The Risk versus Benefit of LUCAS

Is It Worth It?

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The well-written article by Deras et al.,1 “Fatal Pancreatic Injury Due to Trauma After Successful Cardiopulmonary Resuscitation With Automatic Mechanical Chest Compression,” presents an unfortunate case of a patient with resuscitated cardiac arrest who subsequently died with a pancreatic rupture presumably caused by the LUCAS™ Chest Compression System (Physio-Control, Redmond, WA).

There is a renewed focus on automated cardiopulmonary resuscitation (CPR) in the United States because it provides consistent rates and depths of CPR which have been felt to be crucial to optimize survival. Manual high-quality CPR can be difficult to train and to maintain for a very long time. The LUCAS™ device does more than just providing consistent, high-quality CPR works; it works by creating a positive intrathoracic pressure when the chest is compressed. This increased pressure is transmitted to the blood inside the heart. The blood then moves from the relatively high pressure inside the heart to the lower pressure of the systemic vasculature. Conversely, when the chest wall recoils, a small, but critical, negative pressure is created which draws blood back into the heart thereby creating preload. These alternating directional changes in intrathoracic pressure result in enhanced cardiac output, demonstrating that the compression and decompression phases of CPR are equally important.

A common problem during manual CPR is that the chest does not always recoil because of an increase in chest wall compliance (softens). Although other CPR devices provide consistent compression depth and rate, the LUCAS™ device, because of its integrated suction cup, is the only automated device that assists the decompression phase by drawing up on the chest and returning it to neutral.

In a recently completed clinical trial, survival with a favorable neurologic outcome was higher in patients receiving manual active compression/decompression CPR with a suction cup device used with an impedance threshold device (ITD), compared with manual CPR. The manual suction cup device (ResQPUMP®, CardioPump; Advanced Circulatory Systems, Inc., Roseville, MN) was used at a higher lifting force (−20 lbs) during the study compared with lifting force used by the LUCAS™ device (−3 lbs). The ITD is placed in the ventilatory circuit and prevents air from moving into the chest during the decompression phase. This allows for even greater negative intrathoracic pressure and thus greater preload. The rate of adverse chest and abdominal injuries between manual CPR and active compression/decompression CPR, in that study of more than 1,600 subjects, was similar.2

The literature is full of case reports and reviews of manual CPR–induced complications, including cardiac rupture, aortic and vena cava injuries, esophageal rupture, solid organ rupture, and multiple rib fractures.3 However, there is a paucity of any sound methodological studies that compare the true complication rates of CPR methods. The best human study we have is the one referenced by Deras et al., the authors concluded that the injuries seen with LUCAS™ appear to be of the same variety and incidence as those seen with manual CPR.4 The only animal study in the literature actually showed fewer injuries caused by LUCAS™ than manual CPR in a swine model.5

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Image: Alcor Life Extension Foundation.

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As Deras et al. point out, no matter what type of CPR is performed, it is critically important that the compressions be applied in the proper anatomical location, and that the application requires consistent and careful monitoring. Even when performed correctly, the potential for complications from manual and automated CPR is real. However, it is important to keep in mind that these patients are already experiencing the ultimate complication, and we have an obligation to provide all individuals care that gives them the highest chance of survival. That risk versus benefit ratio is a key for readers to consider. To that end, although long-term outcome studies on the LUCAS™ and ITD have not been performed, animal data on the hemodynamic synergy of the two are compelling. Using an ITD in combination with a LUCAS™ may be the next logical treatment strategy for patients experiencing sudden cardiac arrest. The LUCAS™ device does not fatigue or inadvertently interrupt compressions, and it provides a consistent depth and rate of chest compressions. Logistically, it frees up one provider to provide other care and it offers improved access to the patient. The patient can be safely moved and transported while undergoing CPR. Defibrillation can occur while the device is operating. There have been multiple cases of patients undergoing prolonged CPR with complete neurologic recovery, including one that occurred recently at our own institution (2 h and 45 min), without significant injuries to the patient’s vasculature or internal organs. Our patient underwent percutaneous coronary intervention while LUCAS™ was operating and will be one of an upcoming 10-patient case series of similar patients undergoing prolonged CPR with LUCAS™. Very prolonged manual CPR and the use of manual CPR during percutaneous coronary intervention are obviously very difficult, if not impossible in most circumstances.

As the authors note, to date, there have been no studies that have shown an increased survival with LUCAS™. There can be many explanations for this. Perhaps, the decompression phase needs to be more consistent with true active compression/decompression CPR, that is, expand the lifting force beyond 3 lbs. Perhaps, rescuers are concentrating too much on the technology and not enough on performing high-quality CPR before placement of the device or, perhaps, they are interrupting CPR for too long during placement. The most physiological explanation might be that the outcome studies did not include an ITD. Adding an ITD to the respiratory circuit with automated ITD has been shown to result in significant increases in preload, cardiac output, coronary perfusion pressure, and cerebral flow in multiple animal studies.

Although the case presented by Deras et al. is an extremely important reminder of the need to pay close attention throughout the cardiac arrest treatment cycle, it is important to remember this is a single case with an unfortunate outcome. The LUCAS™ represents a significant improvement in performance of CPR for all of the reasons mentioned and we should not throw the baby out with the bath water. In other words, the risk versus benefit ratio is more than met with LUCAS™ and its use should be continued and broadened.

Competing Interests
The author is not supported by, nor maintains any financial interest in, any commercial activity that may be associated with the topic of this article.

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