

# Out-of-Hospital Cardiac Arrest: First Documented Experience in a Mexican Urban Setting

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## Abbreviations:

AHA = American Heart Association  
CPR = cardiopulmonary resuscitation  
EMS = emergency medical services  
ROSC = return of spontaneous circulation  
SCD = sudden cardiac death

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## Abstract

**Objective:** Out-of-hospital cardiac arrest is one of the leading causes of death in Mexico, but many survival and prognostic factors are unknown. The aim of this study was to assess out-of-hospital cardiac arrest in a Mexican city.

**Methods:** This was a prospective, cohort study that evaluated the records of the major ambulance services in the city of Querétaro, Mexico. Means, standard deviation, and percentages for the categorical variables were obtained. Logistic regression was performed to determine the effects between interventions, times, and return of spontaneous circulation (ROSC).

**Results:** For an 11-month period, 148 out-of-hospital cardiac arrest cases were recorded. The mean age of the victims was 54 ±22.6 years and 90 (65.3%) were males. Forty-nine cases were related to cardiac disease, 46 to other disease, 27 to trauma, 18 to terminal illnesses, and three to drowning. Twelve (8.6%) patients had a pulse upon hospital arrival, but none survived to discharge. No victims were defibrillated prior to ambulance arrival. The collapse-assessment interval was 22.5 ±19:1 minutes, the mean value for the ambulance response times was 13:6 ±10:4 minutes. Basic emergency medical technicians applied chest compressions to 40 victims (27.2%), controlled the airway in 32 (21.8%), and defibrillated seven (4.8%). Chest compressions and airway control showed an OR of 8 and 12 respectively for ROSC.

**Conclusions:** The poor survival rate in this study emphasizes the need to improve efforts in provider training and public education. Authorities must promote actions to enhance prehospital emergency services capabilities, shorten response times, and provide community education to increase the chances of survival for out-of-hospital cardiac arrest victims in Mexico.

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## Introduction

Heart disease is the leading cause of death worldwide, especially in high-income countries. In Mexico, cardiovascular diseases are the leading cause of death as well, with acute coronary syndromes causing an estimated 33,000 to 53,000 sudden cardiac deaths (SCD) each year. Due to a lack of an adequate registration system of sudden death events, this information is inaccurate.<sup>1</sup>

Out-of-hospital cardiac arrest is the most common presentation of SCD. It also is the setting in which the most important strategies to diminish death and disability can be implemented, aside from prevention politics.<sup>2–7</sup> Among the most important contributions to SCD treatment—the well-known “Chain of Survival”, a series of interventions focused on reducing times between patient collapse, emergency medical services (EMS) activation, initiation of cardiopulmonary resuscitation (CPR), early defibrillation and advanced cardiac life support (ACLS).<sup>8</sup>

Nevertheless, bystander CPR generates different outcomes from those expected by the general community. Laypersons usually expect a higher number of victims will have return of spontaneous circulation (ROSC).<sup>3–5</sup> This

has led to four specific objectives for SCD treatment: (1) increase public awareness and information about SCD and CPR; (2) ensure all healthcare professionals and lay rescuers are CPR-trained; (3) promote early defibrillation, based on its effectiveness in improving patient outcomes;<sup>7,9,10</sup> and (4) implement EMS systems to provide advanced medical care within a short period of time after patient collapse. To increase public awareness of CPR, the importance of calling for help as soon as possible must be emphasized. Most recently, the American Heart Association (AHA) recommended the application of "Hands Only CPR" by laypersons with no previous experience or training as a method to increase the amount of lay rescuers that actually help out-of-hospital cardiac arrest victims.<sup>1-4</sup>

The AHA guidelines for CPR suggest that brain damage begins four minutes after cardiac arrest, and after 10 minutes, the hypoxic damage is irreversible.<sup>6</sup> The AHA also recommends that Emergency Cardiac Care programs should be designed in order to offer victims defibrillation within five minutes after collapse.

