

# Will Automated Compressing Devices Save More Lives in Recalcitrant Ventricular Fibrillation Cardiac Arrest?

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## Abstract

We present a 55-year-old male that developed ventricular fibrillation cardiac arrest in the setting of ST-elevation acute myocardial infarction with recalcitrant and persistent ventricular fibrillation arrest that was successfully resuscitated with a good neurological outcome. The persistent chest compressions were performed in our intensive care unit with an automated chest compression system. The patient required defibrillations and nonstop chest compressions which were the key factors for his survival. This is an example we should consider in all our intensive care units. It's time for a paradigm shift in replacing the compressor of a code team with an automated system. The out-of-hospital evidence in acute care is compelling to bring this technology that has been proven crucial in transports from hospital areas, ambulances, helicopters, and ships to the inpatient ICU bedside. In ventricular tachycardia and ventricular fibrillation (Vt/Vf), the electrical storm created is the perfect example of the need to have the best compressions to provide the best care possible with the best survival and neurological outcomes.

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**Categories:** Cardiology, Emergency Medicine, Internal Medicine

**Keywords:** cardiac arrhythmia, cardiac arrest outcome, lucas device, ventricular fibrillation (vf) storm, ventricular arrhythmia, pulmonary critical care, in hospital cardiac arrest, chest compressions

## Introduction

Cardiac arrest due to ventricular tachycardia or fibrillation associated with ST-elevation myocardial infarction (STEMI) has a very poor prognosis and mortality. The probability of success generally declines at a rate of 2 to 10 percent per minute of presentation. Early defibrillation and perfusion can make the difference between long-term disability and functional recovery [1-3].

As noted above, refractory ventricular tachycardia or ventricular fibrillation arrest in the setting of STEMI has very high mortality [4,5]. The heart muscle suffers an injury from a ruptured plaque or myocardial infarction which causes further death of heart cells and ventricular fibrillation potentiates further impairment in cardiac output. As the cardiovascular system collapses there is less perfusion to vital organs with the diminished distribution of vital medications and antiarrhythmics [6]. Prompt correction to a perfusion sinus rhythm is key. To do this, consistent uninterrupted chest compressions with prompt defibrillation is necessary. High-quality chest compressions are a key component of proper resuscitation. Studies have shown that coronary perfusion pressure (CPP) >15 mmHg, has the highest possibility of survival. Providing adequate compressions with a rate of 100-120/min and compression depth (2 inches) as well as allowing for full chest recoil while minimizing off time is the cornerstone of cardiac resuscitation [3,7]. Devices that provide mechanical compression of the chest eliminate the shortcomings of human error, lack of consistency, or physical fatigue. The value of automated devices has been recognized in multiple studies on out-of-hospital cardiac resuscitation but the use of in-hospital critical care is not a common occurrence.

## Case Presentation

A 55-year-old male presented to the emergency room, complaining of chest pain that woke him up early in the morning. The patient had substernal chest pain 8/10, received aspirin, oxygen, and morphine. STEMI alert was called, the patient had ST elevation on the inferior leads. The patient was taken to the hemodynamic laboratory (Table 1) and emergent cardiac catheterization was performed. Following placement of the right circumflex stent, the patient was moved to the medical intensive care unit where the patient developed pulseless cardiac arrest secondary to acute anterior wall myocardial infarction. On the rhythm strip, he was noted to be in ventricular fibrillation and prompt advanced cardiac life support (ACLS) protocol was initiated with high-quality cardiopulmonary resuscitation (CPR) and prompt defibrillation was performed early with 200 Joules on a biphasic defibrillator. The LUCAS® Automated Chest Compression System (Jolife AB, a part of Stryker, Lund, Sweden) was placed after the first round of standard CPR (Figures 1, 2).

