CI calculated using profile likelihood.

RESULTS

Variations of BCPR-related indexes and classification of prefectures

The number of OHCAs, showed by the size of symbols in Figure 2, widely differed in the 47 prefectures because of differences in population. The sensitivity of DA-CPR, proportion of bystanders to follow DA-CPR, and bystander's own performance of BCPR in the 47 prefectures was 32.4%‑73.6%, 47.7%‑78.4%, and 24.2%‑41.4%, respectively. Correlation analysis revealed the following findings: 1) The sensitivity of DA-CPR and proportion of bystanders to follow DA-CPR positively correlated to the rate of neurologically favourable 1-M survival (correlation coefficient; 95% CI, 0.306; 0.302‑0.311 and 0.652; 0.649‑0.655, respectively), 2) Bystander's own performance of BCPR negatively correlated to the survival rate (-0.294; -0.299‑-0.290), 3) The three indexes associated with BCPR correlated to each other.

Variations of EMS-related indexes and classification

Annual number of BLS training course participants per 100,000 people ranged from 1,407 to 5,946 with the exception of one prefecture having a very high number. The proportion of aged population was 17.3%‑29.5%. In correlation analysis, it was likely that the number of BLS training course participants per population negatively correlated to the survival rate (-0.420; -0.325‑-0.420), and that the proportion of aged population weakly and positively correlated to the survival rate (0.069; 0.064‑0.073).

The number of emergency hospitals per 100 km^2 of residential area varied from 11.2 to 57.4. The number of ambulance teams per 100 km^2 of residential area ranged from 21.0 to 63.4. The annual number of emergency medical dispatches per one ambulance ranged from 328 to 2,054. In correlation analysis, there was a very weak and negative correlation between each index and neurologically favourable 1-M survival: the number of emergency hospitals per 100 km^2 of residential area, -0.076; -0.081‐-0.071, number of ambulance teams per 100 km^2 of residential area, -0.169; -0.174‐-0.164, number of emergency medical dispatches per one ambulance, -0.076‐-0.081.

The rates of tracheal intubation and adrenalin administration by paramedics widely varied: 0.7%‐25.5% and 4.1%‐27.7%, respectively. In correlation analysis, there was positive correlation between each rate and neurologically favourable 1-M survival: tracheal intubation, 0.528; 0.525‐0.532, adrenalin administration, 0.062; 0.057‐0.067.

Association of regional classifications by DA-CPR and EMS-related indexes with neurologically favourable 1-month survival

Univariable analysis revealed that all regional classifications were significantly associated with neurologically favourable 1-M survival (p<0.01, Table 2). We performed multinomial logistic regression where significant classifications from the univariable analysis were sequentially added to obtain the lowest BIC. The final best fit model included regional classifications based on sensitivity of DA-CPR, proportion of bystanders to follow DA-CPR, number of emergency hospitals, proportion of aged population, and numbers of emergency

hospitals and ambulance teams per 100 km^2 of residential area. When the developing regions were set as reference, adjusted ORs (95% CI) of the advanced region for sensitivity of DA-CPR and proportion of bystanders to follow DA-CPR were 1.615 (1.410‐1.851) and 1.713 (1.518‐1.931), respectively.

Patient factors associated with neurologically favourable 1-month survival

When univariable analysis was performed, age, gender, aetiology of arrest, performance of BCPR, initial rhythm, time interval between witnessing and emergency call, interval between emergency call and EMT arrival on site of OHCA, and interval between EMT arrival on site of OHCA and EMT arrival at hospital were associated with the survival (Table 3).

Multivariable logistic regression analysis for neurologically favourable 1-month survival (Figure 3)

We confirmed the association between DA-CPR-related regional classifications and neurologically favourable

1-M survival by multivariable logistic regression analysis including both patient factors and regional classifications. Factors included in the final model were sensitivity of DA-CPR, proportion of bystanders to follow DA-CPR, provision of BCPR, patient age, aetiology of arrest, initial rhythm, the time interval between witness and emergency call, the time interval between emergency call and EMT arrival at patient, and number of emergency hospitals in residential area. Regarding sensitivity of DA-CPR, adjusted ORs (95% CI) for survival with the developing region as reference was 1.277 (1.131–1.441) and 1.162 (1.058–1.277) for advanced and intermediate regions, respectively. Regarding the proportion of bystanders to follow DA-CPR, adjusted ORs for survival with the developing region as reference was 1.749 (1.554–1.967) and 1.280 (1.188–1.297) for the advanced and intermediate regions, respectively.

