ORIGINAL ARTICLE

Validation of a Rule for Termination of Resuscitation in Out-of-Hospital Cardiac Arrest

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ABSTRACT

BACKGROUND

We prospectively evaluated a clinical prediction rule to be used by emergency medical technicians (EMTs) trained in the use of an automated external defibrillator for the termination of basic life support resuscitative efforts during out-of-hospital cardiac arrest. The rule recommends termination when there is no return of spontaneous circulation, no shocks are administered, and the arrest is not witnessed by emergency medical-services personnel. Otherwise, the rule recommends transportation to the hospital, in accordance with routine practice.

METHODS

The study included 24 emergency medical systems in Ontario, Canada. All patients 18 years of age or older who had an arrest of presumed cardiac cause and who were treated by EMTs trained in the use of an automated external defibrillator were included. The patients were treated according to standard guidelines. Characteristics of diagnostic tests for the prediction rule were calculated. These characteristics include sensitivity, specificity, and positive and negative predictive values.

RESULTS

Follow-up data were obtained for all 1240 patients. Of 776 patients with cardiac arrest for whom the rule recommended termination, 4 survived (0.5 percent). The rule had a specificity of 90.2 percent for recommending transport of survivors to the emergency department and had a positive predictive value for death of 99.5 percent when termination was recommended. Implementation of this rule would result in a decrease in the rate of transportation from 100 percent of patients to 37.4 percent. The addition of other criteria (a response interval greater than eight minutes or a cardiac arrest not witnessed by a bystander) would further improve both the specificity and positive predictive value of the rule but would result in the transportation of a larger proportion of patients.

CONCLUSIONS

The use of a clinical prediction rule for the termination of resuscitation may help clinicians decide whether to terminate basic life support resuscitative efforts in patients having an out-of-hospital cardiac arrest.

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The survival rate after out-of-hospital cardiac arrest is low, especially among patients who have no response to advanced cardiac life support provided by paramedical personnel.[1] Several retrospective studies have identified patients for whom termination of resuscitative efforts outside the hospital can be considered after resuscitative efforts by paramedics trained and equipped to provide advanced cardiac life support have failed.[2-13] As a result, guidelines exist for the termination of resuscitation in this setting, and most emergency medical services (EMS) systems have protocols to permit the practice.[14]

However, because of a lack of data, similar guidelines have not been developed for use when basic life support is provided by emergency medical technicians (EMTs) trained in the use of an automated external cardiac defibrillator. As a result, substantial numbers of patients with little or no potential for survival are regularly transported to emergency departments. Guidelines for EMTs trained in the use of an automated external defibrillator would be extremely useful, since a survey indicated that several cities in the United States have EMS systems that consist in whole or in part of EMTs thus trained.[15]

We recently derived a clinical prediction rule for the termination of basic life support resuscitative efforts by EMTs trained in the use of an external cardiac defibrillator on the basis of a retrospective review of case records from a large, urban EMS system.[16] The presence of three clinical variables identified patients who did not survive out-of-hospital cardiac arrest. The prediction rule proposed that in the absence of available equipment and personnel to provide advanced cardiac life support, termination of resuscitative efforts could be considered in the out-of-hospital setting if there was no return of spontaneous circulation before transportation was initiated, no shock was given before transportation was initiated, and the arrest was not witnessed by EMS personnel (e.g., a firefighter or an EMT). When applied retrospectively to the study population from which it was derived, the prediction rule had a sensitivity of 100 percent for identifying patients who survived to hospital discharge.[16]

Any prediction rule that is derived in a retrospective fashion requires prospective validation before it is implemented clinically.[17,18] Accordingly, we used methods of prospective validation to test the predictive value of this rule. The secondary objective was to evaluate whether a response interval of more than eight minutes (a criterion proposed on the basis of a retrospective study by Petrie et al.[19]) would increase the predictive power of the rule.