In Mexico, many of the circumstances and determinants related to sudden death still are unknown. Its incidence, causes, EMS response times, interventions performed, and survival rates are not yet defined. Also, public access defibrillation programs almost are non-existent in comparison to more developed countries. Thus, EMS providers can shorten the time to definitive interventions after patient collapse. Nonetheless, EMS in Mexico are heterogeneous in quality, training levels, personnel, equipment, fleet management strategies, and economies of scale.<sup>7</sup>

For these reasons, and in order to assess emergency care interventions for patients who experience sudden death, ambulance registries from Querétaro, Mexico were analyzed. It is the biggest city in the state of Querétaro, with an urban population of approximately 800,000 people. Emergency medical services are provided by >14 different private, public, and volunteer agencies, with the local branch of the Mexican Red Cross covering nearly 90% of emergency services.

## Methods

### Study Design

A prospective, cohort study was designed to obtain data from the ambulance registries of patients treated between June 2006 and May 2007 by the local Red Cross ambulance service. All patients who suffered cardiac arrest previous to the arrival of EMS or during transportation to the hospital were identified and included in this study. The registries were reviewed by two independent observers who captured the data, in Utstein style formats. The research proposal was reviewed and approved by the Charles Sturt University Ethics Committee (Australia) and the Mexican Academy of Prehospital Medicine Ethics Committee. When possible, consent from a family member was obtained.

The information obtained included gender, age, possible causes for the arrest, co-morbidities, time of collapse, time at which the call was received, time of arrival, and time in which patient status was assessed. Information related to the procedures performed by the ambulance crew also were registered, including thoracic compressions, assisted ventilations, airway control, defibrillation, and pharmacological

interventions, as well as procedures performed by lay rescuers previous to the ambulance arrival, such as CPR and defibrillation. The causes for the arrest were grouped arbitrarily into a medical category, which was subdivided into cardiac or other causes, such as asthma, diabetes and others, and traumatic. Drowning and terminal illnesses were considered separately because of the implications they have from the emergency cardiac care (ECC) perspective.

### Statistical Analysis

The categorical variables were analyzed using chi-square to compare with estimated values, and the odds ratio was used in order to evaluate possible associations between patient categories and ROSC, arriving alive, or admitted to a hospital. Survival to discharge was not measured, since none of the patients survived to be discharged.

Logistic regression was used to determine the effects between intervals, procedures, and survival (ROSC, arrived alive, and hospital admission). The dependent variables for this study were ROSC previous to hospital arrival, hospital admission, and hospital discharge. For continuous variables, mean values and their standard deviations were calculated. Values missing in the ambulance service registries were excluded from the analysis. The SPSS statistical package v.15 [SPSS, Inc., Chicago, IL] and Excel software [version 2007, Microsoft, Inc., Redmond, WA] were used for statistical processing. A 95% confidence level was used to determine statistical significance.

## Results

A total of 148 cases treated in Querétaro and its urban area during an 11 month period were identified. One case was eliminated because of the poor quality of information reported.