We performed the same analyses in the two subgroups of OHCAs with and without tracheal intubation or adrenalin administration by paramedics (Supplementary Table). Both regional classifications by sensitivity of DA-CPR and proportion of bystanders to follow DA-CPR were associated with neurologically favourable 1-M survival in the subgroup without advanced life support. Only the classification by sensitivity of DA-CPR was associated with the survival in the subgroup with advanced life support.

DISCUSSION

The present study showed that regional variations in sensitivity of DA-CPR and the proportion of bystanders to follow DA-CPR were associated with neurologically favourable 1-M survival after bystander-witnessed OHCAs without any prehospital physician involvement. Surprisingly, regional classification by bystander's performance of BCPR without instruction or number of BLS training course participants per population was not associated with survival.

In Japan, fire departments play a major role in educating citizens regarding BLS. Every year, approximately 1.5 million citizens participate BLS training courses conducted by fire departments [13]. Furthermore, approximately 1.1 million new driver license applicants are required to undergo BLS training in authorized driving schools [15]. Supposing that the participants in these training courses may maintain sufficient skill and willingness to perform BCPR for three years, 5.7% of population are expected to perform BCPR if the need arises. The total number of healthcare providers and care facility staff were estimated to be 3.5 million in 2011 [20]. Thus, the proportion of potential BLS providers in the population will be less than 10% of population even when the estimation is the highest. Furthermore, not all BLS-trained bystanders perform

CPR by their own initiative [21]. Therefore, as in other countries [8,21–23], performance of DA-CPR is one of the major determinants of BCPR in Japan. Indeed, only 36% (25,938/72,295) of BCPRs were initiated without DA-CPR in this study.

In Japan, DA-CPR has been introduced since the release of DA-CPR guidelines by FDMA in 1999 [24]. Medical control system for EMS was implemented in Japan when trained paramedics were allowed to perform tracheal intubation in 2004 [25]. It was very recent (In 2013) that the Japanese DA-CPR guidelines including the standardized protocol and educational approach to the dispatchers' training were released from FDMA [24]. Therefore, quality improvement and training programs for DA-CPR [26] was introduced under medical control only in some prefectures. Education and qualification of dispatchers, which are established in other countries [27,28], have not been implemented in Japan. The sensitivity of DA-CPR is known to be influenced by dispatcher's perceptions of providing DA-CPR and the trustworthiness of the witnesses [8,29] that may be affected by regional differences in backgrounds of callers and resources of the dispatch centre involved in DA-CPR. Therefore, further nation-wide educational approach to dispatchers and quality improvement program for DA-CPR may be needed to correct the regional variations in Japan.

Regional variation in the proportion of bystanders to follow DA-CPR was smaller than that in sensitivity of DA-CPR. These rates in Japan are much higher than those reported from three cities in the United States [30] and comparable with those reported from other cities [31,32]. Although various reasons for callers not providing BCPR have been reported [30,32], the proportion of bystanders to follow DA-CPR is also dependent on the skill of dispatchers to provide a quick just-in-time instruction [33] encouraging the callers.

Considerable regional variations in bystander's performance of CPR without instruction and number of BLS training course participants were observed. However, regional variation in quantity of bystander's performance of BCPR or in number of participants in BLS training courses was not associated with neurologically favourable 1-M survival in this study. It is controversial whether BCPR training alone may improve the survival after OHCAs. Emphasis on widespread CPR teaching in rural areas may not be justifiable [34]. As reported in Denmark [35], nationwide educational efforts toward both citizens and dispatchers would improve the outcomes of OHCAs.

This study has several limitations. The data were analysed in terms of prefectures. Similar regional variations may exist internally in each prefecture. The FDMA database had no information on dispatcher performance or reasons for no DA-CPR provision and refusal of DA-CPR. No data on BCPR quality, known to be a major factor in achieving better OHCA outcomes [2], were collected. Therefore, unmeasured factors associated with DA-CPR and BCPR may influence the results. The final outcomes were measured at one month, although a longer observation period has been recommended [36]. However, this study contains a notably large prospective cohort, and the results of this study suggest the requirement of a national initiative to establish a better DA-CPR protocol with qualified educational system for dispatchers and to improve the compliance with DA-CPR protocol [37].

