Sudden cardiac death: the war is far from over

Probably the first recorded case of sudden cardiac death was that describing Pheidippedes' collapse and instant death after running from Marathon to Athens to announce the defeat of the Persians by the Athenians in 490 BC—an event that gave birth to the marathon race. In modern times, sudden cardiac death remains a major clinical and public health problem that has far-reaching socio-economic implications and accounts for nearly half of all deaths due to cardiovascular diseases. Until four decades ago, sudden cardiac arrest had been almost uniformly lethal, and recovery would have been considered a miracle. Thanks to cardiopulmonary resuscitation (CPR), however, along with training programmes, public education, and medical advances, the odds of survival from this sudden condition have been increased.

In 1960, Kouwenhoven et al[1] rediscovered and advocated the use of closed-chest compression on a patient who had no cardiac output after sudden cardiac arrest. This sternal compression, coupled with positive-pressure ventilation—either from administering mouth-to-mouth respiration or by using a respiration ('Ambu') bag—is now the cornerstone of modern CPR. However, it is well known that initially successful CPR does not necessarily mean either successful maintenance of an effective circulation or the prevention of hypoxic brain death to the level that a patient can survive to discharge from hospital. In fact, successful CPR as defined by successful patient discharge is less than 10% according to most reports in the literature. Research activities have thus focused on finding strategies to improve survival rates among victims of sudden cardiac arrest.

It is clear that CPR is merely one step of a series of critical actions that should be taken to ensure survival following cardiac collapse. Four such actions have been identified and advocated by the American Heart Association, in a so-called 'chain of survival'[2]: (1) *early* access to emergency services (911 in the US; 999 in Hong Kong), (2) *early* CPR, (3) *early* defibrillation, and (4) *early* advanced care after CPR. It is clear from these 'four Es' that time is of the essence and the earlier each step in the chain of survival is initiated, the better the chance of survival for the affected individual. Furthermore, because the majority of sudden cardiac arrests happen outside the hospital setting, the first three actions in the chain of survival are likely to have been performed in and by the community. In US communities where public awareness and CPR training programmes have been successfully initiated and implemented in the 1980s and 1990s, such as in Seattle, Washington, CPR performed early by bystanders can markedly increase the likelihood of survival.[3] Other cities in the US and in Europe have followed the Seattle example, by initiating their own community CPR-training programmes. In addition to the medical and paramedical personnel who are expected to be professionally trained in CPR, basic and advanced classes in CPR are now widely offered to army service personnel, police and fire service officers, and even staff of airline companies, either on a voluntary or a semi-mandatory basis.

In Hong Kong, coronary heart disease remains the second most common disease-specific cause of death, accounting for 15.6% of all deaths,[4] and it tops the list as the most common organ-specific cause of death. Of the 5700 deaths due to cardiovascular diseases in 1999 (the year for which the most recent figures are available), approximately 2500 were sudden. While the incidence and prevalence of coronary heart disease in Hong Kong are considerably lower than those in western countries, the disease remains a major health problem. The mortality rate from coronary artery disease is still on the rise (albeit a small rise), whereas mortality rates in the US and some countries in western Europe have markedly decreased during the past 40 years—to as much as half of what they used to be.[5] Is there anything we can learn and do in Hong Kong to reverse our situation?

In this issue of the *Hong Kong Medical Journal*, The University of Hong Kong Cardiopulmonary Resuscitation Knowledge Study Group[6] reports a telephone questionnaire survey that evaluated the knowledge of basic life support and the CPR-training experience among the public in Hong Kong in an attempt to identify areas of improvement. Not surprisingly, the knowledge of CPR was poor, and only 12% of respondents had received CPR training, compared with the proportion of 20% that the American Heart Association deems necessary for a community. Furthermore, the level of knowledge among those who had previously received training was less than satisfactory. The lapsed knowledge may well be the main factor, and provide the explanation, for the low rate of bystander CPR (15.6%) and the very low rate of survival (1.25%) according to a survey done in 1999, as published in a previous report from Hong Kong.[7]

