Original Article

Are New Resuscitation Guidelines Better? Experience of an Asian Metropolitan Hospital

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Abstract

Introduction: Cardiopulmonary resuscitation (CPR) guidelines were revised in 2005 based on new evidence and expert consensus. However, the benefits of the new guidelines remain undetermined and their influence has not been published in Asia. This study aimed to evaluate the impact of implementing the new resuscitation guidelines and identify factors that influence the discharge survival of out-of-hospital cardiac arrest (OHCA) patients in an Asian metropolitan city. Materials and Methods: This was an observational cohort study of all OHCA patients seen by the emergency medical service during the period before (Nov 2003 to Oct 2005) and after (May 2006 to Oct 2008) implementing the new resuscitation guidelines. Detailed clinical information was recorded using the Ustein style template. Statistical analysis was done using X^2 test or t-test for univariate analysis and the logistic regression model for multivariate analysis. Results: There were 463 patients before and 430 patients after the new guidelines who received resuscitation. The rate of recovery of spontaneous circulation (ROSC), survival-to-intensive care unit (ICU) admission, and survival-to-hospital discharge all showed no benefits regarding the new resuscitation guidelines (ROSC: 42% vs 39%, $P = 0.32$; Survival-to-ICU admission: 33% vs 30%, $P = 0.27$; survival-to-hospital discharge: 10% vs 7%, $P = 0.09$). The rate of ventricular fibrillation/pulseless ventricular tachycardia (VF/pulseless VT), rate of witnessed arrest, and rate of bystander CPR were much lower than in Western studies. After multivariate logistic regression, factors related to discharge survival were witnessed arrest and initial rhythm with VF/pulseless VT. The new resuscitation guidelines did not significantly influence the discharge survival. Conclusions: We did not observe any improvement in survival after implementing the new guidelines. Independent factors of survival-to-hospital discharge are witnessed arrest and initial rhythm with VF/pulseless VT. Because the rates of VF/pulseless VT and bystander CPR in Asia are low, popularising CPR training programmes and increasing the rate of bystander CPR may be more important for improving OHCA survival rates than frequent guideline changes.

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Introduction

Out-of-hospital cardiac arrest (OHCA) is a substantial public health burden that has poor prognosis.[1-3] Patients who receive "good" and "high-quality" cardio-pulmonary resuscitation (CPR) have better outcomes.[4,5] However, survival rate remains dismal despite periodic resuscitation guideline updates every 5 to 8 years.[6,7] The latest international resuscitation guidelines published in 2005 are based on recent clinical studies and the consensus of experts.[8,9] Major changes to the new resuscitation guidelines are: (i) increase in the number of chest compressions per minute and reduce pausing, (ii) one shock only for ventricular fibrillation/pulseless tachycardia (VF/pulseless VT), (iii) no interruptions of chest compression during cardiac arrest out of hospital, and (iv) 5 cycles of CPR before defibrillation for unwitnessed VF/pulseless VT. These changes are mainly

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aimed at reducing no-flow time and improving outcomes.

However, the benefits of new resuscitation guidelines remain controversial. Rea et al[10] and Becker et al[11] report that one shock only defibrillation followed by 2 minutes of CPR improves VF outcome. Steinmetz et al[12] note that the implementation of new guidelines is associated with improved 30-day survival after OHCA. However in Norway, Olasveengen et al[13] have not found any survival benefit. In addition, all of these studies have not been performed in Asia, where there are different healthcare systems and different patient characteristics that can affect the outcome. For example, VF/VT accounts for 25% to 70% of initial rhythms of OHCA in Western countries but the prevalence is much lower in Asia. Studies of OHCA report 11% to 13% of all arrests presenting VF/VT in Taipei, 22.5% in Hong Kong, 7.5% to 20% in Singapore, and 16.8% in Japan.[14-21]

This study aimed to evaluate the impact of implementation of the new resuscitation guidelines and identify factors that influence discharge survival of OHCA patients in an Asian metropolitan city.