CONCLUSION

Wide variations in sensitivity of DA-CPR and proportion of bystanders to follow DA-CPR exist in Japan. Good outcomes of bystander-witnessed OHCAs correlate with regions providing DA-CPR with higher sensitivity of DA-CPR and higher proportion of bystanders to follow DA-CPR. Nation-wide educational approach to dispatchers and quality improvement program for DA-CPR may be needed to correct the regional variations in Japan.

ACKNOWLEGEMENTS

We would like to thank all of the EMS personnel and the FDMA in Japan for their great cooperation in collecting and managing the Utstein-style database.

CONFLICT OF INTEREST

None.

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Figure legends

Figure 1. Overview of nationwide data collection and selection

OHCA, out-of-hospital cardiac arrest; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; CPR, cardiopulmonary resuscitation

Figure 2. Correlation between three DA-CPR- and BCPR-related indexes and OHCA survival

DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; BCPR, bystander cardiopulmonary resuscitation
The size of each symbol reflects the number of out-of-hospital cardiac arrests in each prefecture.
Bivariate normal density ellipsoid (α =0.95) was presented.

Figure 3, Multivariable logistic regression analysis for survival

DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; CPR, cardiopulmonary resuscitation; EMT, Emergency medical technician
Multiple logistic regression analysis was used to examine the association between neurologically favourable 1-M survival, OHCA backgrounds, and regional classification based on BCPR and EMS-related indexes. We sequentially introduced groups of variables into the model: first, basic variables known to be associated with OHCA outcomes, then variables identified as significant in the univariable analysis in a stepwise manner to obtain the lowest Bayesian information criterion (BIC).
The generalized R2 of the final model was 0.2559.

Table 1

Table 1. Definitions of three indexes related to DA-CPR and BCPR

Index		Definitions
Sensitivity of DA-CPR		[Number of bystander-witnessed OHCA cases for which DA-CPR was attempted] / [Number of bystander-witnessed OHCA cases that ***did not*** receive *BCPR on bystander's own initiative*] =([Number of cases in the *BCPR following DA-CPR* group] + [Number of cases in the *no BCPR despite DA-CPR* group]) / ([Number of all bystander-witnessed cases included in the study] - [Number of cases in the *BCPR on bystander's own initiative* group])
Proportion of bystanders to follow DA-CPR (the rate of DA-CPR accepted by bystanders)		[Number of bystander-witnessed OHCA cases that received BCPR following DA-CPR] / [Number of bystander-witnessed OHCA cases for which DA-CPR was attempted] =[Number of cases in the *BCPR following DA-CPR* group] / ([Number of cases in the *BCPR following DA-CPR* group] + (Number of cases in the *no BCPR despite DA-CPR* group])
Bystander's own performance of BCPR		[Number of bystander-witnessed OHCA cases that received *BCPR on bystander's own initiative*] / [Number of bystander-witnessed OHCA cases for which DA-CPR ***was not*** attempted] =[Number of cases in the *BCPR on bystander's own initiative* group] / ([Number of cases in the *BCPR on bystander's own initiative* group] + [Number of cases in the *no BCPR without DA-CPR* group])

CPR, cardiopulmonary resuscitation; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; BCPR, bystander cardiopulmonary resuscitation

BCPR on bystander's own initiative = bystander-initiated CPR without DA-CPR

Table 2

Table 2. Association of variation of BCPR- and EMS-related indexes with 1-M neurologically favourable survival