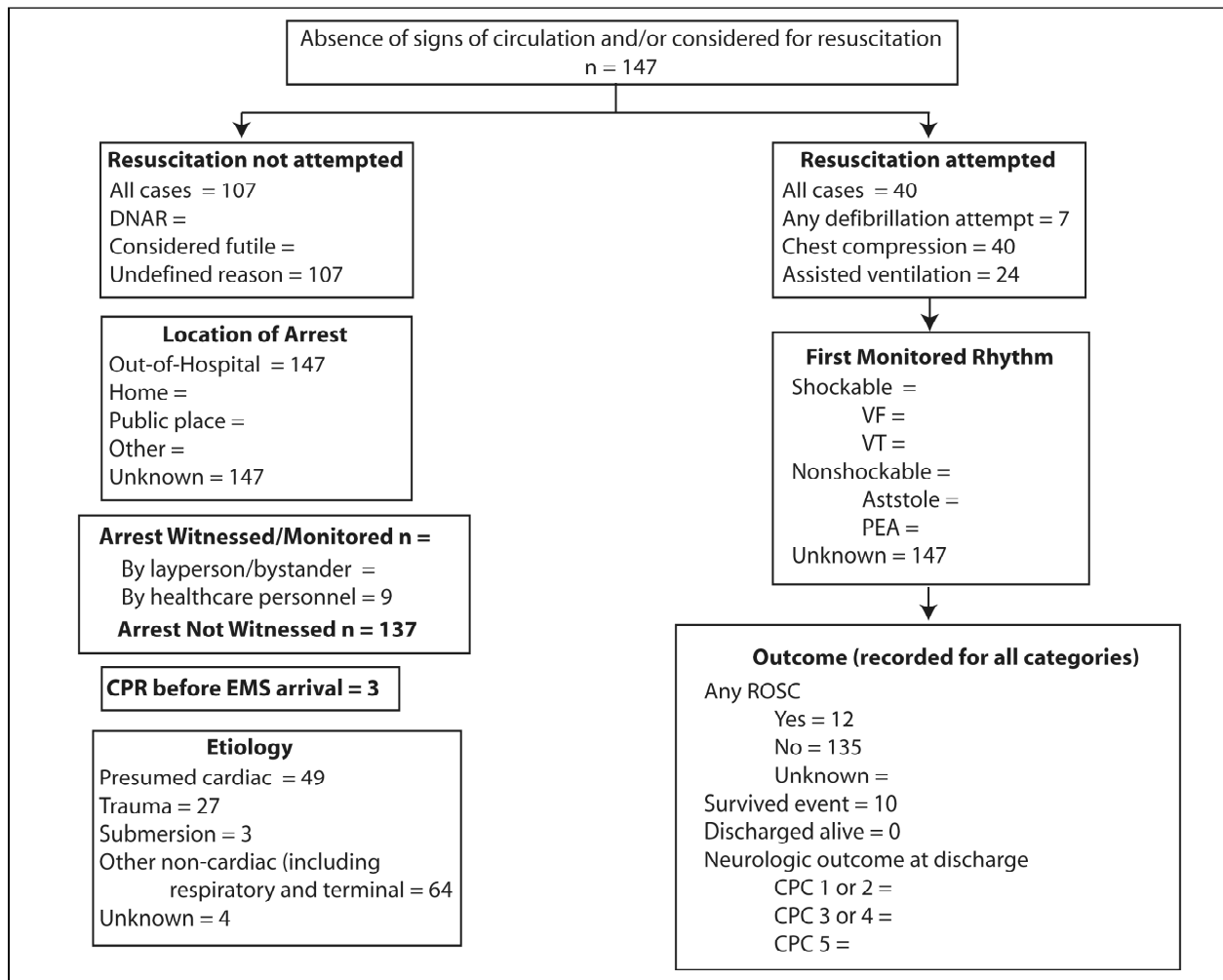
Figure 1 shows the general outcomes of the 147 remaining patients. Of the victims, 94 (65.28%) were males, and the average age was 54 ±22.6 years. All patients experienced an out-of-hospital cardiac arrest, but the reports did not include where the cardiac arrest occurred (home, street, etc.). According to the patients' histories reported by ambulance crews, the cause of arrest: (1) could not be determined in four (2.7%) of the cases; (2) was considered of cardiac origin in 49 (33.3%); (3) was due to other diseases, including respirator-related arrests, in 46 (31.1%); (4) was associated with severe trauma in 27 (18.4%); (5) resulted from a terminal illness in 18 (12.2%); and (6) was due to drowning in three (2%).