METHODS

STUDY DESIGN

The study was conducted to validate a clinical prediction rule according to the method described by Wasson et al.[17] and Laupacis et al.[18] A total of 12 urban and rural regions in Ontario, Canada, served by 24 EMS systems participated in the study. The regions included areas ranging in population from 40,000 to 2.5 million persons, with population densities ranging from 8 to 3939 persons per square kilometer. All participating EMS systems received approval from the regional institutional ethics board. Because of the clinical setting, the standard requirement of written informed consent was waived.

STUDY POPULATION

The study population was made up of consecutively enrolled adult patients (persons 18 years of age or older) who were treated for an out-of-hospital arrest of presumed cardiac cause[20] between January 1, 2002, and January 30, 2004. Patients who had a cardiac arrest were evaluated and given basic life support exclusively by an EMT trained in the use of an automated external defibrillator. We excluded patients who received advanced cardiac life support (e.g., intubation and administration of intravenous fluids and medication), those who had a written or oral do-not-resuscitate order, and those who had an arrest attributable to an obvious cause (e.g., trauma or asphyxia).[20] Prehospital care was documented with the use of a standard call-report form used by ambulance personnel throughout the province of Ontario.

RESUSCITATION ALGORITHM

The protocol for basic life support included the use of an automated external defibrillator and conformed with the recommendations of the American Heart Association and the International Liaison Committee on Resuscitation.[21] In accordance with these recommendations, all patients received cardiopulmonary resuscitation, with pauses every one or two minutes to assess rhythm with an automated external defibrillator and to deliver a shock as dictated by the automated analysis of the defibrillator. The rhythm was analyzed no more than three times, with the delivery of no more than three shocks at each analysis, as indicated. On either successful defibrillation or the completion of this algorithm, the patient was rapidly transported to the hospital and cardiopulmonary resuscitation was continued, if necessary.

STUDY PROTOCOL

Before the start of the study, all EMTs trained in the use of an automated external defibrillator received instruction in the prediction rule. After a patient was transferred to the receiving hospital, the EMTs completed a data-collection form that included all relevant clinical characteristics of the cardiac arrest as well as the elements of the prediction rule. Patients were categorized according to the recommendations of the prediction rule. For patients treated with the complete resuscitation algorithm who had no return of spontaneous circulation before the initiation of transport to the hospital, those who had not received any shocks before transport was initiated, and those whose cardiac arrest was not witnessed by EMS personnel (a firefighter or an EMT), the rule recommended the termination of resuscitation. On the data-collection form, this recommendation was designated by the term “terminate.” Otherwise, the prediction rule recommended continued basic life support resuscitation efforts and transportation to the hospital, as designated by the term “transport.”

Study coordinators at each study site reviewed the data-collection forms for accuracy before they were sent to a central coordinating office. The data were abstracted by four trained abstractors using a standardized form. Problems related to missing, unclear, or ambiguous data were resolved by querying the site for additional information. Definitions used in the data-collection form conformed to the Utstein style of reporting a cardiac arrest, when possible.[20]

OUTCOME MEASURES

Study coordinators at each site obtained information on patients’ outcomes from the receiving hospitals six to eight months after the cardiac arrest. Outcomes were categorized as follows: the patient was pronounced dead in the emergency department, died after admission to the hospital, was alive in the hospital at six months, or had been discharged from the hospital. The outcomes were analyzed as a binary measure of “died” (the first two outcomes) or “survived” (the last two outcomes). Cerebral performance (Table 1)[22,23] was also assessed, either at discharge from the hospital or at six months for those in the hospital at that point.