Indexes / Regions (number of prefectures)	Regional value of index (range)	1-M neurologically favourable survival rate	*p* value / Unadjusted odds ratio (95%CI) for survival	Adjusted odds ratio (95%CI) for survival
Sensitivity of DA-CPR, %			*p*<0.001 /	
Advanced prefectures (N=5)	70.9% (63.4-73.6)	4.8%(781/16,232)	**1.495 (1.349-1.657)**	**1.615 (1.410-1.851)**
Intermediate prefectures (N=37)	51.7% (42.9-62.4)	4.0%(4,737/118,422)	**1.232 (1.139-1.335)**	**1.399 (1.254-1.561)**
Developing prefectures (N=5)	40.6% (32.4-41.6)	3.3%(734/22,439)	Reference	Reference
Proportion of bystanders to follow DA-CPR , %			*p*<0.001 /	
Advanced prefectures (N=5)	77.3% (76.1-78.4)	5.4%(527/9,697)	**1.761 (1.587-1.953)**	**1.713 (1.518-1.931)**
Intermediate prefectures (N=33)	70.0% (63.7-75.9)	4.2%(4,967/106,319)	**1.332 (1.251-1.419)**	**1.233 (1.142-1.332)**
Developing prefectures (N=9)	57.7% (47.7-62.8)	3.2%(758/41,077)	Reference	Reference
Bystander's own performance of BCPR, %			*p*<0.001 /	
Advanced prefectures (N=15)	35.4% (32.8-41.4)	3.5%(978/24,101)	**0.847 (0.783-0.916)**	Excluded
Intermediate prefectures (N=26)	29.5% (26.6-32.8)	4.0%(3,326/82,524)	0.970 (0.916-1.027)	
Developing prefectures (N=6)	25.4% (24.2-26.5)	4.2%(1,948/46,932)	Reference	
Number of BLS training course participants per 100,000 population			*p*<0.001 /	
Advanced prefectures (N=10)	3039 (2,356-5,946)	3.9%(734/18,607)	**0.852 (0.773-0.939)**	Excluded
Intermediate prefectures (N=32)	1,988 (1,613-2,355)	3.9%(4,509/116,545)	**0.835 (0.779-0.896)**	
Developing prefectures (N=5)	1,515 (1,407-1,585)	4.6%(1,009/21,941)	Reference	
Proportion of aged (≧65 y) population, %			*p*<0.001 /	
Advanced prefectures (N=11)	27.3% (26.4-29.5)	3.3% (593/18,018)	**0.757 (0.692-0.827)**	**0.584 (0.518-0.659)**
Intermediate prefectures (N=26)	24.2% (22.2-26.4)	3.9% (2,410/63,549)	**0.877 (0.831-0.925)**	**0.720 (0.653-0.794)**
Developing prefectures (N=10)	20.7% (17.3-22.1)	4.3% (3,249/75,526)	Reference	Reference
Number of emergency hospitals per 100 km^2 of residential area			*p*<0.001 /	
Advanced prefectures (N=11)	43.7 (32.4-57.4)	4.2%(1,954/46,772)	**1.340 (1.248-1.439)**	**1.260 (1.143-1.389)**
Intermediate prefectures (N=21)	25.4 (20.8-31.8)	4.4%(2,967/68,084)	**1.400 (1.311-1.496)**	**1.269 (1.182-1.364)**
Developing prefectures (N=15)	16.7 (11.2-19.9)	3.2%(1,331/42,237)	Reference	Reference
Number of ambulance teams per 100 km2 of residential area			*p*<0.001 /	
Advanced prefectures (N=5)	58.0 (55.2-63.4)	4.2%(1,311/31,321)	**1.336 (1.189-1.506)**	**1.481 (1.257-1.746)**
Intermediate prefectures (N=37)	36.0 (28.3-54.8)	4.0%(4,578/114,305)	**1.276 (1.147-1.425)**	**1.144 (1.021-1.285)**
Developing prefectures (N=5)	24.5 (21.0-27.5)	3.2%(363/11,467)	Reference	Reference
Annual number of emergency medical dispatches per one ambulance			*p*<0.001 /	
Advanced prefectures (N=5)	1,563 (1,141-2,054)	4.6% (2,486/54,306)	**1.206 (1.128-1.290)**	Excluded
Intermediate prefectures (N=22)	830 (630-1,096)	3.6% (2,361/66,056)	0.932 (0.871-0.997)	
Developing prefectures (N=20)	523 (328-628)	3.8% (1,405/36,731)	Reference	
Rate of tracheal intubation by paramedics, %			*p*<0.001 /	
Advanced prefectures (N=5)	25.5% (22.2-26.4)	5.2% (816/15,725)	**1.142 (1.035-1.259)**	Excluded
Intermediate prefectures (N=37)	7.9% (3.0-18.3)	3.7% (4,565/122,323)	**0.809 (0.752-0.872)**	
Developing prefectures (N=5)	1.4% (0.7-1.6)	4.6% (871/18,174)	Reference	
Rate of adrenaline administration by paramedics, %			*p*<0.001 /	
Advanced prefectures (N=5)	27.7% (23.9-33.8)	4.0% (615/15,578)	1.137(0.982-1.321)	Excluded
Intermediate prefectures (N=37)	14.1% (5.2-23.2)	4.0% (5,378/134,089)	**1.156 (1.021-1.316)**	

Developing prefectures (N=5)	4.1% (1.3-4.9)	3.5% (259/7,426)	Reference

DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; BCPR, bystander cardiopulmonary resuscitation; 95% CI, 95% confidence interval

Forty-seven prefectures were classified into three groups by ranking for each index: advanced, intermediate region, and developing regions.