The arrest was witnessed in one (0.7%) case. Nevertheless, in three (2%) patients, CPR was initiated by lay rescuers. None of the patients received defibrillation prior to ambulance arrival. There was one patient (0.7%) in which the use of implantable automatic defibrillator was reported.

The interventions performed by EMS personnel included thoracic compressions in 40 patients (27.2%), endotracheal intubation or airway control in 32 (21.8%), assisted ventilations in 26 (17.7%), and defibrillation in seven cases (4.8%).

Nine out of the 148 cases did not have information about their condition upon hospital arrival and 12 (8.6%) had ROSC. Nevertheless, no patients were discharged alive.

Table 1 includes the main causes of cardiac arrest by age groups. Trauma and other diseases are responsible for more cardiac arrests at a younger age, while cardiac diseases are more related to cardiac arrest at older ages.



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**Figure 1**—Results from out-of-hospital cardiac arrest using the Utstein Template (CPC = cerebral performance category; CPR = cardiopulmonary resuscitation; DNAR = do not resuscitate order; PEA = pulseless electrical activity; ROSC = return of spontaneous circulation; VF = ventricular fibrillation; VT = ventricular tachycardia)

Cause of Arrest/Age groups (years)	1–15 n (%)	16–35 n (%)	36–55 n (%)	56–65 n (%)	66–75 n (%)	≥76 n (%)	Total n (%)
Cardiac	-	3 (9.4)*	7 (25.9)	12 (52.2)	11 (44.0)	15 (53.6)	48 (34.0)
Other Diseases	4 (66.7)	15 (46.9)	4 (14.8)	-	1 (3.6)	1 (3.6)	25 (17.7)
Trauma	1 (16.7)	10 (31.3)	10 (37.0)	9 (39.1)	7 (28.0)	8 (28.6)	45 (31.9)
Drowning	1 (16.7)	1 (3.1)	-	-	-	-	2 (1.4)
Terminal Illnesses	-	3 (9.4)	6 (22.2)	2 (8.7)	6 (24.0)	1 (3.6)	18 (12.8)
Total	6 (4.3)	32 (21.8)	27 (18.4)	23 (15.6)	25 (17.0)	28 (19.0)	141**

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**Table 1**—Causes of arrest by age groups  
\*All data are number of cases (percentage of total)  
\*\*Percentages do not add to 100% due to rounding

Table 2 lists the different intervals measured: (1) collapse-patient assessment; (2) collapse-emergency call; (3) emergency call-ambulance arrival; (4) and ambulance arrival-patient assessment. The collapse-patient assessment interval was 23

±9 minutes, with an average response times from call to ambulance arrival of 14 ±10 minutes. The average time from collapse to an ambulance call was 10 ±34 minutes.

		Mean	SD	n
Intervals	Collapse Assessment	0:22:52	0:19:13	109
	Collapse to Call	0:09:31	0:34:09	122
	Call to Arrival	0:13:56	0:10:43	137
	Arrival to Patient Assessment	0:02:20	0:04:45	121

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**Table 2**—Time intervals in minutes (SD = standard deviation)

After processing the data using logistic regression, neither the cause of cardiac arrest nor the age group were related statistically to the ROSC. Thoracic compressions were related positively to ROSC (75% vs. 25%, OR 8.5, CI 1.2–61.3,  $p < 0.03$ ), as well as airway control (58.3% vs. 41.7%, OR 12.9, CI 1.3–130.4,  $p < 0.03$ ). Defibrillation and ventilation did not show a positive effect toward ROSC previous to hospital arrival. Performing any kind of intervention is related to an increased possibility to regain circulation prior to hospital arrival (OR 7.88, CI 2–30.8,  $p < 0.003$ ; Table 3). The interval patient collapse–patient assessment of < 8 minutes did not show a statistically significant difference in comparison with longer intervals regarding the chances of pulse recovery before hospital arrival (OR 1.6 CI 0.17–15.2,  $p > 0.05$ ).

