Resuscitation in 2005:
New Ways to Optimize Manual CPR

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Figure 2: Two-handed airway management with facemask.

A better understanding of the fundamental mechanisms that govern perfusion during CPR will help EMS providers optimize their CPR performance. This primer highlights some new insights to optimizing blood flow to the vital organs during CPR and emphasizes new ways to enhance blood flow to the heart and brain during CPR in adults in order to maximize the chances for a return of spontaneous circulation and successful resuscitation.

Compression and Release

The goal of CPR is to provide blood flow to the vital organs. Compressing the sternum increases pressure within the chest, forcing blood out of the heart to vital organs and air out of the lungs. New data support the importance of providing, as much as possible, uninterrupted chest compressions, since every interruption causes a dramatic decrease in perfusion pressure.[1] Compressions should be at a rate of 100 a minute and the chest should be compressed 1½–2 inches, with half the time spent compressing the chest and half spent allowing the chest to fully recoil.

Full release (full chest-wall recoil) is also essential. New data have shown that a small vacuum (negative pressure) develops within the thorax each time the chest is allowed to fully recoil; this vacuum draws blood back into the heart (preload) and some air into the lungs.[2] It is during the chest-recoil phase that blood flows through the coronary arteries, providing the heart muscle with blood. One way to promote complete chest-wall recoil is to compress the chest with the palm of one hand, with the second hand on top of the first and the fingers interlocked. Allow the fingers of the lower hand to stay in light contact with the chest to maintain proper hand position (see *Figure 1*). During the recoil or release phase, lift the palm slightly but completely off the chest to enable full recoil. Performing CPR in this manner, with continuous compressions and full chest-wall recoil, will optimize blood flow to the heart and brain.[3] Finally, CPR is tiring; make sure you rotate compression duties every several minutes to avoid fatigue.

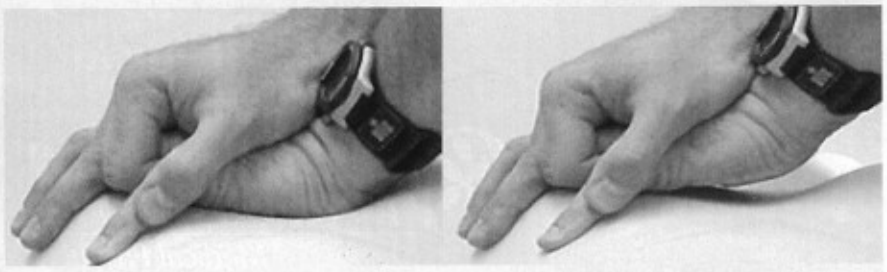

Figure 1: Hand position during chest compression and release. (Note: Palm is completely lifted off chest wall.)

Ventilation

New studies demonstrate that ventilations are often performed too fast, and that this hyperventilation can be deadly. In one study, overzealous rescuers ventilated an average of 30 times a minute instead of the recommended 12.[4] Each time a breath is delivered to the patient, pressure inside the chest increases. While ventilation provides oxygenation, the increase in pressure impedes

blood from returning to the heart. This decreases the amount of blood that fills the heart (preload) during the decompression (chest-wall recoil) phase of CPR, which in turn results in less blood being delivered to the heart and brain in subsequent compressions. In light of this critical interaction between the lungs and heart, it is important to provide enough oxygen, but not too much.

Ventilations should be performed with a compression-to-ventilation ratio of 15:2 with an unsecured airway and at a rate of 12 breaths per minute with a secured airway, as currently recommended by the American Heart Association (AHA).[3] When the airway is secure, make sure each breath is given over one second, to avoid prolonged increases in intrathoracic pressure with each breath.[5] New research suggests that in the future, even less frequent ventilations may further enhance circulation during CPR.[6-8]

As has been recommended by the AHA for years, the facemask should be held securely by one rescuer while maintaining an open airway. A second rescuer, if available, should focus only on compressing the bag-valve resuscitator with supplemental oxygen, delivering breaths over 1–2 seconds at recommended tidal volumes. To perform this two-person ventilation technique, tilt the head back and pull the jaw toward you to open the airway, as shown in *Figure 2*. Too high a volume or delivery of the breath over too long a period of time will decrease blood flow to the heart and brain for the same reason that rapid ventilation rates are dangerous.[4] A good continuous facemask seal during both ventilations and chest compressions is critical when using an impedance threshold device (ITD, described below) to enhance circulation.