The authors suggest that the situation can be improved by enhancing the volume and quality of CPR training in Hong Kong by educating the public about the importance of CPR in saving lives; publicising CPR more widely; making training facilities more accessible to the general public; and providing training to targeted groups, including families of survivors of sudden cardiac arrest and families of those at risk of this condition. The list of trainees could probably be expanded to university and senior high school students, as well as to citizens who are interested in learning CPR. As a consequence, we could effectively and vastly increase the number of citizens in Hong Kong who are trained in CPR, and we could eventually achieve a ratio of trained people to citizens of 1:5 (20%). Of course, retraining every 3 to 5 years is also needed, to ensure that effective bystander CPR can continue within the community. To this end, various professional organisations have taken the

initiative of providing and assessing CPR training. For example, the Hong Kong College of Cardiology has been working with the Hong Kong College of Family Physicians and other professional bodies in the past several years, to train and certify doctors and allied health professionals in basic, as well as in advanced, CPR.

The last two Es in the chain of survival—early defibrillation and early advanced post-CPR care—are covered in a review article also in this issue of the Journal, by Kwok et al.[8] The most important and potentially life-saving step in the treatment of victims of cardiac arrest due to ventricular fibrillation is undoubtedly early defibrillation, within 3 to 5 minutes of cardiac arrest. For out-of-hospital cases of cardiac arrest, the development of automatic external defibrillators (AEDs) has made a tremendous difference in the rescue of patients in a variety of situations. For example, AEDs are now installed in some aeroplanes and can be operated by airline personnel who have received training. The use of AEDs by ambulance paramedics in Hong Kong over the past 10 years also attests to the importance of early defibrillation in treating sudden cardiac arrest.

Following initially successful CPR, the patient must be haemodynamically stabilised, and all correctable factors must be dealt with expeditiously. Patients with significant ischaemia should be considered for early revascularisation procedures to prevent a recurrence of ischaemia-induced cardiac arrest. Of the various anti-arrhythmic drugs available, only β-blockers and amiodarone have been found in clinical trials to reduce sudden death among survivors of myocardial infarction. Finally, the use of implantable cardioverter defibrillators has now been accepted as the most effective therapy for the primary and secondary prevention of sudden cardiac death among selected at-risk groups, especially those with documented ventricular tachycardia or fibrillation. The use of these devices has been vastly increased since the early 1990s, because they have now been made so small that they can be implanted with relative ease, under local anaesthesia, by trained cardiologists or surgeons.

Despite the major advances made in the treatment and prevention of sudden cardiac arrest, there remains the problem of identifying individuals who are at high risk, with a reasonably high degree of sensitivity and specificity. It is still not clear why acute ischaemic syndrome develops in certain individuals with atherosclerosis in their coronary arteries, whereas others remain stable with angina on exertion only and others still have no symptoms for many years but are equally subject to sudden cardiac arrest. In other words, we have not solved the complexity of the biological, pathophysiological, and even perhaps genetic mechanisms that underlie sudden cardiac arrest.

Until we are able to prospectively single out individuals at high risk of sudden cardiac arrest, our approach to the primary prevention of this condition should be aimed at reducing risk factors for coronary heart disease. We now have very effective drugs to lower levels of low-density lipoprotein–cholesterol (statins), a wide choice of antihypertensive agents, and evidence-based outcome data on the reduction of renal and cardiovascular damage in patients with diabetes mellitus, with the use of angiotensin-converting enzyme inhibitor and angiotensin-receptor blocker. Activities to promote heart health should aim at increasing public awareness of the link between coronary heart disease and sudden cardiac arrest, and the development of community CPR-training programmes. In addition, wider availability and use of AEDs at various locations in the community will likely help reduce the number of sudden cardiac deaths and increase the chance of survival among patients. We are gaining some ground in our battles against sudden cardiac death, but the war is far from over.

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