### How to cite this article

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WHITE BLOOD CELL COUNT	22x10 <sup>3</sup> / $\mu$ l
B-TYPE NATRIURETIC PEPTIDE	850 pg/mL
FERRITIN	450 ng/l
D-DIMER	>5 ng/ml

**TABLE 1: Laboratory investigations**



**FIGURE 1: The LUCAS® 3 Chest Compression System**


# LUCAS<sup>®</sup> 3

CHEST COMPRESSION SYSTEM







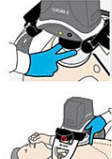



## QUICK REFERENCE GUIDE

LUCAS is intended for use as an adjunct to manual CPR when effective manual CPR is not possible (e.g., during patient transport or extended CPR when fatigue may prohibit the delivery of effective/consistent compressions to the victim, or when insufficient EMS personnel are available to provide effective CPR). Refer to the Instructions For Use for complete directions for use, indications, contraindications, warnings, precautions and potential adverse events.

US



MANUAL POSITIONING OF THE SUCTION CUP

RESCUER 1 (LUCAS Operator)	RESCUER 2
<b>1. POWER ON LUCAS.</b>	
 <ul style="list-style-type: none"> <li>Push <b>ON/OFF</b> to start self-test and power up the LUCAS device</li> <li>The device will be ready and in the <b>ADJUST</b> mode</li> </ul>	 <ul style="list-style-type: none"> <li>Provide manual CPR</li> </ul>
<b>2. PLACE THE LUCAS BACK PLATE.</b>	
 <ul style="list-style-type: none"> <li>Pause manual CPR briefly</li> <li>Put the <b>BACK PLATE</b> under the patient, immediately below the armpits</li> </ul>	 <ul style="list-style-type: none"> <li>Assist <b>BACK PLATE</b> placement</li> <li>Resume manual CPR</li> </ul>
<b>3. ATTACH THE UPPER PART.</b>	
 <ul style="list-style-type: none"> <li>Pull the <b>RELEASE RINGS</b> once to open <b>CLAW LOCKS</b>. Then let go of the rings</li> <li>Stop manual CPR briefly while attaching the <b>UPPER PART</b> to the <b>BACK PLATE</b>. Listen for "CLICK" sound</li> <li>Pull up once to ensure attachment</li> </ul>	 <ul style="list-style-type: none"> <li>Continue manual CPR as long as possible</li> <li>Help to attach the <b>UPPER PART</b></li> </ul>
<b>4. PUSH DOWN SUCTION CUP. ADJUST POSITION IF NEEDED.</b>	
 <ul style="list-style-type: none"> <li>Push down the <b>SUCTION CUP</b></li> <li>The lower edge of <b>SUCTION CUP</b> should be immediately above the end of the sternum</li> <li>Adjust if necessary (stay in <b>ADJUST</b> mode)</li> </ul>	 <ul style="list-style-type: none"> <li>Assist</li> </ul>
<b>5. LOCK POSITION. START COMPRESSIONS.</b>	
 <ul style="list-style-type: none"> <li>Push <b>PAUSE</b> to lock <b>START POSITION</b></li> <li>Push <b>ACTIVE (continuous)</b> or <b>ACTIVE (30:2)</b> to start compressions</li> </ul>	 <ul style="list-style-type: none"> <li>Assist</li> </ul>
<b>... ATTACH STABILIZATION STRAP. FOLLOW CPR PROTOCOLS.</b>	

stryker

LUCAS<sup>®</sup> 3 Chest Compression System – INSTRUCTIONS FOR USE  
101034-00 Rev G, valid from CO J3353 © 2021 Jolife AB

**FIGURE 2: LUCAS Chest Compression System Quick Reference Guide**

The patient was defibrillated several times as he continued to remain in VT/VF, over 25 minutes. He received several rounds of 1 mg epinephrine every 3-5 minutes, amiodarone IV 300 mg bolus followed by the second dose of IV 150 mg. After 25 minutes of constant CPR performed by the LUCAS<sup>®</sup> Automated Chest Compression System with multiple shocks, the patient had a Return of Spontaneous Circulation (ROSC), confirmed with end tidal CO<sub>2</sub>. Within the next 30 minutes, the patient started having purposeful movements and started to wake up. He required fentanyl and a propofol drip for sedation. He remained on vasopressors and amiodarone but the hypothermic protocol was not started due to improvement in mental status. His Arterial Blood Gases (ABG) were 7.23, pCO<sub>2</sub> 53, pO<sub>2</sub> 45. The patient also required epinephrine drip at 4 mcg/min and amiodarone. Overnight saturation improved over the course of the next five days, the patient was extubated with discharge to home on day 11 and referred to follow up with cardiac rehab. At the time of discharge, his cerebral performance score was 1 (Good cerebral performance, conscious, alert, able to work, having mild neurological deficit).

