

## Thoracic Pressure Changes Show Impact of Bundles of Care

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I'm not a physician or EMS researcher, but as editor-in-chief of *JEMS*, I'm often afforded the opportunity to observe the work of pioneers in our field who are conducting research and advancing the science and practical applications that can help us improve our [prehospital care](#).

I had one such opportunity when I joined some of the most prominent physicians and researchers in the field of resuscitation at a special innovations summit with pig and human cadaver labs in Minneapolis as a part of the [Take Heart America](#) (THA) initiative.



**The human cardiac system is similar to the way an engine works. CanStockPhoto/archy13**

THA's mission is to develop and implement state-of-the-art systems of care outside and inside the hospital to restore full life after cardiac arrest. THA has adopted a "bundle of care" philosophy that no single intervention is effective in the treatment of cardiac arrest, but rather, that multiple personnel, treatments and devices are needed due to the highly complex nature of the disease state.

According to the Bureau of Labor Statistics (BLS), the need for paramedics during the decade between 2014 – 2024 is expected to grow 24 percent, faster than the average for other professions.

The elements of this bundle are synergistic: When the entire bundle is available and used as needed, the data shows that survival rates from cardiac arrest soar.

After a morning of presentations by researchers and cardiologists that focused on their work and results, we were taken to labs to watch as a carefully monitored pig was placed into v fib and then resuscitated by standard and enhanced methods as described in this month's articles, "[Resuscitation Gems: Resuscitation outcomes consortium \(ROC\) studies dig deep into the science of resuscitation](#)," by Keith Lurie, MD; Ralph J. Frascone, MD, FACEP, FAEMS and Jeffrey M. Goodloe, MD, NRP, FACEP, as well as "[And the Dead Shall Rise: Introducing head up CPR & the revolutionary research model used to develop it](#)," by Ralph J. Frascone, MD, FACEP, FAEMS, on pp. 28–37.

We watched the procedures and, more importantly, the physiological improvements as the resuscitation protocols were followed.

The results shown through the use of devices and procedures were amazing. The impedance threshold device (ITD) lowered intrathoracic pressure during the chest recoil phase of CPR, drawing more blood back into the heart and lowering intracranial pressure; active compression-decompression (ACD) CPR and an ITD (ACD + ITD) provided 2–3 times more blood flow to the heart and the brain compared with traditional manual CPR.

Head-up CPR (head and shoulders elevated at a 30-degree upward angle) and automated CPR resulted in a significant reduction in intracranial pressure, therefore allowing more cardiac perfusion of the brain because the two pressures weren't opposing each other. Cerebral oximetry provided a way to visually determine both the amount of oxygen being delivered to the brain and, consequently, the likelihood of recovery after resuscitation. Extracorporeal membrane oxygenation (ECMO) was shown to maintain circulation for an extended period of time until the heart and brain recover from the trauma of cardiac arrest.

Lurie and his team of experts pointed out that patients in refractory v fib taken to the cath lab on ECMO have a 50% change of complete recovery vs. < 10% with traditional therapies.<sup>1</sup>

It's hard to explain the dramatic impact these bundles of care and tweaks in resuscitation procedures have on intrathoracic pressure (ITP) regulation inside the body, but it's significant, as [shown in Figure 5](#) on p. 37.

Accepting New Ideas

Seeing is believing when you're in the lab with all the physiological parameters and procedure impacts are in front of you. But, without a transparent window into the head and chest of our patients, and perhaps a colored gas injected to show the changes occurring, it's hard for many people to visualize in their mind and, therefore, accept.

So I'll take you back to my youth, when my uncle explained a similar concept to me: how an internal combustion engine needed a precise mixture of air and fuel for it to operate and produce power.

I had a hard time visualizing the concepts, so he bought a transparent engine model and assembled the 150+ pieces needed to make it operate. When it was completed, I could see and appreciate its operation as I watched the transparent engine block, cylinders, crankshaft, connecting rods, pistons, spark plugs, fuel injectors, intake and exhaust valves, camshafts, and timing belt operate in the exact sequence necessary to make the engine operate efficiently.

I never forgot that and, leaving the lab in Minneapolis, realized how similar body parts—particularly the heart, lungs and brain—are to a vehicle engine. As pistons move in a downward stroke, intake valves (like our heart valves) open to allow of air and fuel to fill a combustion chamber—like blood being drawn into the chambers of the heart. The intake valve then closes (like our heart valves do) and the pistons (like our ventricles) move on an upward stroke and compress the air/fuel mixture.

This compression mixture allows a vehicle's engine to combust with greater force than if it wasn't compressed (which is similar to what the ITD does).

The spark plug ignites the air/fuel mixture, causing it to burn explosively (like the heart's electrical system does) and forces the piston down in into another downward stroke (like blood forced through the ventricles).

During the fourth stroke of an engine, as the piston begins its second upward stroke (known as the "exhaust stroke"), the exhaust valve opens and burned air/fuel is forced out of the combustion chamber through the exhaust valves.

Watch the two fast-moving engine assembly and operation clips presented in the reference section to better understand what I mean.<sup>2,3</sup>

## Conclusion

The THA resuscitation researchers and my firsthand observation of the impact of intrathoracic pressure changes—caused by devices like the ITD, ACD-CPR, and mechanical CPR provided by a device that used a chest suction cup to increased intrathoracic pressure—made me appreciate the bundle of care practices and their dramatic impact on patient resuscitation.

And the almost instantaneous reduction in ICP and improved coronary perfusion of the brain when the patient was placed in a elevated head position during CPR was truly eye opening because we could see it in real-time.

The message? Keep your mind (and your patient's brain and cardiac flows) open because the science of resuscitation is improving and will guide the methods we use in the field.

#### References

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