### Discussion

Out-of-hospital cardiac arrest is the leading cause of mortality in Mexico. Early interventions, such as lay rescuer CPR and defibrillation, have improved the prognosis for patients who suffer prehospital cardiac arrest. This is demonstrated by the fact that in many instances, out-of-hospital cardiac arrest survival one year from the event increases from 6 to 14% depending on the series reviewed.<sup>9–11</sup>

Several studies demonstrate survival rates from cardiac arrest to hospital arrival of 68 to 92% that were related to layperson CPR, participation of advanced EMTs, or when response times and initial defibrillation were provided in <8 minutes of the arrest.<sup>12,13</sup> On the contrary, when CPR was not performed by lay-rescuers or the arrest was not witnessed (such as in this study), the arrest occurred at the patient's home. For older patients, or cases when time intervals were longer, chances of survival were lower.<sup>14</sup>

This study showed an out-of-hospital cardiac arrest survival rate of 0%, even at a relatively short period of 24 hours after the event. The low rate of ROSC before hospital arrival can be explained by the low intervention rate in all patients, the prolonged response times, the lack of adequate prehospital care, the low rate of early defibrillation, and the long intervals between patient collapse and the call for EMS. It is possible that EMTs did not even encounter rhythms treatable by defibrillation. This can be explained

Variable	Odds Ratio	95% CI
Layperson CPR	0	-
ICD	0.0001	-
Cardiac Maneuvers EMS	8.5**	1.18–61.32
Ventilation by EMS	0.01**	0.0009–0.22
Airway Control by EMS	12.90**	1.28–130.45

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**Table 3**—Odds ratios for the different interventions (CPR = cardiopulmonary resuscitation, ICD = implantable cardioverter/defibrillator)

\*\* $p < 0.01$

again by the long times between collapse and ambulance call, and because the average interval between collapse and patient assessment was almost 23 minutes. Just the average interval from call to ambulance arrival was almost 14 minutes.

There was no relationship between the cause of cardiac arrest and the decision not to resuscitate the patient. The sample size is small, but with few exceptions, basic EMTs do not have the medical authority to decide to withdraw or withhold CPR. Training programs should be reviewed and the clinical criteria included in the EMT curriculum.

The average age of the arrest victims was 54 years, an age in which most people still are considered productive. The economic impact of preventing these premature deaths might have some social benefit. These facts strengthen the need to implement educational programs focused on the general population and on EMS personnel.

It also is important to educate local governments and decision-makers in the search to strengthen Cummins's "Chain of Survival"<sup>18</sup> by diminishing EMS response times, increasing laypersons CPR knowledge, and promoting public access defibrillation programs.

Some limitations include the fact that these results are local and might not reflect the entire country of Mexico. The low survival rate may be related to the long time intervals between collapse and patient assessment. Nevertheless, in Mexico City, the response times exceed, on average, 40 minutes,<sup>12</sup> providing reason to think that the outcomes might not be favorable. This may be a national problem, but more studies are needed to substantiate the argument.

These results also imply that secondary treatments for patients who suffer sudden death, such as angioplasty or implanted defibrillators, are not even considered, since no patients survived the initial arrest.

### Conclusions

Cardiac arrest is a common health problem in many countries, and Mexico is not an exception. The fact that this is the first published document analyzing out-of-hospital cardiac arrest in Mexico reflects the lack of awareness regarding this problem. As demonstrated by the low survival rate

(0%) in the city of Querétaro, the reasons in Mexico are multi-factorial, and related to long response times (23 minutes), lack of public education regarding CPR (2% of victims received CPR before EMS arrival), the absence of a public access defibrillation programs (0% of patients defibrillated before EMS arrived), and EMS preparedness. Although this study cannot be generalized to assume that this condition prevails across all of Mexico, it is recom-

mended that similar studies and registries be done in other Mexican cities and different interventions implemented and measured in order to diminish the high mortality rates documented in this study.

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