Unadjusted odds ratio was obtained by simple nominal logistic regression. Adjusted odds ratio was obtained by multinomial logit analysis in which all variables were sequentially added to obtain the lowest Bayesian information criterion. Generalized R^2 of the final best-fit model was 0.0075.

Table 3

Table 3. Patient factors associated with 1-month neurologically favourable survival in bystander-witnessed out-of-hospital cardiac arrests without any prehospital involvement of physician

	1-month neurologically favourable survival		*p* values by chi-square test with Pearson's correction or Wilcoxon rank sum test	Unadjusted odds ratio (95%CI) for survival by multiple logistic regression analysis [b)]
	Yes N= 6,252	**No** N= 150,841		
Patient's age, y, median (IQR)	64 (52-74)	78 (66-86)	p <0.0001	undetermined
Patient's gender, N (%)			p <0.0001	
Male	4676 (74.8%)	89,572 (59.4%)		2.029 (1.915-2.151)
Female	1,576 (25.2%)	61,269 (40.6%)		Reference
Bystander CPR, N (%)			p <0.0001	
Provided	3,636 (58.2%)	68,659 (45.5%)		1.664 (1.581-1.751)
Not provided	2,616 (41.8%)	82,182 (54.5%)		Reference
Aetiology of arrest, N (%)			p <0.0001	
Presumed cardiac	5,012 (80.2%)	82,276 (54.5%)		3.368 (3.163-3.587)
Presumed noncardiac	1,240 (19.8%)	68,565 (45.5%)		Reference
Initial rhythm, N (%)			p <0.0001	
Shockable	3,967 (63.5%)	17,441 (11.6%)		13.28 (12.58-14.01)
Non-shockable	2,285 (36.6%)	133,400 (88.4%)		Reference
Time intervals, min, median (IQR)				
Witness-call	1 (0-3)	2 (0-5)	p <0.0001	undetermined
Call-EMT arrival at patient	7 (5-9)	8 (6-10)	p <0.0001	undetermined
EMT arrival at patient-EMT arrival at hospital	20 (16-27)	22 (17-29)	p <0.0001	undetermined

IQR, interquartile range; BCPR, bystander cardiopulmonary resuscitation; 95% CI, 95% confidence interval, EMT; emergency medical technician.

Unadjusted odds ratio was obtained by simple nominal logit analysis.