### Discussion

Performing cardiopulmonary resuscitation (CPR) can be laborious and fatiguing, the consistency in depth of compressions, quality, and non-interrupted compression is the cornerstone to perfuse the vital organs. CPR

can also be an obstacle for percutaneous coronary interventions. Over the past decades, the use of automated electrical devices (AED) delivery of electricity and rhythm detectors has been placed in most public places and the emphasis on quality CPR has been recommended by the American Heart Association. Nevertheless, in most places in America, intensive care units (ICU), emergency rooms (ER), pre-surgical centers, and even some cardiac catheterization laboratories depend on the training and practice of a CPR provider [1,2,4,5]. We have the technology to provide safe, effective, and consistent compressions of the chest during cardiac arrest. The ICU has been the place where pulmonologists and intensivists, support organs such as the lungs during respiratory failure, hemodialysis for kidney failure. The next evolution should be consistent chest compressions during cardiac arrest. In cardiac catheterization, critical care unit, or even in an acute emergency room, the use of the LUCAS®, a rugged device that has proven its efficacy in the outpatient field, could provide constant labor-intensive support. It frees acute care personnel that can provide support to the resuscitating team and maximizes resuscitation efforts [6-8]. The use of LUCAS® Automated Chest Compression System by the critical care physician/nurse in an ICU presents equivalent to manual capabilities in critical care settings, as this frees up manpower for patients to be monitored, supported on a ventilator, measure arterial, venous PaO<sub>2</sub> content, and titrate medications. This device can be used in coordination with the catheterization lab to provide ongoing chest compressions up to the point of stent deployment, providing increased resuscitative efforts up to the point of a percutaneous potentially lifesaving intervention.

Chest compressions are the key component of any type of advanced cardiovascular life support and cannot be over-emphasized. The LUCAS® has been used for over a decade in ambulances, on hard concrete, and helicopters. It has proven itself in the acute care setting during high-impact trauma scenarios, subzero hypothermic resuscitation where we don't let go or call a code until the patient has a normal core temperature which can take hours of resuscitation [2,3]. An automated chest compression system allows rescuers to transport the patient to an intensive care unit for additional lifesaving interventions.

Several animal models have shown that perfusion and mechanical devices can provide good consistent chest compression in transport. Patients that have survived out of hospital cardiac arrest from hypothermia described in case reports where CPR was performed by the automated chest compressors may have not survived using standard one- or two-man CPR. Doing consistent and good-quality CPR for hours in a non-hospitable environment is just not a realistic proposal. Double placebo control trials to show in-hospital use in the ICU setting are lacking but they are difficult to perform. If we extrapolate from the outpatient and paramedic experience, it warrants further consideration. Large meta-analyses have suggested that good quality CPR for outpatient resuscitation efforts may be complemented with the compression system.

## Conclusions

The case illustrates the use of an automated system that was helpful to our intensive care team in resuscitating this patient. Good quality CPR for outpatient resuscitation efforts may be complemented with the automated compression system. Acute ventricular fibrillation/tachycardia with no perfusion in the scenario of myocardial infarction presents an opportunity for using the device in a hospital setting. It showed that a mechanical device is able to break the electrical storm by shocking and compressing actively in a nonstop coordinated way, ultimately providing good perfusion, illustrated by ROSC and a PO<sub>2</sub> of > 400, 25 minutes after losing the pulse from ventricular fibrillation. The fact that the patient was discharged home with mild neurological sequelae is a testimony for the excellent management of our nurses, respiratory therapist, acute care team, and the use of automated persistent, non-stop consistent compressions, with multiple rounds of defibrillation. The value of automated devices has been recognized in multiple studies on out-of-hospital cardiac resuscitation but the use of in-hospital critical care is not a common occurrence and this needs more case studies and reviews. As pulmonologists, intensive care and acute care specialists we need to consider the next evolution of CPR into an automating and standardizing chest compression system as part of our intensive care units.

## Additional Information

### Disclosures

**Human subjects:** Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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