SUDDEN CARDIAC DEATH AND RESUSCITATION – THE SHOCKING TRUTH*

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INTRODUCTION

This symposium was designed to give an overview of the problem of sudden cardiac death in the community and in particular to emphasise strategies to improve the current dismal prognosis of such conditions. For individuals suffering an out-of-hospital cardiac arrest, the only chance of survival lies in rapid and effective cardiopulmonary resuscitation and defibrillation – the chain of survival (see Figure 1).

Professor S.M. Cobbe, Walton Professor of Cardiology at the University of Glasgow, outlined the epidemiology of sudden cardiac death.

The majority of sudden deaths are due to ventricular fibrillation (VF) secondary to acute myocardial infarction. Primary ventricular arrhythmias, bradycardia/asystole and electro-mechanical dissociation (EMD) are the other direct mechanisms of death in these patients. Most sudden deaths are due to cardiac pathology but a proportion has another aetiology. Thomas *et al*.[1] published a large autopsy series of 'natural' sudden death. Sixty-six per cent of deaths were cardiac and 89% of these were due to ischaemic heart disease. Respiratory deaths, including many due to pulmonary emboli, were the next most common cause and the remainder a miscellany of central nervous system (CNS) causes, ruptured aortic aneurysms, gastointestinal (GI) bleeding, alcohol-related and other, unknown, causes.

One of the problems in preventing sudden cardiac death is that it is often the first presentation of cardiac disease. For example, in one study Roberts *et al*.[2] estimated that in 23% of patients the first presentation of coronary heart disease (CHD) is sudden cardiac death. Another difficulty is that the risk factors for CHD presenting *de novo* as sudden cardiac death are very similar to that for all CHD. However, in contrast, the risk factors for sudden cardiac death *after* myocardial infarction are quite distinct, and a reduced ejection fraction discovered on investigation is particularly important in this regard. Prior history of primary ventricular tachycardia (VT)/VF, frequent ventricular ectopics/nonsustained VT, decreased heart rate variability, decreased baroreflex sensitivity and an abnormal signal averaged ECG (SAECG) are important predictors, too. The third problem is the paradox that, in a given population, most sudden cardiac death occurs in patients from the lowest risk and, conversely, the least numbers of sudden cardiac death are found in the highest risk group.[3] Therefore, one of the most important strategies to reduce sudden cardiac death is standard CHD primary prevention. Aspirin, beta blockers, ACE