Material and Methods

Study Population and Study Design

This before-and-after observational study was conducted in the emergency department (ED) of Shin-Kong Wu Ho-Su Memorial Hospital, a university teaching hospital with 921 beds in northern Taipei City in Taiwan. The ED had an adult intensive care unit bed capacity of 60 with approximately 75,000 ED visits annually. Taipei City had a population of 2.6 million in an area of 272 km^2. The emergency medical services (EMS) are all fire-based, with 3 levels of care providers (EMT-I, EMT-II and EMT-P), and activated by a universal access number (119).

The 40-hour national training programme of EMT-I aimed to ensure vital sign measurement, basic life support (BLS) skills, and AED (automated external defibrillator) operation. EMT-II should receive 280 hours of training, including EMT-I material and prescribing oral glucose water and intravenous saline. Entrants to EMT-P (paramedics) course were selected from the best members of EMT-II and they completed the 1280-hour curriculum. EMT-Ps were capable and authorised to perform tracheal intubation, and intravenous injections of medications for cardiac arrest. EMT-I and EMT-II were also called BLS-D (basic life support and defibrillation) team, while EMT-P was called ALS (advanced life support) team.

All EMTs received renewed courses for the new resuscitation guidelines and passed the certification examinations. All providers were requested to use the newest revised guidelines by 1 May 2006. They also had to re-certify by attending approved refresher courses within a prescribed period. Medical directors and physicians on medical consulting committees were responsible for pre-hospital quality assurance and medical oversight by reviewing resuscitation records or by direct observation.

Taipei city had phased in ALS service from 2003, and until 2006, the first ALS team was established in the serving area of our hospital. All incoming calls for EMS were processed by a central dispatch centre, staffed by dispatchers with 40-hours of training. The dispatcher would activate the ALS and BLS-D teams simultaneously for OHCA patients. Because the EMT-Ps were limited (only 3% of all EMTs), most OHCA patients only received the BLS-D treatment. Land ambulances were the main form of transportation for patients in Taipei city.

All OHCA patients treated by EMS were included in periods before (Period I: 1 Nov 2003 to 31 Oct 2005) and after (Period II: 1 May 1 2006 to 31 Oct 2008) the new guidelines. There was a 6-month learning and practicing period between the 2 periods. The BLS-D team treated all patients before they arrived at the hospital. During period II, the ALS team started to serve in the region and some OHCA patients were treated by both BLS-D and ALS teams. Exclusion criteria were age <18 years, resuscitation not performed (signed "do not attempt resuscitation" or obvious signs of death), and cardiac arrest secondary to trauma. Patients who were treated by an ALS team were also excluded to decrease confounding factors. The institutional review board approved the study protocol.

Data Collection and Definitions

A resuscitation form was created in 2000 and nurses became familiarised with completing such forms if they participated in the resuscitation. All OHCA patients were enrolled prospectively in a database using a standard collection tool that was consistent with the Utstein criteria.[22] The resuscitation records consisted of 2 parts: one filled in by the emergency medical technicians and the other filled in by a nurse during the resuscitation period. If the patients were discharged, detailed information of patients in the final cohort was obtained retrospectively from their medical records by one of two physicians with extensive experience in chart review procedures. The following data were prospectively recorded for each patient: age, gender, co-morbidities, witnessed arrest, bystander CPR, initial rhythm and response time. Response time was calculated from the time of the emergency medical service dispatch until arrival of the respective unit at the call location. Patient outcome was recorded as ROSC (Recovery of Spontaneous Circulation), survival-to-intensive care unit (ICU) admission and survival-to-hospital discharge.

Statistical Analysis

Statistical calculations were performed using the SPSS for Windows (Release 10.0, SPSS Inc., Chicago, IL, USA). The appropriate sample size was calculated to allow detection of differences in survival between 13% before implementation of the new guidelines and 20% after implementation. A sample size of 800 patients was needed to prove this difference (set at 0.05; set at 0.2; power: 80%) Continuous variables were presented as mean±standard deviation (SD) and categorical variables as frequencies and percentages. All of the patients were initially stratified into 2 groups based on the period before and after implementation of the new resuscitation guidelines. Comparisons between the groups were made with Pearson χ^2 test for categorical variables and independent samples t-test for continuous variables. A *P* value <0.05 was accepted as significant.