Figure 1

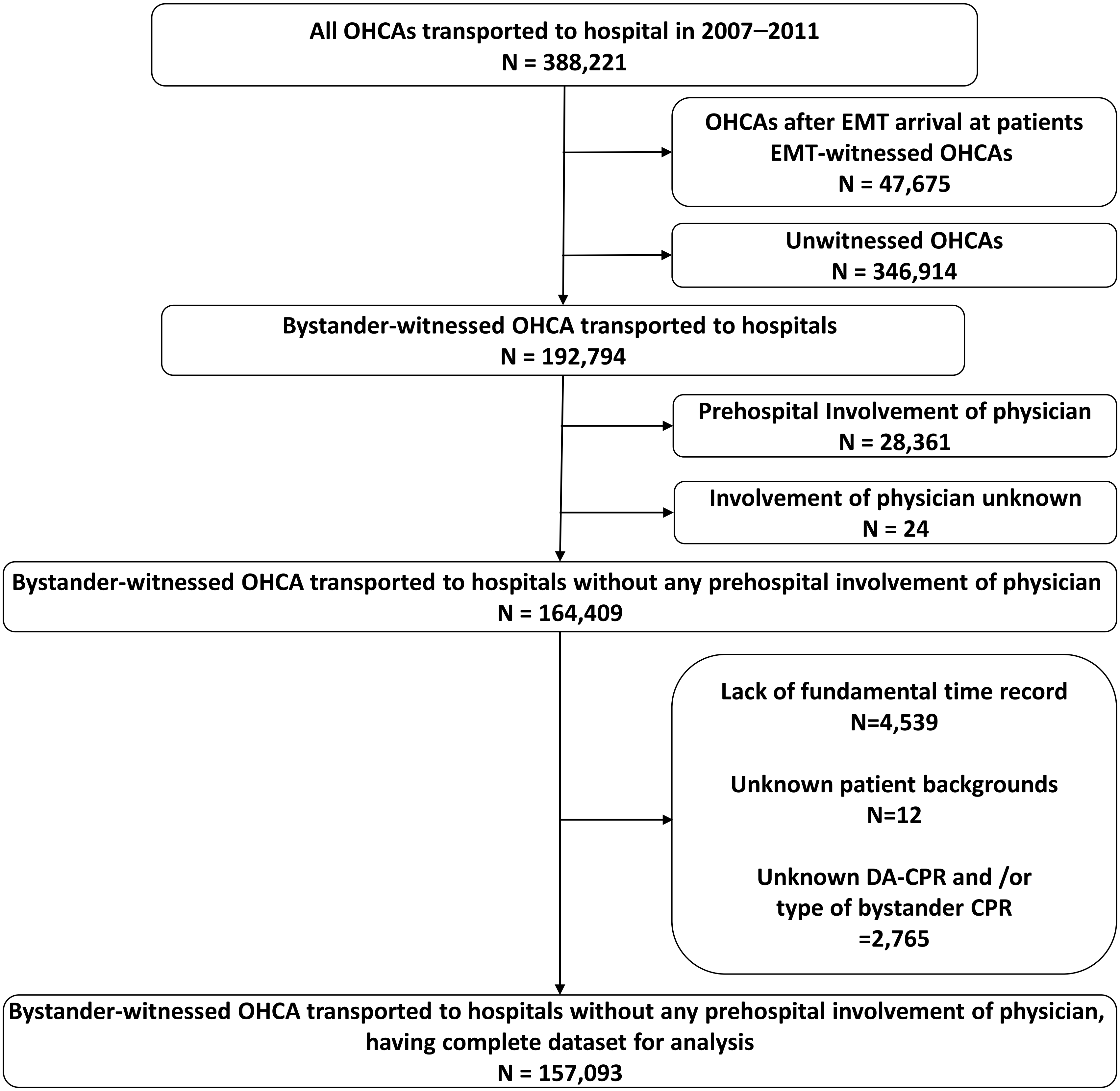

All OHCAs transported to hospital in 2007–2011
N = 388,221
OHCAs after EMT arrival at patients
EMT-witnessed OHCAs
N = 47,675
Unwitnessed OHCAs
N = 346,914
Bystander-witnessed OHCA transported to hospitals
N = 192,794
Prehospital Involvement of physician
N = 28,361
Involvement of physician unknown
N = 24
Bystander-witnessed OHCA transported to hospitals without any prehospital involvement of physician
N = 164,409
Lack of fundamental time record
N=4,539
Unknown patient backgrounds
N=12
Unknown DA-CPR and /or
type of bystander CPR
=2,765
Bystander-witnessed OHCA transported to hospitals without any prehospital involvement of physician,
having complete dataset for analysis
N = 157,093