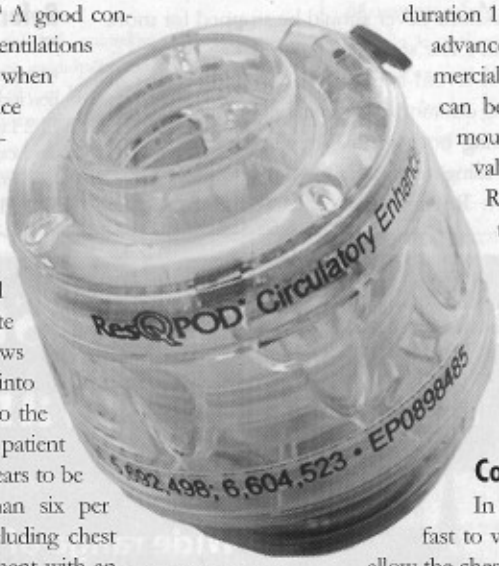

Figure 3: ResQPOD

Gasping

Patients often gasp in the early stages of cardiac arrest. This natural reflex is the body's final effort to create a vacuum inside the chest, which draws more blood back to the heart and air into the lungs. CPR should be provided to the gasping patient in cardiac arrest. If the patient is unconscious and pulseless and appears to be gasping (typically at a rate less than six per minute), the patient needs CPR, including chest compressions, ventilations and treatment with an ITD. Sometimes good-quality CPR will result in the patient beginning to gasp, as this reflex is initiated when the brain stem gets enough blood to trigger the gasping effort. If gasping is noted, continue to perform CPR until there is a return of circulation.

Impedance Threshold Device (ResQPOD)

Using an impedance threshold device (*Figure 3*) like the ResQPOD during CPR has been shown to increase blood flow to the heart and brain, raise blood pressure and improve survival after cardiac arrest.[9-13] It can be used on a facemask during BLS airway management (*Figure 4*) or on an advanced airway (e.g., an endotracheal tube),[14] as shown in *Figure 5*. The ITD is a single-use device that regulates pressures within the chest during CPR. It helps create and sustain a greater vacuum inside the chest during the chest-wall recoil (decompression) but still allows the rescuer to freely ventilate and the patient to freely exhale. This all-important vacuum inside the thorax refills the heart more effectively after each compression, thereby increasing blood pressure and increasing forward blood flow to the vital organs. It contains ventilation timing assist lights, which can be turned on when using the ResQPOD on a secured airway. The lights provide guidance on the correct ventilation rate and duration by flashing for a one-second duration 12 times a minute. When using the ResQPOD on an advanced airway, remember to secure the tube with a commercial device designed for this purpose. The ResQPOD can be used with all cardiac arrest rhythms and during mouth-to-mask ventilation, or with a demand-valve, bag-valve or automatic transport ventilator. When using the ResQPOD during facemask ventilation, make sure there is a tight seal between the mask and the patient at all times (during both ventilations and chest compressions), or the vacuum will be lost and the ITD will not be as effective as it could be. The ResQPOD should be removed once the patient has a return of spontaneous circulation and CPR is no longer required.


Figure 4: ResQPOD on facemask

Common Mistakes

In the heat of the moment, it is difficult to know how fast to ventilate or compress the chest and to remember to allow the chest to fully recoil after each compression.[15]


Figure 5: ResQPOD on ET tube

Common mistakes during CPR include:

- Compressing too fast or too slowly[15–17]
- Not allowing the chest to fully recoil after each compression[15,18]
- Compressing too deeply (>2 inches) or not enough (<1 inch)[19]
- Interrupting chest compressions for too long[16,20]
- Ventilating too frequently or delivering breaths too slowly[4]
- Not performing CPR on a gasping patient
- Allowing fatigue to set in, which results in poor CPR performance[21]
- Not performing CPR for at least 30 minutes, regardless of the initial rhythm. It takes time to "prime the pump" and allow the functions of the ResQPOD to benefit the patient.[22]

Each of these common errors results in decreased blood flow to the heart and brain and poorer survival. It takes lots of practice and teamwork to deliver high-quality CPR at the scene of cardiac arrest and avoid these common problems.

Key Points to Remember

Table 1 highlights the following key new points to remember during performance of manual CPR.

