

ORIGINAL INVESTIGATIONS

Coronary Artery Disease in Patients With Out-of-Hospital Refractory Ventricular Fibrillation Cardiac Arrest



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ABSTRACT

BACKGROUND The prevalence of coronary artery disease (CAD) among patients with refractory out-of-hospital (OH) ventricular fibrillation (VF)/ventricular tachycardia (VT) cardiac arrest is unknown.

OBJECTIVES The goal of this study was to describe the prevalence and complexity of CAD and report survival to hospital discharge in patients experiencing refractory VF/VT cardiac arrest treated with a novel protocol of early transport to a cardiac catheterization laboratory (CCL) for extracorporeal life support (ECLS) and revascularization.

METHODS Between December 1, 2015, and December 1, 2016, consecutive adult patients with refractory OH VF/VT cardiac arrest requiring ongoing cardiopulmonary resuscitation were transported by emergency medical services to the CCL. ECLS, coronary angiography, and percutaneous coronary intervention were performed, as appropriate. Functionally favorable survival to hospital discharge (Cerebral Performance Category 1 or 2) was determined. Outcomes in a historical comparison group were also evaluated.

RESULTS Sixty-two (86%) of 72 transported patients met emergency medical services transport criteria. Fifty-five (89%) of the 62 patients met criteria for continuing resuscitation on CCL arrival; 5 had return of spontaneous circulation, 50 received ECLS, and all 55 received coronary angiography. Forty-six (84%) of 55 patients had significant CAD, 35 (64%) of 55 had acute thrombotic lesions, and 46 (84%) of 55 had percutaneous coronary intervention with 2.7 ± 2.0 stents deployed per patient. The mean SYNTAX score was 29.4 ± 13.9 . Twenty-six (42%) of 62 patients were discharged alive with Cerebral Performance Category 1 or 2 versus 26 (15.3%) of 170 in the historical comparison group (odds ratio: 4.0; 95% confidence interval: 2.08 to 7.7; $p < 0.0001$).

CONCLUSIONS Complex but treatable CAD was prevalent in patients with refractory OH VF/VT cardiac arrest who also met criteria for continuing resuscitation in the CCL. A systems approach using ECLS and reperfusion seemed to improve functionally favorable survival. (J Am Coll Cardiol 2017;70:1109-17) © 2017 by the American College of Cardiology Foundation.



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ABBREVIATIONS AND ACRONYMS

- ACLS** = advanced cardiac life support
CAD = coronary artery disease
CCL = cardiac catheterization laboratory
CPC = Cerebral Performance Category
CPR = cardiopulmonary resuscitation
ECLS = extracorporeal life support
EMS = emergency medical services
LUCAS = Lund University Cardiac Arrest System
OH = out-of-hospital
OHCA = out-of-hospital cardiac arrest
PCI = percutaneous coronary intervention
ROSC = return of spontaneous circulation
VF = ventricular fibrillation
VT = ventricular tachycardia

The vast majority of all survivors of out-of-hospital cardiac arrest (OHCA) present to emergency medical services (EMS) with an initial shockable rhythm (ventricular fibrillation [VF]/pulseless ventricular tachycardia [VT]) (1-3). Even with this favorable presenting rhythm, >60% of patients with VF/VT are refractory to current treatment and never achieve return of spontaneous circulation (ROSC) or they die before they are admitted to the hospital (4).

Currently, the American Heart Association Advanced Cardiac Life Support (ACLS) guidelines recommend treating patients with refractory VF/VT at the scene of cardiac arrest for 30 to 45 min until they have ROSC or are declared dead (5).

Building on recent studies showing improved functionally favorable survival by rapid reversal of coronary artery ischemia after successful resuscitation following VT/VF OHCA (6-11), we implemented a new, systems-based approach that included early EMS transport of patients with refractory VF/VT to an ST-segment elevation myocardial infarction-receiving hospital with ongoing mechanical cardiopulmonary resuscitation (CPR).

On arrival at the cardiac catheterization laboratory (CCL), early circulatory support with extracorporeal life support (ECLS), immediate angiography after ECLS, and percutaneous coronary intervention (PCI) were performed, as indicated. The present article describes the prevalence of coronary artery disease (CAD), incidence of acute coronary occlusion/stenosis, and the influence of reperfusion therapy on functionally favorable survival rates to hospital discharge in patients with refractory OH VF/VT cardiac arrest.

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METHODS

The University of Minnesota refractory VF/VT protocol has been described elsewhere (12). Briefly, early EMS transport criteria were as follows: 1) VF/VT OHCA as the first presenting rhythm; 2) 18 to 75 years of age; 3) three EMS-delivered direct current shocks and 300 mg of intravenous/intraosseous amiodarone without achieving ROSC; 4) body morphology able to accommodate a Lund University Cardiac Arrest System (LUCAS) automated CPR device; and 5) estimated transfer time from the scene to the CCL of <30 min (Figure 1).

Early EMS transport exclusion criteria included: 1) cardiac arrest of noncardiac etiology (e.g., blunt or penetrating traumatic arrest, burn-related, exsanguination, hanging, known overdose); 2) contraindications to mechanical CPR; 3) known pregnancy; 4) nursing home residents; 5) valid do not resuscitate/do not intubate orders; and 6) known terminal illness (e.g., cancer; end-stage liver, kidney, or heart disease).

North Memorial and St. Paul Fire EMS systems participated in the protocol. These 2 agencies service a population of 570,000 people in an area of approximately 1,100 square miles within a 30-min driving radius from the University of Minnesota. Patients meeting criteria were mobilized with ongoing CPR by using a LUCAS 2 automated CPR device (Physio-Control, Inc., Redmond, Washington) that compressed the chest 100 times/min. All patients had an advanced airway device placed. An inspiratory impedance threshold device (ResQPOD, Zoll Medical, Roseville, Minnesota) was used in all cases (2,13,14). Ventilation was provided in accordance with standard ACLS protocols (5,15). Patient treatment continued in the ambulance, and ACLS was performed until the patients arrived in the CCL (5).

A team of interventional cardiologists provided rotating around-the-clock call for response within 20 min of activation. Every patient requiring CPR on arrival was placed on the CCL table with the LUCAS device operating. The initial arterial access and ECLS initiation details have been described previously (12). At the initial arterial puncture, arterial blood gas and lactic acid samples were sent for processing.

ECLS was initiated in all patients meeting early transport criteria who had no Resuscitation Discontinuation Criteria and had not obtained ROSC by that time (Figure 1). ECLS was performed with a pre-primed CardioHelp circuit consisting of a centrifugal pump (Maquet Rotaflow, Maquet Cardiovascular, LLC, Wayne, New Jersey). Interventional cardiologists placed all devices.

Once hemodynamic/perfusion stability was obtained with either achievement of ROSC or initiation of ECLS, coronary angiography was performed and revascularization accomplished based on the clinical judgment of the interventional cardiologist. All coronary interventions were performed with intravenous heparin and an activated clotting time target of 250 to 300 s. At the initiation of ECLS, all patients received a bolus of unfractionated heparin (100 U/kg). At the end of the case, all patients treated with PCI were given aspirin and ticagrelor through a nasogastric tube. If the nasogastric tube could not be placed, ticagrelor was infused intravenously until ticagrelor

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