Table 1. Categories of Cerebral Performance.*

Category	Classification	Description
1	Good cerebral performance	Patient is conscious, alert, and able to work and lead a normal life. Patient may have minor psychological or neurologic deficits (e.g., mild dysphasia, hemiparesis that is not incapacitating, or minor cranial-nerve abnormalities).
2	Moderate cerebral disability	Patient is conscious and has sufficient cerebral function to be able to work part time in a sheltered environment or perform activities of daily living (e.g., dress, travel by public transportation, or prepare meals) independently. Patient may have hemiplegia, seizures, ataxia, dysarthria, dysphasia, or permanent changes in memory or mental status.
3	Severe cerebral disability	Patient is conscious, dependent on others for daily support (in an institution or at home with an exceptional effort made by the family), and has at least limited cognitive ability. A wide range of cerebral abnormalities may be present, ranging from the ability to walk but with severe memory disturbance or dementia precluding independent living to paralysis and the ability to communicate only with the eyes (as in the locked-in syndrome).
4	Coma or vegetative state	Patient is unconscious, unaware of surroundings, and without cognitive ability; no verbal or psychological interaction with the environment.
5	Death	Patient is certified as brain dead or dead.

* Data are adapted from Safar and Bircher[22] and the Brain Resuscitation Clinical Trial II.[23]

STATISTICAL ANALYSIS

The statistical analysis was performed with SAS software (version 8.0). The prediction rule was evaluated as a diagnostic test, and test characteristics were calculated. These test characteristics include sensitivity, specificity, and positive and negative predictive values. It was assumed that an ideal test would not recommend the termination of resuscitation efforts if the patient could potentially survive cardiac arrest. Thus, the specificity of the rule (the probability that the rule suggests transport when the patient survives) and its positive predictive value (the probability of death when the rule proposes the termination of resuscitative efforts) were identified as the important test characteristics. The survival rate among patients for whom the prediction rule recommended the termination of resuscitation was also determined. Similar analyses were performed with the addition to the prediction rule of the prespecified variable of an EMS response interval of more than eight minutes, as well as the addition of the post hoc variable of a cardiac arrest that was not witnessed by a bystander.

The estimated sample size was calculated on the basis of a survival rate of 1 percent or less when the prediction rule recommended the termination of resuscitation. This survival rate of 1 percent or less has been suggested as reflective of medical futility.[24] The rate of survival to discharge from the hospital was estimated to be 0.3 percent when the prediction rule suggested termination of resuscitation. This estimate of 0.3 percent was derived from our previous study involving a single EMS system.[16] For a one-tailed test of significance at the 0.05 level, 773 subjects were required to provide a one-sample test of proportions with a statistical power of at least 80 percent to detect a survival rate significantly lower than 1.0 percent (PASS 2000 Power Analysis and Sample Size software).

RESULTS

During the survey period, 1620 eligible out-of-hospital cardiac arrests were recorded; EMTs did not complete a data-collection form in 379 cases, and in 1 case, the elements of the prediction rule could not be assessed on the basis of the information provided. A total of 1240 patients with cardiac arrest were therefore enrolled. The 12 participating sites had an overall enrollment rate of 76.5 percent, ranging from 21.1 to 100 percent at each site.

Table 2 shows the demographic characteristics of 1240 patients and selected features of each cardiac arrest. The mean age of the patients was 69.2 years, and 855 were men (69.0 percent). The cardiac arrest was witnessed in 712 cases (57.4 percent), and the median time to a response by the EMS team was 8.0 minutes. With respect to the variables included in the clinical prediction rule, of 1240 cardiac arrests reported, there was no return of spontaneous circulation in 1172 cases (94.5 percent), no shocks were delivered in 868 cases (70.0 percent), and the cardiac arrest was not witnessed by EMS personnel in 1120 cases (90.3 percent).

Follow-up data were obtained on all the patients enrolled in the study (Table 3). A total of 1140 patients with a cardiac arrest (91.9 percent) were pronounced dead in the emergency department, 59 (4.8 percent) died after admission to the hospital, 2 (0.2 percent) were still in the hospital at the six-month follow-up, and 39 (3.1 percent) survived to discharge.

