Advances in defibrillation

Improved technology, increased accessibility puts help just a heartbeat away

By JOHN ANDERSON

For many centuries no explanation was offered for the sudden collapse and instantaneous death of a patient. Even as recently as the early 19th century, it was assumed that sudden death was caused by sudden stoppage of the heart when in the diastolic phase. However, in 1889, John MacWilliam in Aberdeen, Scotland, proposed a then astonishing hypothesis, namely that the cause of sudden cardiac death was indeed ventricular fibrillation (VF).[1]

Today, approximately 1,000 patients daily have sudden cardiac arrest caused by VF in the U.S.; about 90 percent of these cases occur out of the hospital. Early access to the patient is vital. Reports show survival rates of 43 percent after four minutes of fibrillation, rates of 18 percent between five and nine minutes, 8 percent at 10 to 14 minutes, and only 5 percent at 14 minutes.[2]

The Belfast experience

In 1968, Pantridge in Belfast instigated a study with two medical students, McNeilly and Pemberton, to investigate his concern that many of the deaths through sudden coronary events were occurring outside the coronary care unit. This research initiative had profound implications for external defibrillation and led to the finding that 60 percent of deaths from sudden cardiac death were occurring within one hour from the onset of symptoms.

The result of this study was the launching in 1968/1969 of the world's first mobile coronary care unit in Belfast. Traditional equipment of the coronary care unit — particularly the defibrillator —was totally unsuitable for the portable environment to service this newly identified area. The first defibrillator to be used in the mobile coronary care unit was a mains-operated defibrillator powered by a static converter, which housed a car battery. The whole device weighed about 120 lbs., but demonstrated for the first time that defibrillation was an effective methodology outside the hospital.[3]

In 1969, as a young engineer, I joined the Royal Victoria Hospital team, and one of my primary directives was to develop new portable equipment in support of mobile coronary care and, in particular, to address the weight of the device used to correct sudden cardiac death, i.e. the defibrillator. The Belfast experience, as it came to be known, became a model that was adopted throughout the western world. Early defibrillator developments led to new capacitors and circuit miniaturization and, eventually, semi-automatic defibrillators, followed by automatic defibrillators, which are standard practice in use today.

Life and death

If a bystander or a clinician finds themself in a real-life cardiac arrest situation, reaction time and efficacy of the basic life support (BLS) administered can mean the difference between life and death to a patient. Suitable training and procedures that are easily followed are imperative. Electrodes applied in the wrong position, cardiopulmonary resuscitation (CPR) administered at the incorrect rate, depth and location can all significantly affect clinical outcome and 24-hour survival rate. Therefore, development of user-friendly, effective and lightweight defibrillators has been vital in the improvement of out-of-hospital survival rates over the past 30 years.

Early defibrillation is considered by many experts to be the most important factor for return of spontaneous circulation (ROSC) and survival in patients with VF. Immediate defibrillation as soon as a defibrillator is made available is advocated in the guidelines for CPR. Whether CPR is performed before attempted defibrillation also influences outcomes. CPR before defibrillation decreases by at

least 50 percent the magnitude of reduction in survival associated with passage of time from collapse.[4] Therefore, early access is currently the greatest challenge in improving survival rates post-cardiac arrest.

Public access defibrillation

Automated external defibrillators (AEDs) have become increasingly prevalent in the workplace and public areas such as airports, schools and sports centers. And with more than 70 percent of cardiac arrests occurring in the home, there is a major need for public access defibrillators (PADs) designed to operate in these environments.[5]

Recent developments in PADs aim to address these challenges by offering lightweight, portable and easy-to-use systems with optimal user interfaces. PADs are increasing their IP rating, which now includes rigorous testing for enclosure protection against particle and water ingress.

Peoples' fear of using an AED is one of the obstacles trainers face. Shocking someone isn't an everyday occurrence. It is necessary to be prepared, which is why good training is so important. Product enhancements include a metronome system to give operator feedback on CPR depth and rate. Improvements to the current waveform and circuitry are presently being researched and will result in a significant reduction in the energy delivered to the patient, thereby minimizing damage. Algorithm improvements with the introduction of hemodynamic measurements such as the impedance cardiogram are also being investigated to improve both the sensitivity and specificity of PADs.

It is vital that the next generation of PADs is designed to maximize sensitivity and specificity while minimizing damage to the patient post-resuscitation.

Every individual at risk should have access to a defibrillator. Research is now focused on safety and efficacy of use while, at the same time, reducing cost. Pantridge's original concept of defibrillators being as available as fire extinguishers is now becoming viable with the increased performance of public access defibrillators.

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HeartSine

HeartSine Technologies, Inc., a world leader in personal and public access automatic external defibrillators, is celebrating its 10th anniversary of bringing lifesaving defibrillation therapy to non-traditional areas of care.
For more information on HeartSine defibrillators, visit www.heartsine.com, or contact HeartSine Technologies, Inc., 105 Terry Drive, Newtown, PA 18940, Tel. (215) 860-8100.

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