To identify factors that influence survival in OHCA, all of the patients were re-stratified into 2 groups. Univariate factors of survival-to-hospital discharge that were significant at level *P* <0.1 were eligible for inclusion in a forward selection multiple logistic regression model, which identified factors that were independent for survival-to-hospital discharge at *P* <0.05 (two-tailed).

Results

Overall, during the study period, 1309 OHCA patients were managed by EMS. Of the 416 excluded, 165 were due to trauma injury, 37 were aged younger than 18 years, 28 had no resuscitation, 171 were treated by the ALS team, and 15 had missing data. The remaining 893 patients were included in the final analysis and the overall outcomes were shown in Figure 1 using the revised Utstein template. Among these, 463 patients were treated before the implementation of the new guidelines and 430 were treated after. There were no patients who received hypothermia or ECMO (extracorporeal membrane oxygenation) treatment. No patient received public AED (automated external defibrillator).

The patient and arrest characteristics of the study population are shown in Table 1. There were no differences in age, gender, co-morbidities, witnessed arrest, bystander CPR, initially monitored rhythm, response time and defibrillation time between the 2 study periods. Major outcomes in the before and after periods showed no difference in ROSC (42% vs 39%, *P* = 0.32), survival-to-ICU admission (33% vs 30%, *P* = 0.27), and survival-to-hospital discharge (10% vs 7%, *P* = 0.09) (Table 2).

Only 77 patients were alive to hospital discharge among the 893 patients. The characteristics of patients alive or not alive to hospital discharge are listed in Table 3. By univariate analysis, the following discharge related factors were significant: treatment after new guidelines (*P* = 0.09), witnessed arrest (*P* <0.05), and initial rhythm with VF/pulseless VT (*P* <0.01) and asystole (*P* <0.01). After multivariate logistic regression analysis, implementing new guidelines and initial rhythm with asystole did not show significant improvement in survival-to-hospital discharge. Witnessed arrest and initial rhythm with VF/pulseless VT were significant independent factors of survival-to-hospital discharge (Table 4).

Sub-group analysis of patients with and without EMT-P during period II was also performed (Table 5). There was

Table 1. Univariate Comparisons of Patients between the Two Periods

	Period I (n = 463) (Before new guidelines)	**Period II (n = 430) (After new guidelines)**	***P***
Characteristics			
Age, mean ± SD, y	66.6±16.2	65.4±18.4	0.29
Male gender, n (%)	263 (57%)	270 (62%)	0.07
Comorbidities, n (%)			
Diabetes	99 (21%)	103 (24%)	0.36
Hypertension	115 (25%)	123 (29%)	0.20
CAD	103 (22%)	98 (21%)	0.85
CVA	60 (13%)	52 (11%)	0.70
Bystander CPR, n (%)	37 (8%)	44 (10%)	0.24
Witnessed arrest, n (%)	204 (44%)	165 (40%)	0.09
Initial rhythm, n (%)			
VF/pulseless VT	26 (6%)	31 (7 %)	0.33
PEA	39 (8%)	38 (9%)	0.83
Asystole	398 (86%)	361 (84%)	0.40
Response time, mean (SD), min	4.7 (2.3)	4.7 (2.1)	0.82
Defibrillation time, min	13.6±5.2	12.5±3.8	0.93

CAD: coronary artery disease; CVA: cerebrovascular accident; CPR: cardio-pulmonary resuscitation; VF/pulseless VT: ventricular fibrillation/pulseless ventricular tachycardia; PEA: pulseless electrical activity; SD: standard deviation; Defibrillation time: record time from collapse to defibrillation in VF/pulseless VT

Table 2. Comparisons of Patient Outcomes between the Two Periods

	Period I (n = 463) (Before new guidelines)	**Period II (n = 430) (After new guidelines)**	***P***
ROSC, n (%)	194 (42%)	166 (39%)	0.32
Survival to ICU admission, n (%)	155 (33%)	129 (30%)	0.27
Survival to hospital discharge, n (%)	47 (10%)	30 (7%)	0.09