The characteristics of diagnostic tests for the prediction rule are shown in Table 4. For 37 of the 41 patients who survived, the prediction rule recommended transportation to the hospital and continuing basic life support resuscitative efforts, resulting in a specificity of 90.2 percent (95 percent confidence interval, 88.4 to 91.8 percent). For 772 of 1199 patients who died, the prediction rule recommended the termination of resuscitation, resulting in a sensitivity of 64.4 percent (95 percent confidence interval, 61.6 to 67.0 percent). Of 776 patients for whom the prediction rule recommended the termination of resuscitation, 772 died, resulting in a positive predictive value of 99.5 percent (95 percent confidence interval, 98.9 to 99.8 percent). The prediction rule recommended transportation to the emergency department for 464 patients, of whom 37 survived, resulting in a negative predictive value of 8.0 percent (95 percent confidence interval, 6.6 to 9.7 percent).

Of the 776 patients for whom the prediction rule recommended the termination of basic life support resuscitation efforts, 4 survived (0.5 percent; 95 percent confidence interval, 0.1 to 0.9 percent). This survival rate was significantly lower ($P=0.04$) than the threshold of 1 percent that has been suggested as reflective of medical futil-

Table 2. Characteristics of Patients and Selected Features of Cardiac Arrests Included in the Study.*

Characteristic	No. of Responses	Value
Patients	1175	
Age — yr		
Mean		69.2±14.1
Range		18–100
Male sex — no. (%)	1240	855 (69.0)
Cardiac arrest witnessed — no. (%)	1240	
By bystander		571 (46.0)
By firefighter		42 (3.4)
By EMT		99 (8.0)
Cardiopulmonary resuscitation performed by bystander — no. (%)		331 (26.7)
EMS intervals — min†		
EMS response	1230	
Median		8.0
Interquartile range		5.0–12.0
Patient response	1226	
Median		9.0
Interquartile range		6.0–13.0
Transportation to emergency department	1235	
Median		6.0
Interquartile range		3.0–11.0
EMS response of ≤8 min — no. (%)		654 (53.2)
Prediction-rule variables — no. (%)		
No return of spontaneous circulation		1172 (94.5)
No shock advised		868 (70.0)
Not witnessed by EMS personnel		1120 (90.3)

* Plus–minus values are means ±SD.
† The interval between the time the call is received by the responding paramedics and the arrival of the EMS vehicle at the scene of the cardiac arrest is the EMS response interval. The interval between the time the call is received by the responding paramedics and the arrival of the EMS vehicle at the scene of the patient with cardiac arrest is the patient-response interval. The interval between the time the EMS vehicle leaves the scene of the cardiac arrest and arrives at the emergency department is the transportation to the emergency department interval.

ity.[24] Of these four patients, three were discharged home or to a long-term care facility and were considered to have good cerebral performance (category 1) and one patient had severe cerebral disability (category 3).

Additional variables were added to the original prediction rule to see if the rate of survival could be further refined. The inclusion of the prespecified variable of a response by EMS personnel in more than eight minutes was associated with a survival rate of 0.3 percent among patients for whom the rule recommended the termination of resuscitation (Table 5). The addition of this variable to the original prediction rule increased the positive predictive value to 99.7 percent and increased the specificity to 97.6 percent.

The inclusion of the post hoc variable of a cardiac arrest that was not witnessed by a bystander was associated with a survival rate of 0 percent among patients for whom the rule recommended the termination of basic life support resuscitative efforts. It increased both the positive predictive value of the rule and the specificity to 100 percent.

The addition of the prespecified variable or the post hoc variable to the original prediction rule would have increased the number of patients recommended for transportation to the emergency department. The addition of the prespecified variable increased this number from 464 (37.4 percent) to 848 (68.4 percent). The addition of the post hoc variable increased this number to 764 (61.6 percent).

Table 3. Outcomes of 1240 Reported Cardiac Arrests.

Outcome	No. (%)
Death	1199 (97)
Deaths pronounced in the emergency department	1140 (92)
Deaths after admission	59 (5)
Survival	41 (3)
In hospital at 6 mo after cardiac arrest	2 (<1)
Discharged	39 (3)
Category of cerebral performance*	
Good performance	29 (71)
Moderate disability	5 (12)
Severe disability	6 (15)
Coma, vegetative state	1 (2)

* Values for categories of cerebral performance were calculated as percentages of the 41 survivors.