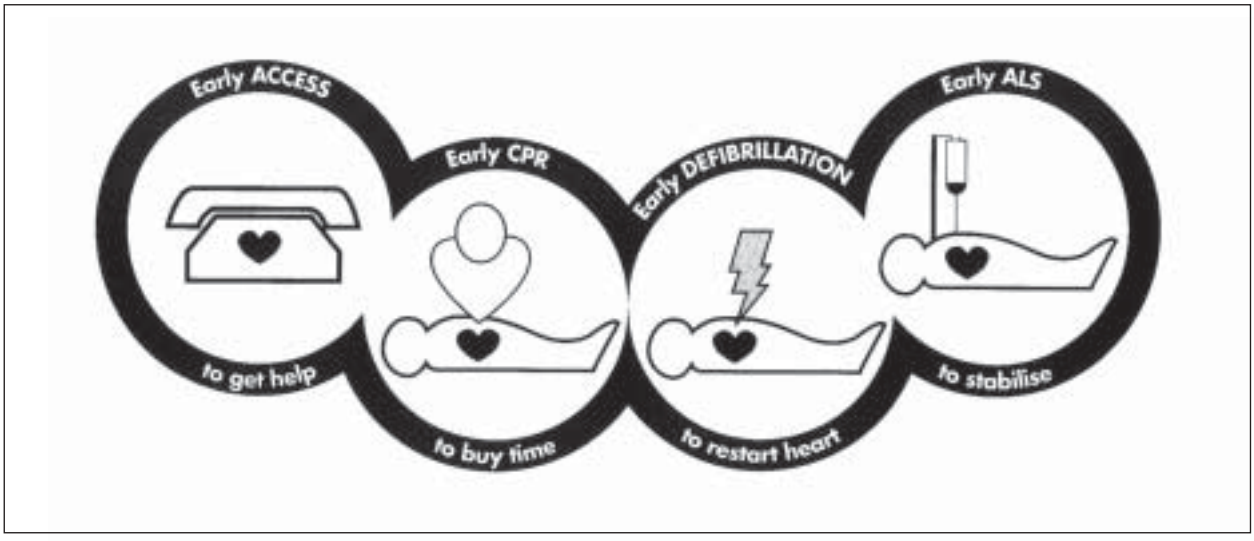

FIGURE 1
The chain of survival. (© Laerdal: http://www.leardal.co.uk/document.asp?docID=1116809)

*From a symposium held on 30 October 2001 at the College.

inhibitors and statins have all been shown to reduce sudden cardiac death.

The HeartStart Scotland programme has provided automated external defibrillators (AEDs) in all 'frontline' ambulances in Scotland since 1988, and the associated database relating to their use has been maintained at Glasgow University. The database includes details of every ambulance-attended cardiac arrest and has data on nearly 25,000 cases. This database has provided a number of important insights into the epidemiology of sudden cardiac death:

- two-thirds of arrests were in the home, 12% in the street and only three per cent in the workplace; this has obvious implications for the likely impact of public access defibrillators (PADs) on sudden cardiac death;
- fifty per cent of cardiac arrests were attended within seven minutes of the 999 emergency call, and 90% within 14 minutes;
- in only 38% of cases was bystander cardio-pulmonary resuscitation (CPR) in progress when the ambulance arrived, although in 60% of cases the collapse was witnessed by a bystander;
- seven per cent of the cohort survived to hospital discharge; this figure increased to 11·6% if the patients were in a 'shockable' rhythm when the ambulance arrived, i.e. VF or VT; in contrast, only 1·3% survived if the rhythm was non-shockable, i.e. asystole or EMD;
- if bystander CPR was given survival to discharge doubled, and this improvement was consistent across all groups;
- eighty-nine per cent of survivors had no or only mild neurological deficit; two per cent had severe deficit and were then in long-term care; and
- it has been estimated that HeartStart Scotland has resulted in 200 successful resuscitations annually, which equates to a one per cent reduction in CHD mortality, a similar mortality reduction to other CHD 'treatments', e.g. CABG.

Professor Douglas Chamberlain, Honorary Professor of Resuscitation Medicine at the University of Wales College of Medicine, then discussed 'The gold standard: what can be achieved in resuscitation?'

The possibility of rescuing potential victims of sudden cardiac death has attracted interest for centuries, but it became an accepted goal of practical medicine only 40 years ago. Huge efforts have been made, an industry has evolved, impressive technological advances have been made and large sums of money continue to be spent. However, expected improvements in results have proved elusive.

CAN WE ACHIEVE MORE BY CPR?

Seattle has led the world in all aspects of resuscitation and to an extent the city's treatment methods remain the gold standard. The importance of bystander CPR has been confirmed in numerous studies and a meta-analysis indicated that bystander CPR improved the odds of survival by 2·47.[4] Seattle investigators trained 80,000 citizens in CPR and observed a remarkable improvement in survival from out-of-hospital cardiac arrest – 18·7% of witnessed VF.[5]

Hence, more people need to be trained in basic CPR skills, but can changing what we teach improve outcomes? There are some early intriguing data that it might. A recent clinical study examined telephone CPR training by ambulance control staff.[6] Bystanders at actual cardiac arrests were either instructed in compressions only, or both compressions and ventilation. Of the former group, 14·6% survived to hospital discharge compared to 10·4% of the group who were given both ventilation and compression. If no ventilation was performed, 675 compressions in eight minutes are possible compared with 308 compressions if the current 15:2 (compression: ventilation) ratio guideline is followed.[7] Furthermore, a recent and as yet unpublished study indicated that lay people retain reasonable cardiac massage skills but very poor ventilation abilities. The study also showed that a strategy of retraining made little or no impact on these findings. This whole area demands further urgent study.

CAN WE ACHIEVE MORE WITH DEFIBRILLATION?