ICU: intensive care unit; ROSC: recovery of spontaneous circulation

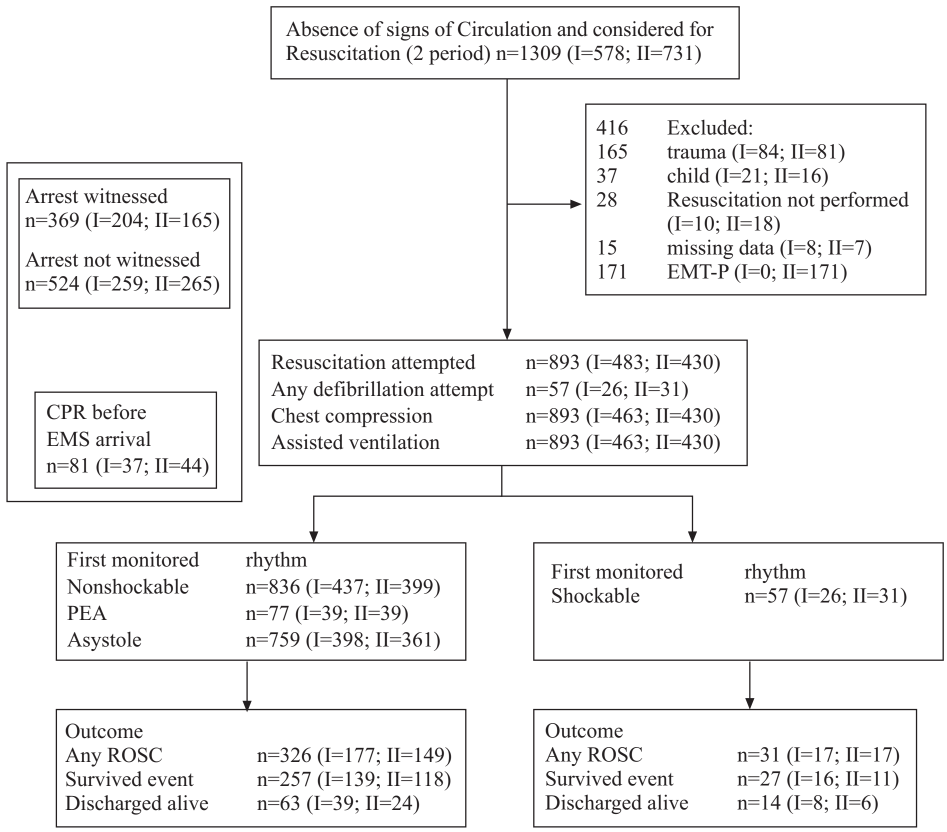

Fig. 1. Overall outcomes of out-of-hospital cardiac arrest patients in Utstein template (Period I: Nov 2003 to Oct 2005, Period II: May 2006 to Oct 2008).

no significant outcome difference between the 2 groups. The 171 EMT-P treated patients were also placed into the full model for analysis but the outcome remained the same (Table 6).

Discussions

Implementation of new guidelines is meant to reduce no-flow time during resuscitation[12,23] and is thought to improve the outcome of OHCA. However, the benefits of the guidelines are indeterminate. Several studies[10-12] report that the guidelines significantly increase survival rate in OHCA patients, especially in those with VF/pulseless VT. In contrast, Olasveengen et al[13] have not been able to document a statistically significant difference. The current study does not show any improvement in outcomes after implementation of the new guidelines, which are also not significant related factors in the prognosis of OHCA.

In this study, the rate of survival-to-discharge for all OHCA patients is 8.6% (77/893) and 24.6% (14/57) in VF/pulseless VT patients. These results are similar to other studies[1-3,14] and are even better than those in many other Asian countries.[15,16] The response times in both periods were 4.7 minutes and similar to previous studies.[10-13] However, the rate of VF/pulseless VT, witnessed arrest, and bystander CPR, which are the reported factors related to patient prognosis,[8,9] are much lower in this study. The VF/pulseless VT rate is only 6.3% in this study and is much lower than in previous reports. OHCA patients with initial rhythm of VF/pulseless VT are proven to have a much higher survival rate, and in Western countries, its prevalence is 25% to 70%.[1-3,24,25] This lower VF/pulseless VT prevalence is noted in many Asian countries,[16-21] and the rate in the city is only 9% to 12% in previous studies.[14,15] Prolonged response times, absence of bystander CPR and lower ischaemic heart disease are thought to make the difference in Asia.[21] Changes made in the new guidelines are thought to improve benefits to VF/pulseless VT.[11,12] The lower prevalence rate of VF/pulseless VT may reduce the influence of new guidelines in Asia.