DISCUSSION

We prospectively evaluated a previously derived clinical prediction rule for the termination of basic life support resuscitative efforts in out-of-hospital cardiac arrests in the absence of advanced cardiac life support. The prediction rule indicates that EMTs may consider the termination of resuscitation if there is no return of spontaneous circulation before a patient is transported to the emergency department and if the patient received no shocks before transportation was initiated and had a cardiac arrest that was not witnessed by EMS personnel responding to the call. The prediction rule had a positive predictive value of 99.5 percent and a specificity of 90.2 percent. Among patients whose condition met these three criteria, the survival rate was 0.5 percent. The prediction rule would have resulted in the transportation of 37.4 percent of patients (464 of 1240), rather than the current rate of 100 percent.

Three aspects of the overall survival rate of 0.5 percent among these patients should be mentioned. First, current guidelines for the termination of resuscitative efforts are based on retrospective literature that reported survival rates of 0.4 to 1.9 percent when the guidelines suggested the termination of resuscitative efforts.[4,7,25] Second, the survival rate of 0.5 percent falls below a previously suggested threshold of less than 1 percent for medical futility.[24] This definition of medical futility has been questioned,[26] particularly in the field of resuscitation.[27] However, such a view simply raises the question of how many times failure must occur before an intervention is considered futile.[28] Finally, we consider that our prediction rule offers guidance for clinicians but is not obligatory. In an editorial published more than 20 years ago, Cummins and Eisenberg[29] suggested that prediction rules for the termination of resuscitation efforts should remain advisory and that they should be tempered by the full clinical picture, taking into account the very small possibility of successful resuscitation when the prediction rules suggest termination.

When the prediction rule was modified to include either the prespecified variable (a response by EMS personnel in more than eight minutes) or post hoc variable (a cardiac arrest that is not witnessed by a bystander), the positive predictive value and the specificity were increased. Addition of either of the two variables would have identified most or all four of the survivors for whom the termination of basic life support resuscitative efforts was recommended. The addition of these variables also increased the proportion of patients for whom the rule would suggest transportation to the emergency department. The number of patients needed to be transported for one patient to survive was also increased. In the derivation study, neither of these additional variables added a predictive value that was not provided by other variables.[16] Measurement of the response interval was also considered too unreliable to justify inclusion in the rule,[30] and response intervals are not routinely available to EMTs before the patient is treated.

Clinical prediction rules for the termination of basic life support resuscitative efforts in out-of-hospital cardiac arrest are desirable for many reasons. The transportation of a patient with a refractory cardiac arrest limits the availability of EMS personnel to care for other patients, increases patients' waiting times in emergency depart-

Table 4. Test Characteristics of the Clinical Prediction Rule for the Termination of Resuscitation (TOR) in 1240 Reported Cardiac Arrests.*

Action According to Prediction Rule	Outcome		
	Death	Survival	Total No. of Cardiac Arrests
Terminate basic life support (test positive)	772	4	776
Transportation to emergency department (test negative)	427	37	464
Total	1199	41	1240
Survival rate when termination recommended by TOR — % (95% CI)	0.5 (0.1–0.9)		
Sensitivity — % (95% CI)†	64.4 (61.6–67.0)		
Specificity — % (95% CI)‡	90.2 (88.4–91.8)		
Positive predictive value — % (95% CI)§	99.5 (98.9–99.8)		
Negative predictive value — % (95% CI)¶	8.0 (6.6–9.7)		