Recent attention has been focused on the role of PADs in reducing the time to defibrillation and thus improving survival. The most impressive result is from a study in US casinos.[8] A remarkable 53% of 105 cases of VF survived to hospital discharge. Preliminary results from other studies placing AEDs in police cars or airports are also encouraging.

CAN NEW DRUGS OR DEVICES HELP DURING RESUSCITATION?

A recent study examined the use of thrombolysis during cardiac arrest and suggested a potential benefit from this therapy.[9] A larger randomised study is planned. None of the devices aimed at improving the haemodynamics of CPR has been shown to improve survival.

CONCLUSION

While resuscitation may never live up to some of the more optimistic expectations of the 1960s, the next decade will see a resurgence of progress.

Hazel Moss, Perinatal Effectiveness Facilitator, Greater Glasgow Health Board, then gave the patient's perspective drawing on her own personal experience.

Hazel is a 30-year-old mother of two young children who had her first cardiac arrest at age 15 and a second aged 17. After surviving a third arrest she received an Implanted Cardioverter Defibrillator in 1993 and has subsequently

had three appropriate shocks for VF. She gave a very moving account of the challenges that she has faced and overcome. She had difficulty gaining employment because of her medical history and further has experienced problems with her work colleagues' attitudes.

She has now come to terms with her illness although she still gets bitter at times. She resents but understands not being able to drive. She tries to be positive and to live life to the full. The only other limitation she finds is not feeling confident enough to holiday abroad. She is very active in the cardiomyopathy and ICD patient self-help groups.

Dr Stig Holmberg Chairman of the Working Group for CPR in Sweden, discussed the Swedish experience of educating the public in CPR.

In 1983 the first national training programme for CPR was set up in Sweden and was designed for training both medical professionals and lay people. It was a one session, three hour training programme where all medical information was conveyed via a video and two and a half hours were spent on hands-on practice.

To be able to train a large proportion of the population it was necessary to recruit and train large numbers of instructors. This was achieved through the 'cascade principle', where instructor-trainers train instructors who then eventually train the rescuers. Every year, approximately 200 instructor-trainers, 3,000 instructors and 100,000 rescuers have been trained. Since 1983, approximately 4,000 instructor-trainers, 47,000 instructors and one and a half to two million rescuers have been trained.

Mr Ronnie Downie, Emergency Life Support Coordinator, Argyll & Clyde Health Board, spoke about emergency life support training in the community.

Argyll and Clyde has the second highest mortality rate in the UK from coronary heart disease. In 1997, John Bryden, Consultant in Public Health Medicine, formed a partnership with the Scottish Ambulance Service (SAS) and the British Heart Foundation through HeartStart Scotland to establish Emergency Life Support (ELS) training within its community.

Since 1997, 111 schemes (15 community groups, 91 schools and five other schemes) have been established with 600 trainers who have trained a total of 17,000 members of the public. One problem that they have faced is that people becoming trainers have not gone on to train others! Mr Downie estimated that only 30% of trainers were active.

Dr Jill Pell, Consultant in Public Health Medicine, Greater Glasgow Health Board presented public access or first responder defibrillation – The HeartStart Model.

The American Heart Association has identified four potential strategies to reduce the time to defibrillation in the community:

- public access defibrillators (PADs);
- other first responders with defibrillators, such as police or fire crews;
- other trained first responders, e.g. aircrews; and
- friends/relatives of at risk patients to have AEDS.

The SAS has collected data on all out-of-hospital cardiac arrests since 1988 as part of the HeartStart Scotland initiative. HeartStart Scotland data were used to model the potential impact on survival of two strategies, PADs and other first responders. Both studies included arrests over a seven year period and excluded non-cardiac causes and crew-witnessed arrests.

PADS

The database includes the location of all cardiac arrests and from these data it was possible to estimate that 79% of arrests would have been unsuitable for PADs (usually occurring in the home), 18% were in definitely suitable locations and three per cent in possibly suitable locations. The model assumed that if a PAD were available then the chance of survival of patients with an actual time to defibrillation of greater than three minutes would improve to the same chance of survival of patients with times to defibrillation of three minutes. The use of targeted PADs, i.e. use in definitely suitable locations and widespread PADs where AEDs were in 'definitely' and 'possibly' suitable locations only, were examined. In the whole cohort this would improve survival from five per cent to 6·3% with targeted PADs, and to 6·5% with widespread PADs.