The rate of witnessed arrest is 41% and rate of bystander CPR is 9% in this study. These are similar to results of a previous study in the city.[14,15] Compared to recent studies that show better outcome of the new guidelines, their rates are much higher than those in this study (witnessed arrest: 40% vs 60% to 70%, bystander CPR: 10% vs 25% to 58%).[10-12] Lower rates of witnessed arrest and bystander CPR mean prolonged "no flow time". The VF/pulseless VT can also turn to asystole for progressive cellular ischaemia and acidosis, and decrease the chances of defibrillation.[26-28] After

Table 3. Univariate Comparisons between Patients Alive and Not Alive to Discharge

	Not alive to discharge (n = 816)	Alive to discharge (n = 77)	*P*
Characteristics			
Age, mean±SD, y	66.0±17.4	65.8±15.6	0.90
Male gender, n (%)	489 (60%)	44 (57%)	0.63
Co-morbidities, n (%)			
Diabetes	181 (22%)	21 (27%)	0.31
Hypertension	214 (26%)	24 (31%)	0.34
CAD	184 (23%)	17 (22%)	0.93
CVA	106 (13%)	6 (8%)	0.19
Bystander CPR, n (%)	74 (9%)	7 (9%)	0.99
Witnessed arrest, n (%)	326 (4%)	43 (6%)	<0.05
Initial rhythm, n (%)			
VF/pulseless VT	43 (5%)	14 (18%)	<0.01
PEA	71 (9%)	6 (8%)	0.79
Asystole	702 (86%)	57 (74%)	<0.01
Response time, mean (SD), min	4.7 (2.2)	4.6 (1.7)	0.80
Implementation of new guideline, n (%)	400 (49%)	30 (39%)	0.09

CAD: coronary artery disease; CVA: cerebro-vascular accident; CPR: cardio-pulmonary resuscitation; VF/pulseless VT: ventricular fibrillation/ pulseless ventricular tachycardia; PEA: pulseless electrical activity; SD: standard deviation

Table 4. Multivariate Analysis of Independent Factors of Discharge Survival

	Odd ratio (95% CI)	*P*
Treatment after new guidelines	0.65 (0.40-1.06)	0.08
Witnessed arrest	1.75 (1.08-2.83)	<0.05
VF/pulseless VT	4.03 (1.43-11.36)	<0.01
Asystole	1.05 (0.43-2.52)	0.92

CI: confidence interval; OR: odd ratio; VF/pulseless VT: ventricular fibrillation/pulseless ventricular tachycardia

Table 5. Comparison between Patients with and without EMT-P during Period II

	Patients with EMT-P (n = 171)	Patient without EMT-P (n = 430)	*P* value
Characteristics			
Age (Mean±SD) (years)	68.1 ±14.9	65.4 ±18.4	0.06
Male gender, n (%)	96 (56 %)	270 (63 %)	0.13
Bystander CPR, n (%)	25 (15 %)	44 (10 %)	0.13
Witnessed arrest, n (%)	73 (43 %)	165 (38 %)	0.33
VT/VF, n (%)	14 (6%)	31 (7 %)	0.68
ROSC, n (%)	78 (46%)	166 (39%)	0.11
Survival event, n (%)	59 (35%)	129 (30%)	0.28
Survival to discharge, n (%)	14 (8%)	30 (7%)	0.61

EMT-P: emergency medical technician-paramedic; SD: standard deviation; CPR: cardio-pulmonary resuscitation; VF/pulseless VT: ventricular fibrillation/pulseless ventricular tachycardia; ROSC: recovery of spontaneous circulation