* CI denotes confidence interval.
† Value is the number of cases in which the patient died when the rule recommended the termination of basic life support resuscitative efforts divided by the total number of cases in which the patient died.
‡ Value is the number of cases in which the patient survived when the rule recommended transportation to an emergency department and continuation of basic life support resuscitative efforts divided by the total number of cases in which the patient survived.
§ Value is the number of cases in which the patient died when the rule recommended the termination of basic life support resuscitative efforts divided by the total number of cases in which the rule recommended termination.
¶ Value is the number of cases in which the patient survived when the rule recommended transportation to an emergency department and continuation of basic life support resuscitative efforts divided by the total of number of cases in which the rule recommended transportation.

ments, decreases the available beds and equipment in emergency departments and hospitals,[2] and diverts care from patients who are potentially more likely to survive. Emergency "lights and sirens" transportation by ambulance carries many risks to motorists, pedestrians, and the EMS personnel, including that of vehicular collisions.[31] In addition, EMS personnel performing interventions in a moving vehicle or engaged in resuscitative efforts are at increased risk for occupational biohazards.[32] For the health care system, there are fewer costs involved in the termination of resuscitation in the field than in the transferal of the patient to the emergency department.[2,4,33,34] Provision of advanced cardiac life support in the hospital is associated with a considerable expense, approaching $1 billion annually in the United States.[2] Finally, rates of termination of resuscitative efforts vary for different regions, paramedics, and physicians when the decision to cease such efforts is left to the discretion of the health care provider, rather than being in accordance with a clinical prediction rule.[35] Eckstein et al. reported significant variability in the rates of termination of resuscitation (5 to 37 percent) between cases in which as a matter of policy physicians delegate the decision to paramedics by telephone and cases in which the decision was left to the discretion of the health care provider.[35] Use of a clinical prediction rule may allow distributive justice to be applied equally among all patients having an out-of-hospital cardiac arrest — in practical terms, the decision to terminate resuscitation would be applied equitably in this population whether it was applied by a physician, a paramedic, or EMS personnel.

The EMS system of care needs to consider the effects of an out-of-hospital death on a family who receives notification and on the paramedic who notifies the family. Surveys suggest that family members are comfortable with the decision to terminate resuscitative efforts in and out of the hospital setting,[36] and several studies have shown that medical personnel who are not physicians can convey the message regarding a death effectively to family members.[37] Future research should aim to measure with a validated instrument the psychological comfort of the EMS provider who is terminating resuscitation efforts and providing notification of death to family members in the out-of-hospital setting.[38]

In our study, the site-specific rate of the enrollment ranged from 21 to 100 percent of all eligible patients who had a cardiac arrest, with

Table 5. Outcomes of the Original Termination of Resuscitation (TOR) Prediction Rule, with Additional Prespecified and Post Hoc Variables.*

Variable	Survival When Termination Was Recommended	Positive Predictive Value	Specificity	No. (%) Transported to the Emergency Department	No. Needed to Transport†	Incremental No. Needed to Transport‡
		% (95% CI)				
Original TOR prediction rule		99.5 (98.9–99.8)	90.2 (88.4–91.8)	464 (37.4)	13	NA
No./total no.	4/776					
Rate (95% CI)	0.5 (0.1–0.9)					
Addition of EMS response that takes ≥8 min		99.7 (99.2–99.9)	97.6 (96.5–98.3)	848 (68.4)	22	128
No./total no.	1/389					
Rate (95% CI)	0.3 (0.0–1.7)					
Addition of cardiac arrest not witnessed by a bystander		100 (99.6–100)	100 (99.6–100)	764 (61.6)	19	75
No./total no.	0/476					
Rate (95% CI)	0 (0.0–1.0)					

* CI denotes confidence interval.
† The number needed to transport was calculated as the number transported to the emergency department divided by the total number of survivors, as predicted by the rule.
‡ The incremental number needed to transport was calculated by obtaining the difference between number of patients transported to the emergency department according to the original TOR prediction rule and the number transported with the additional variable and then dividing this difference by the number of additional survivors predicted according to the revised rule.

an overall rate of 76.5 percent. Data were not included for patients who were not included in the overall sample. However, data on 89 to 100 percent of all eligible patients were available at the four largest sites, and the demographic characteristics of the patients and the survival rates were similar at all 12 sites. We therefore suggest that the missed cases were probably similar to those included in the study.