Figure 2

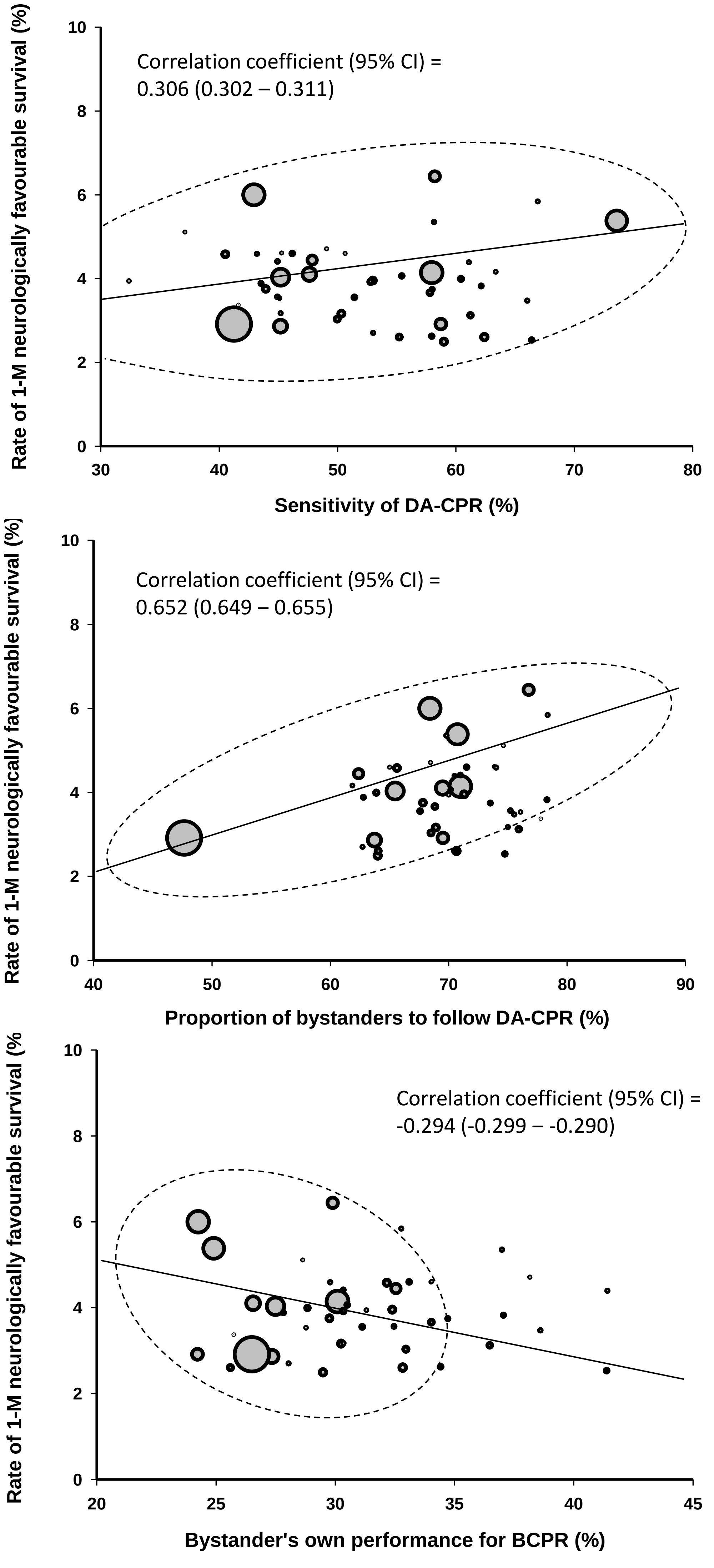
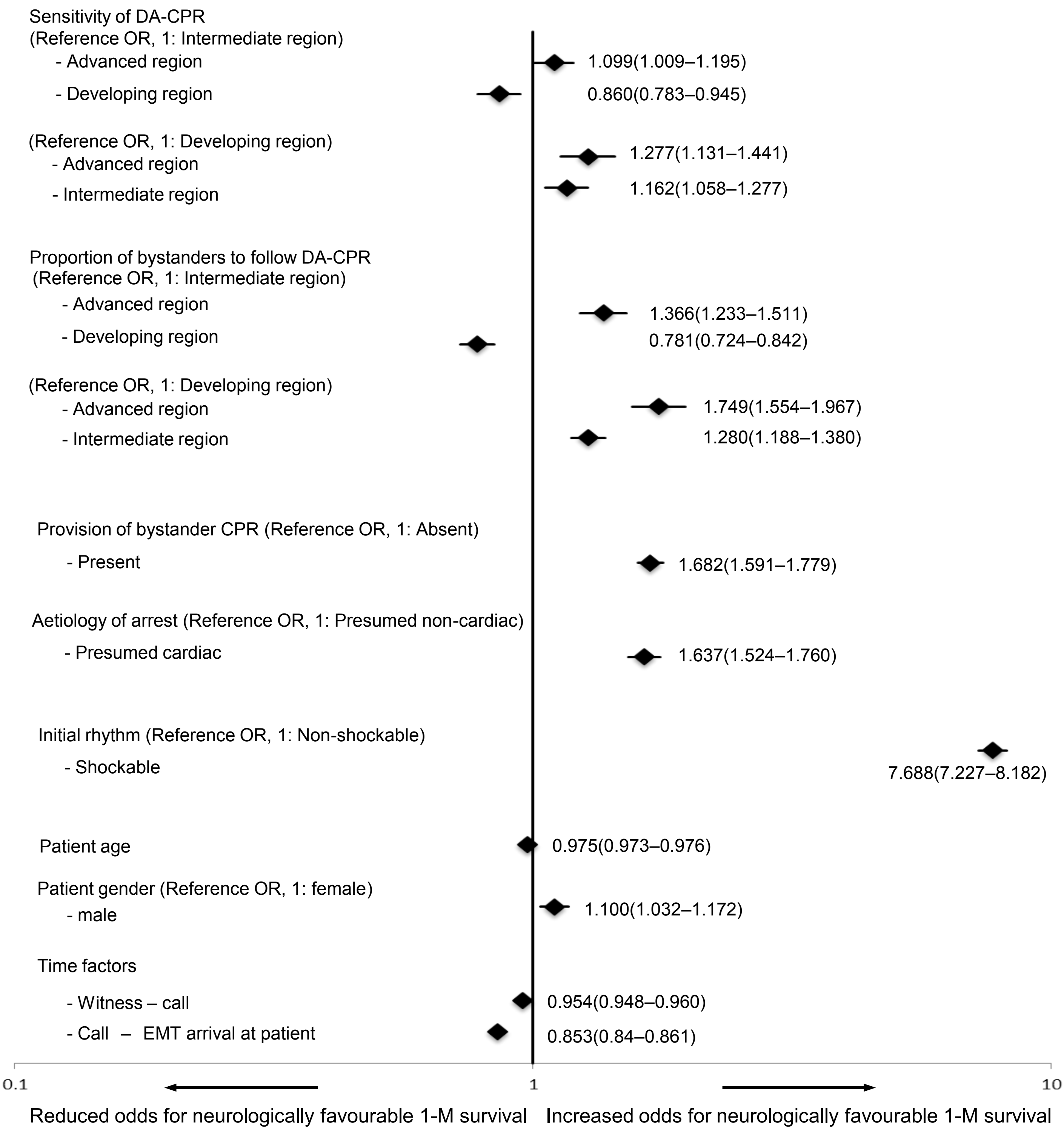