Table 6. Comparison of All Patients between Periods I and II (including EMT-P)

	Period I (n = 463)	Period II (n = 601)	*P* value
Characteristics			
Age (Mean ± SD) (years)	66.6±16.2	66.4±18.0	0.84
Male gender, n (%)	263 (57%)	366 (61%)	0.18
Bystander CPR, n (%)	37 (8%)	69 (11%)	0.06
Witnessed arrest, n (%)	204 (44%)	238 (40%)	0.14
VT/VF, n (%)	26 (6%)	45 (7%)	0.23
ROSC, n (%)	194 (42%)	244 (41%)	0.67
Survival event, n (%)	155 (33%)	188 (31%)	0.45
Survival to discharge, n (%)	47 (10%)	44 (7%)	0.10

EMT-P: emergency medical technician-paramedic; SD: standard deviation; CPR: cardio-pulmonary resuscitation; VF/pulseless VT: ventricular fibrillation/pulseless ventricular tachycardia; ROSC: recovery of spontaneous circulation

multivariate analysis, witnessed arrest remains a significant discharge survival related factor, but not bystander CPR. Some literature have similar findings.[13,15] The inability of bystander CPR to reach statistical significance may be a result of the low performance rate. The quality of CPR may also play a role. Good bystander CPR have significantly better hospital discharge rates than those with no or with poor bystander CPR.[4] Mechanisms to improve the lower citizen CPR practice are very pertinent and challenging in this community.

The new resuscitation guidelines introduced in 2005 and based on evidence-based resuscitation studies and evaluation processes include evidence evaluation, review of literature and focused analysis.[29,30] The guidelines do represent a great advance that simplifies the technique. However, several limitations are noted, including[30]: (i) inadequate clinical trial evidence, (ii) practicality of converting experimental evidence to clinical practice, (iii) educational considerations and (iv) safety considerations. In addition to these, survival rate is not significantly increased despite frequent changes in guidelines in the past. Some reports mention that adequate CPR only influences short-term survival and that some patients who are easily resuscitated will survive despite poor CPR.[13,31-33] Meertens et al[34] suggest less frequent changes in guidelines because the work and costs involved are tremendous. Implementing new guidelines may also cause confusion among clinicians. Nonetheless, the new resuscitation guidelines may benefit OHCA patients. However, the low rate of VF/pulseless VT and low bystander CPR rate in Asia will minimise the advantage. Popularising CPR programmes and increasing the rate of bystander CPR may be more important than frequent guideline changes in Asia.

There are several limitations to this study. First, this study could not assess compliance to the new guidelines and the individual difference when performing resuscitation. All rescuers in this study had passed the 2005 ACLS training protocol and 6 months have been excluded to allow for the learning of new guidelines. Physicians on the medical consulting committees (required by law) are responsible for pre-hospital quality assurance and medical oversight by record review or direct observation to ensure adherence.[35] This study also could not assess the practices of bystanders, although the rate of bystander CPR is very low.

Second, OHCA patients treated by an ALS team were excluded in the period II group to reduce confounding factors. This may influence the outcome. All ALS treated patients were placed in a full model and were included in sub-group analysis. The influence of ALS treatment did not provide significant difference in terms of survival rate. Previous literature shows similar results that advanced life support does not influence survival rate in OHCA patients.[14,30] Third, because this is a before-and-after observational study without randomisation or blindness, a variety of confounding influences may affect the outcomes. Selection bias was minimised by assessing the same population in the same city and they were treated in the same hospital. Differences in patients between periods I and II may have confounded the outcomes. Attempts were made to conduct regression analysis to adjust for related factors. In addition, no patient received advanced post-resuscitation care like ECMO or hypothermia therapy.

Conclusions

This study has been undertaken to assess the effects of implementing the 2005 resuscitation guidelines in an Asian metropolitan city. There is no improvement in survival-to-discharge after implementing the new guidelines although there is no assessment of the compliance to the changes. Factors related to discharge survival of OHCA patients are witnessed arrest and initial rhythm with VF/pulseless VT. Popularising CPR programmes and increasing the rate of bystander CPR may be more important than frequent guideline changes.

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