Table 1: Key Points to Remember

- Compress the chest at 100 times/minute *and* allow full chest-wall recoil.
- Minimize interruption of chest compressions during CPR.
- Avoid hyperventilation.
- Deliver ventilations with a facemask over two seconds and with an ET tube over one second.
- Rotate rescuers (quickly) every 2–3 minutes to avoid fatigue.
- Perform CPR when the arrested patient is gasping.
- Use the impedance threshold device to optimize circulation during CPR.

1. Compress and allow the chest to fully recoil at 100 times a minute. This can be achieved with a slight change in hand position (slightly lifting the palms completely off the chest wall after each compression).

2. Compress to a depth of 1½–2 inches and avoid prolonged interruptions. During BLS (facemask use), stop only for delivering the breaths and then rapidly resume chest compressions. Compress the chest continuously (no interruptions) during ALS (advanced airway in place) CPR. Except for intubation and defibrillator use, chest compressions never should be stopped for more than a few seconds.

3. Avoid hyperventilation and breaths of long duration. Maintain a tight facemask seal during both ventilations and compressions by using a two-person ventilation technique.

4. Rotate duties quickly and frequently (every 2–3 minutes) to avoid fatigue and the poor CPR quality that results.

5. Using an impedance threshold device (like the ResQPOD) will further enhance circulation during CPR.

6. Finally, provide resuscitative efforts for at least 30 minutes. Blood flow is much lower during CPR, even if the CPR is performed properly. It takes longer to get vital nutrients and oxygen to the heart and brain, especially after prolonged down times. Give good CPR a chance to work. ■

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INDUSTRY*News*

Wheeled Coach, Inc., announced that Tim Hutchens has joined the company as VP of sales. Wheeled Coach, a wholly owned subsidiary of Collins Industries, Inc., is the world's largest manufacturer of ambulances. Hutchens will be responsible for all aspects of the organization, including national account sales, the authorized representative network and the national direct sales organization. He will report directly to President Robert Collins. Hutchens holds a bachelors degree in business administration from the University of Texas in Arlington, TX. For more, go to www.collinsind.com.

SAM Medical Products, creator and manufacturer of innovative medical products for emergency and hospital care, has announced that two of its products were honored among the best consumer products of 2005 by the ***International Design Magazine.*** A leading publication covering the art and culture of design, *I.D. Magazine* chose SAM's Soft Shell Splint and Blist-0-Ban skin bandage for recognition out of approximately 2,000 products in its Annual Design Review, America's most prestigious juried design competition. A third product, the SAM Splint, was selected for exhibit by the **New York Museum of Modern Art** (MoMA). Founded by Sam Scheinberg, MD, a board-certified orthopedic surgeon, and his wife Cherrie, the Newport and Portland, OR-based company has quietly become the market leader in emergency splinting products. A previous winner of the Governors Exporter of the Year Award and the Small Business Exporter of the Year award, SAM Medical Products has successfully operated under the radar following its belief that "the simplest design solution is usually the most elegant."

National Paramedic Institute, Inc. announced that it has entered into an exclusive distribution agreement with **Medtronic, Inc.,** (NYSE: MDT), the global leader in medical technology, to distribute the institute's annual video subscription series, the *Medic Monthly.* This physician-directed continuing education series offers innovative case-based learning for first responders, EMTs and paramedics on VHS, DVD and online streaming video. Videotaped using actual medics in the field dealing with medical situations, it is the only program written and hosted by a physician. Each issue meets National Registry requirements and the series is approved by the Continuing Education Coordinating Board for Emergency Medical Services (CECBEMS) for 12 CE hours per year.

Raytheon JPS Communications, an innovator in key communications interoperability technologies for local, regional, statewide and wide area applications, has appointed Sandy Waters as VP of sales and marketing. Waters will be responsible for the company's global sales and marketing strategy and its execution in the company's federal, state, public safety, military, commercial and international markets. In his more than 30 years experience in high-tech markets, strategic and business planning, and product and business development, Waters has been a manager and senior contributor at **Digital Equipment Corporation, Nortel, Allied Bunker-Ramo** and **Perkin-Elmer;** consultant or chief marketing officer to a number of start-up companies; and a member of the Senior Executive Service corps at the Department of Commerce for the **National Technological Information Service** (NTIS). Visit www.jps.com for more. ■