Improving the Success Rate of Chest Compression-Only CPR by Untrained Bystanders in Adult Out-of-Hospital Cardiac Arrest: Maintaining Airway Patency May Be the Way Forward

Anthony M.-H. Ho, MD, FRCPC, FCCP* Glenio B. Mizubuti, MD, MSc,† and Song Wan, MD, FRCS, FACC†

Although declining over the past decade, 326,200 out-of-hospital cardiac arrests (OHCA) occurred in the United States in 2011.¹ The worldwide yearly incidence of adult OHCA is ~55 per 100,000 persons.² Strategies for resuscitating patients from cardiac arrest were pioneered more than 50 years ago by anesthesiologist Dr Peter Safar. Commonly known as the Father of Modern Cardiopulmonary Resuscitation (CPR) and a 3-time Nobel Prize nominee, Safar and other investigators originated the technique of head-tilt-chin-lift (HTCL) and mouth-to-mouth breathing, combined with external chest compression. The goal of this combined approach was to keep the heart and brain perfused and oxygenated until definitive treatment could be initiated. This “Airway, Breathing, and Circulation” technique rapidly became standard practice and was taught to the lay public for decades.

The outcome of nonasphyxiated cardiac arrest depends on early detection, prompt defibrillation and drug administration, and the availability of expertise. The timely availability of such support is highly variable in OHCA, and survival rates are typically half of that of in-hospital arrests.

One recent strategy to improve OHCA survival is the elimination of mouth-to-mouth breathing by untrained bystanders. In the early 2000’s, animal studies suggested that coronary perfusion fell dramatically and took precious time to recover after chest compressions were interrupted to allow ventilation.³ Moreover, similar studies suggested no benefit to ventilation during CPR. In one 1998 study, CPR initiated 30 seconds after onset of ventricular fibrillation followed by defibrillation 6 minutes later resulted in similar survival rates in pigs administered CO-CPR (chest compression only CPR) with a clamped endotracheal tube and in those administered chest compression and ventilation.⁴

Such findings were recapitulated in humans. A 2010 meta-analysis⁵ of 3 randomized controlled trials (RCTs)⁶–⁸ found slightly improved survival with CO-CPR when compared to the conventional CPR (2 rescue breaths followed by 15 compressions to 2 breaths cycles).⁵ Researchers hypothesized that oxygen levels in the blood in the first 10 minutes after a witnessed cardiac arrest were likely adequate to sustain life. As such, stopping CPR to perform mouth-to-mouth breathing was considered counterproductive, given that in cities with a mature emergency medical services (EMS) a defibrillator typically arrives under 10 minutes.

Along with known adverse consequences of mouth-to-mouth breathing such as hyperventilation, vomiting, and early rescuer fatigue, and studies suggesting that mouth-to-mouth breathing strongly deterred laypeople from performing CPR, the pendulum gradually swung toward eliminating ventilation from bystander CPR. In 2008, the American Heart Association (AHA), a member of The International Liaison Committee on Resuscitation (ILCOR), recommended CO-CPR by the lay public. In 2015, ILCOR reaffirmed the recommendation of CO-CPR by untrained bystanders attending to adult OHCA.⁹

We believe that all 3 RCTs⁶–⁸ on which the 2010 meta-analysis⁵ was based are fundamentally flawed. All 3 trials used a similar methodology. Once patients were enrolled in the study, an untrained bystander was instructed over the telephone to perform either conventional CPR or CO-CPR. However, laypeople recently certified in CPR generally require 16 seconds to perform 2 rescue breaths on a manikin,¹⁰ and 9 seconds to perform 15 compressions at 100/min. At a 15:2 chest compressions to rescue breaths ratio, the chest compression fraction during CPR is thus only 36% (and improves to only 53% for the current 30:2 ratio, well below the recommended >60%). In addition, chest compressions are likely to be delayed if an anxious novice must be instructed over the phone on how to perform HTCL and deliver 2 rescue breaths. Existing study suggests that teaching laypersons HTCL, rescue breathing, and chest compression using television is ineffective.¹¹ Teaching via telephone during a real crisis is unlikely to be better. In contrast, the CO-CPR group required fewer instructions for a less complicated task.

Thus, all 3 RCTs actually compared high (chest compression only, started immediately) versus low (chest compression with ventilation).
compression and rescue breathing, started after consider-
able delay) chest compression fraction CPR. The conclu-
sion that complete elimination of ventilation is superior is thus questionable. Moreover, a 14% survival to hospital discharge rate with CO-CPR remains poor. Although more recent data suggest better survival, considerable room for improvement exists. What else can untrained bystanders do before trained personnel arrive? While all agree that immediate initiation of uninterrupted chest compression is crucial, ventilation, in our opinion, need not be sacrificed to achieve that goal.