The study was conducted in, and is applicable to, settings in which EMS systems were staffed by EMTs trained to provide basic life support and automated external defibrillation. The prediction rule is not applicable to resuscitations involving EMTs who are trained in advanced life support or to EMTs who are not trained in the use of an automated external defibrillator. It is also not clear that the prediction rule would produce similar results if it were used in a basic life support program in which nonautomated defibrillators were used, since the administration of shocks would then depend on the provider's independent interpretation of the rhythm.

The basic life support protocols we used were consistent with the Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.[21] Since the completion of the study, the 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, formulated in collaboration with the International Liaison Committee on Resuscitation, have been released.[39] They differ in some respects from the basic life support protocols we used. As newer guidelines are introduced, such protocols will continue to change, in an effort to increase survival. The likely result will be an increase in the rate of the return of spontaneous circulation and the incidence of a rhythm requiring defibrillation. Thus, an increasing number of patients would receive continued resuscitative efforts and would be transported to the emergency department if the prediction rule were to be applied. Although such changes will alter the rate of transportation to the emergency department, the rule will continue to be helpful in identifying patients who are unlikely to survive despite optimized therapy.

We prospectively evaluated a clinical prediction rule for the termination of basic life support resuscitative efforts by EMTs trained in the use of an automated external defibrillator for a cohort of patients with out-of-hospital cardiac arrest and found that the rule had a positive predictive value of 99.5 percent and a specificity of 90 percent.

Among patients who fulfilled the criteria for the termination of resuscitative efforts, a total of 0.5 percent survived. The rule may assist clinicians in making decisions to terminate resuscitative efforts in out-of-hospital cardiac arrest.

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APPENDIX

The following persons and EMS systems in Ontario, Canada, participated in the study: *Steering Committee* — R. Verbeek (chair), L.J. Morrison, L.M. Visentin, D. Eby, R. Theriault; *Data Management Committee* — L.J. Morrison (chair), L.M. Visentin, M. Vermeulen, A. Kiss; *Waterloo Region–Wellington–Dufferin Base Hospital Paramedic Program* — D. Waldbillig, K. Ballah, Royal City Ambulance Service; *Associate Base Hospital Program, Eastern Counties* — L. Briere, C. Brandt, Cornwall SD&G EMS, Prescott/Russell EMS; *Base Hospital Advanced Life Support Program for Durham Region* — R. Vandersluis, M. Epp, S. Driscoll, Durham Region EMS; *Grey–Bruce–Huron Paramedic Base Hospital Program* — D. Eby, C. Prowd, M. Muir, Grey County EMS, Bruce County EMS, Huron County EMS; *Hamilton Health Sciences Base Hospital Program* — M. Welsford, K. Stuebing, Norfolk County EMS, Haldimand County EMS, County of Brant Ambulance Service, Six Nations Ambulance Service; *Sunnybrook–Osler Centre for Prehospital Care* — P.R. Verbeek, S. Cheskes, R. Theriault, L. McCleary, J. Summers, Toronto EMS, Peel Region Ambulance Service; *Base Hospital Program, Peterborough Regional Health Centre* — V. Arcieri, P. Mathers, City of Kawartha Lakes Ambulance Service, Haliburton EMS, Northumberland EMS; *Sault Area Hospital Base Hospital Program* — P. Hoogeveen, J. Scott, E. Mooney, Algoma EMS, Sault Ste. Marie EMS; *Royal Victoria Hospital Base Hospital for Simcoe and Muskoka* — M. Murray, T. Waite, Muskoka Ambulance Service, Health Trust Ambulance Service; *Timmins and District Base Hospital Paramedic Program* — C. Loreto, M. Pilkington, Cochrane District EMS, James Bay Ambulance Service; *York Regional Base Hospital Program* — D. Austin, W. Beckett, A. Donnelly, D. Kunihiro, York Region EMS.

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