SOMETHING NEW IN CPR?

If intrathoracic rather than direct pressure on the heart moves the blood, resuscitation techniques may change

IT'S WIDELY assumed that when you do CPR you compress the patient's heart between his sternum and his backbone and so push blood out and up to the brain. But according to investigators at Johns Hopkins that's not what happens in most patients. Instead, they suggest, it's the rise in intrathoracic pressure that moves the blood and they're experimenting with a new way of doing CPR that takes this mechanism into account and so may prove to be more effective.

Several clinical clues suggest that the prevailing theory about CPR may not be the correct one, Drs. Michael T. Rudikoff, W. Lowell Maughan, and Mark Effron, Paul Freund, and Dr. Myron L. Weisfeldt report in *Circulation* (Vol. 61, p. 345). Direct compression of the heart should be easy to do in patients with flail chest, yet in the experience of the Johns Hopkins investigators CPR doesn't work at all until such patients have a belt put around the rib cage to restrict the paradoxical motion of the rest of the chest wall. Direct compression should be very difficult in patients with emphysema, on the other hand, given their barrel chest and small heart, yet CPR works well for them. And during CPR the investigators have repeatedly observed that rises in arterial pressure and blood flow are greatest when chest compression coincides with lung inflation—which is when the sternum and backbone are actually farthest apart.

All these observations suggest that it isn't direct compression of the heart but rather the rise in pressure throughout the entire chest that's responsible for making CPR work, says the Johns Hopkins team. To back up these clinical impressions, they headed for the laboratory. And in experiments on dogs they found that chest compression produced very nearly identical pressures throughout the chest. Pressures in the various chambers of the heart, the great vessels, and the esophagus—which provides a good measure of general intrathoracic pressure—all matched.

The next step was to increase intrathoracic pressure—to supplement the external source of pressure with an internal one by keeping the lungs inflated during chest compression. That maneuver just about doubled the aortic systolic pressure and tripled carotid blood flow, without causing any significant backflow in the jugular vein.

Turning to clinical application, Drs. Rudikoff and Weisfeldt and Dr. Nisha Chandra devised a new protocol for CPR, reducing chest compressions from 60 to 40 per minute and making them simultaneous with ventilation, rather than alternating them as present CPR methods do. Airway pressures were raised to 60 to.

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110 cm H_2O during compressions and permitted to drop to atmospheric pressure between compressions. They put this protocol to use in 10 patients in cardiac arrest, using a computerized compression apparatus designed to do both conventional and new CPR, alternating between the two every 15 to 60 seconds. Carotid flow index during new CPR averaged about $2^1/_2$ times that produced by conventional CPR, the investigators report in *Lancet* (No. 8161, p. 175).

Putting new CPR into practice would take a new generation of more sophisticated CPR equipment, says Dr. Weisfeldt, who is director of cardiology and professor of medicine at Johns Hopkins Medical Institutions. "It would be necessary to have a system that would coordinate compression and ventilation, and the apparatus would probably need to have a safety that would shut off the ventilation system if the compression device failed, because the air pressures involved are high enough that they could conceivably cause a pneumothorax if they weren't balanced by external pressure."

Such high airway pressures are of course beyond reach when the only source of air is the rescuer's lungs, Dr. Weisfeldt observes, so one- or two-man CPR would stay essentially the same as it is now. But even in a situation where there's no special equipment available it might still be possible to boost intrathoracic pressures by binding the patient's abdomen. The investigators tried this out in their dog experiments, using an inflatable bladder, and found it strikingly effective for increasing carotid blood flow. "The technique restricts downward movement of the diaphragm during chest compression, thus raising intrathoracic pressure, and increases circulating blood volume. It may also divert blood flow from the abdomen and so increase blood flow to the brain," the Johns Hopkins cardiologist told EM.

"I wouldn't advise anyone to start binding abdomens just yet, though," says Dr. Weisfeldt. "We haven't fully established whether it's a safe thing to do. It has been suggested that abdominal binding could make the liver vulnerable to laceration or rupture from contact with the rib cage. We didn't find such damage in any of the dogs' livers but of course a dog's chest is different from a human's. We've used the technique on four patients who've died and been autopsied and none have shown evidence of liver damage but that's still not evidence to justify recommending it."

Dr. Weisfeldt also advises that new CPR not be pressed into clinical service until it has thoroughly proved itself. "We don't have a clear picture yet of either the risks or the benefits involved," he points out. "There's a possibility, for instance, that the procedure could interfere with gas exchange, since the chest compression keeps the lungs from becoming fully inflated. We're concerned that such patients as those with chronic obstructive lung disease would be adversely affected by that. And there's some evidence from work we're doing now to suggest that this concern is justified.

"As for the benefits, our studies have shown clear physiologic differences with new CPR but of course the bottom line is whether fewer people will die or end up with neurologic complications if new CPR is used. And at this point we don't know the answer to that. We hope to make efforts ourselves to find out but the principal responsibility for assessing our findings lies with others. There are organizations that are responsible for maintaining standards for CPR and assessing the validity of any new techniques, and they're the ones who must judge whether new CPR has a clinical future."

Dr. A. James Lewis, chairman of the American Heart Association subcommittee on emergency cardiac care, comments, "We are extremely interested in Dr. Weisfeldt's findings. We're looking at the subject very carefully, we're watching the research being done, and we're encouraging further research. The data are preliminary; they have been substantiated by one or two other groups but still more clinical investigation is needed. Nonetheless, I think that in the not too distant future this will be an accepted way to do CPR in a hospital or even a paramedical situation, where you have mechanical resuscitators readily available for use." □