Correlation coefficient (95% CI) =
0.306 (0.302 – 0.311)
Rate of 1-M neurologically favourable survival (%)
Sensitivity of DA-CPR (%)
0
2
4
6
8
10
30
40
50
60
70
80
Correlation coefficient (95% CI) =
0.652 (0.649 – 0.655)
Rate of 1-M neurologically favourable survival (%)
Proportion of bystanders to follow DA-CPR (%)
0
2
4
6
8
10
40
50
60
70
80
90
Correlation coefficient (95% CI) =
-0.294 (-0.299 – -0.290)
Rate of 1-M neurologically favourable survival (%
Bystander's own performance for BCPR (%)
0
2
4
6
8
10
20
25
30
35
40
45

Figure 3


Sensitivity of DA-CPR
(Reference OR, 1: Intermediate region)
- Advanced region
1.099(1.009–1.195)
- Developing region
0.860(0.783–0.945)
(Reference OR, 1: Developing region)
- Advanced region
1.277(1.131–1.441)
- Intermediate region
1.162(1.058–1.277)
Proportion of bystanders to follow DA-CPR
(Reference OR, 1: Intermediate region)
- Advanced region
1.366(1.233–1.511)
- Developing region
0.781(0.724–0.842)
(Reference OR, 1: Developing region)
- Advanced region
1.749(1.554–1.967)
- Intermediate region
1.280(1.188–1.380)
Provision of bystander CPR (Reference OR, 1: Absent)
- Present
1.682(1.591–1.779)
Aetiology of arrest (Reference OR, 1: Presumed non-cardiac)
- Presumed cardiac
1.637(1.524–1.760)
Initial rhythm (Reference OR, 1: Non-shockable)
- Shockable
7.688(7.227–8.182)
Patient age
0.975(0.973–0.976)
Patient gender (Reference OR, 1: female)
- male
1.100(1.032–1.172)
Time factors
- Witness – call
0.954(0.948–0.960)
- Call – EMT arrival at patient
0.853(0.84–0.861)
0.1
1
10
Reduced odds for neurologically favourable 1-M survival
Increased odds for neurologically favourable 1-M survival

Supplemental Table

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