By eliminating rescue breathing altogether, ILCor does not consider that mouth-to-mouth rescue breathing involves 2 components: maintaining a patent airway and delivering breaths. The potentially harmful physiologic effects of ventilation and psychological barrier to mouth-to-mouth breathing all come from delivering positive pressure breaths. If the airway is at least partially patent, gasping, which is associated with improved outcome, can be effective, and passive ventilation can occur during chest compression. Some authors even suggest that ventilation probably can be safely withheld during the first 15 minutes of chest compressions as long as the patient is gasping. Indeed, the 2015 AHA guidelines for resuscitation included a new class IIb recommendation that EMS personnel may initiate resuscitation with 3 initial periods of 200 continuous chest compressions with passive oxygen insufflation through an advanced airway device. In addition, ventilation is vital when the origin of cardiac arrest is respiratory (the predominant cause in 6% of adult OHCA) and in pediatric patients, if defibrillation is delayed (particularly true in the rural setting), if CPR is delayed (as in unwitnessed arrest), or if spontaneous circulation is not quickly reestablished.

Maintenance of a patent airway need not be time consuming, difficult, or “distasteful.” A layperson may alleviate airway obstruction without delaying or interrupting chest compression in 2 ways. A second bystander, if present, may provide chin-lift by pulling back the chin. This move results in HTCL even without pushing the occiput caudally to exaggerate the head tilt. Chin-lift lifts the tongue away from the pharynx, but more importantly, prevents the tongue from being pulled toward the pharynx during inspiration. In humans without chin-lift, passive ventilation during chest compression generates tidal volumes smaller than anatomic dead space. However, passive ventilation through an oropharyngeal airway results in substantially higher tidal volumes, and among patients with witnessed ventricular fibrillation, a survival advantage greater than that achieved with bag-valve-mask ventilation. In addition, unlike mouth-to-mouth ventilation, passive breathing does not increase intrathoracic pressure or insufflate the stomach, and delivers more oxygen-rich air. Allowing air entry into the lungs may also facilitate chest recoil, an important component of optimal CPR. HTCL produces adequate airway patency in 91% of anesthetized patients. If no second bystander is available to perform chin-lift, turning the head as far as possible to either side may partially open up the airway, allowing at least some passive ventilation while the sole bystander performs CO-CPR. In one 2015 study, head rotation in the supine position during propofol-induced sleep endoscopy in patients with obstructive sleep apnea decreased the frequency of complete airway collapse when compared with the neutral head-supine position.

Another 2008 study involving healthy patients without sleep apnea found that half of patients had reduced upper airway collapse while under anesthesia when the head was turned from neutral to the lateral position. In clinical practice, we have found that turning the head of anesthetized or deeply sedated supine patients from neutral to the lateral position will sometimes transform total airway obstruction into a partial one or improve on a partial one, whereas chin-lift usually results in greatly improved airway patency.

Sometimes a willing bystander is unable to position the victim in a supine position, such as when a heavyset patient is slumped in a sofa with neck anteflexed. Current ILCor guidelines provide no recommendation for what a layperson can do other than wait for help. We argue that in such circumstances performing chin-lift may allow effective gasping, an important factor in survivability.

Adding chin-lift and head-turn should not overly complicate the teaching of CO-CPR to the public. CO-CPR plus chin-lift or head-turn is applicable to all cardiorespiratory arrests regardless of whether the arrest is witnessed or unwitnessed. One relevant concern about widespread adoption of chin-lift and head-turn in CPR is concomitant unstable cervical spine injury. However, cervical instability is uncommon (<4% of serious blunt trauma patients), and such patients have an extremely poor prognosis should they arrest. Therefore, in our opinion, airway patency should take precedence over the rare incidence of cervical spine instability.

We believe that ILCor, by eliminating rescue breathing as a whole from adult OHCA CPR, threw the baby out with the bath water. According to the AHA, slightly over 50% of OHCA are unwitnessed, meaning that precious minutes have already elapsed before resuscitation begins. Victims of such arrests need both ventilation and circulation. We believe that anesthesiologists should push for a bigger role in the charting of CPR guidelines and reverse the decision to completely discard airway management from adult OHCA.

Worldwide, some 5 million OHCA occur each year. Even a 2% improvement in survival could translate into 100,000 lives saved. Our proposal makes physiologic sense and, unlike most medical interventions, requires no additional equipment. We agree that reintroduction of airway patency into CO-CPR needs validation, and recommend that RCTs be conducted not just in the urban setting in affluent countries, as with almost all previous RCTs and observational studies, but also in rural areas where the EMS response time is considerably longer. Alternatively, before–after studies could compare historic outcomes from CO-CPR and outcomes after the introduction of CO-CPR plus chin-lift/head-turn in a public educational campaign. These studies may take years. In the meantime, we believe that the favorable benefit/risk analysis of continuous passive ventilation favor incorporation of these airway maneuvers in untrained layperson CPR. 

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Chest Compression-Only CPR and Importance of Airway Patency

Name: Glenio B. Mizubuti, MD, MSc.
Contribution: This author helped with significant intellectual contributions, participated in manuscript preparation and revision, and approved the final version for publication.
Name: Song Wan, MD, FRCS, FACC.
Contribution: This author helped with significant intellectual contributions, participated in manuscript preparation and revision, and approved the final version for publication.
This manuscript was handled by: Avery Tung, MD, FCCM.

REFERENCES