FIRST RESPONDER MODEL

The model examined the potential benefit of reducing the so-called 'first responder' time**.** The SAS is currently required to attend 90% of arrests within 14 minutes. The equivalent target for the fire service is five minutes. Therefore, using the fire brigade (and others) as additional first responders should significantly improve time to defibrillation.

The cohort was randomly allocated into two equal groups. Multiple logistic regression was applied to Group I to determine the factors associated with survival to discharge. The coefficients obtained were applied to Group II to model the potential impact of reducing response time. For example, reducing 90% of first responses to ≤8 minutes would improve survival by 1·9–2·4% to 8·1–8·6%. Improving 90% to ≤5 minutes would improve survival to 10·2–10·9%.

CONCLUSIONS

1. Prioritise improving first responder times over PADs; and
2. prioritise targeted PAD over widespread PADs.

Andrew K. Marsden, Medical Director, Scottish Ambulance Service discussed the coordination of first responders.

> All first responder programmes must operate under strict medical control by physicians qualified and experienced in emergency programme management, who will have responsibility for ensuring that each link of the Chain of Survival is in place and who have appropriate access to patient outcome information permitting audit using the Utstein template. [10]

Medical coordination is essential for several reasons:

- the coordination of despatch and targeting of first responders to the right cases;
- the compatibility of equipment including quality control systems, maintenance arrangements, seamless transfer of consumables, exchange systems etc.;
- compatibility of data transfer – electronic and manual for audit, outcome determination and feedback;
- accreditation of training and skill maintenance;
- updating of standards and procedures; and
- 'care' and support to the first responders.

Dr Ken Proctor, Medical Director, Highland Primary Care Trust spoke on the role of general practitioners as first responders in rural areas. He was previously the director of the Grampian Doctors on Call Services.

Grampian doctors on call services provide comprehensive out of hours emergency cover for all of the Grampian region from a fleet of eight cars. Each car is manned by a driver and a GP and equipped with all advanced life support drugs and equipment (including an AED). The GPs receive regular training and re-training in all aspects of basic and advance life support. Efforts are ongoing to introduce a similar scheme in the Highland region.

Scott Bateman MBE, national coordinator, First Response outlined the role of the First Response charity.

First Response is a registered charity that provides a life saving first responder service to the community. The service is provided by serving Armed Forces personnel who volunteer for the scheme and man the service in their free time.

Schemes already exist in four areas with plans in place to create more shortly. The scheme in each area consists of one first response car manned by 30 volunteers. These volunteers are able to offer any NHS ambulance service a dynamic first responder service that can be deployed anywhere in the area responding to primarily cardiac-related incidents. To date they have been on duty for 41,500 hours and have attended 1,100 emergencies, and on average they have arrived six and a half minutes before paramedic crews.

Mr Kevin Ford, Training Department, Cleveland Fire Brigade presented 'What can the British Fire Service offer the UK's Emergency Medical Services in their bid to improve the outcomes for pre-hospital cardiac arrest victims?'

There are 984 fire appliances in urban areas and 1,805 in rural areas, all of which could potentially be first responders. To date, four fire brigades have appliances fitted with AEDs. However, there is wide variation in the use to which the respective ambulance services have utitlised this additional first responder resource, and the scheme needs to be rapidly expanded.

To these ends, a co-responder task force has recently been set up and has members from both the ambulance service and fire brigade as well as the British Heart Foundation (BHF). The primary aim of this group is 'to explore with the Ambulance Service the possibilities of an integrated approach which enables all the Emergency Services to work more effectively to form one cohesive pre-hospital team, working for the best interests of the public'.

Dr Anthony J. Handley, Chief Medical Advisor, Royal Life Saving Society UK then outlined the current and potential roles of the voluntary rescue and first aid societies.

The voluntary sector represents an extensive but largely untapped source of potential first responders. The four voluntary organisations have a total of 75,000 members and own a large number of AEDs. The St John's organisation has 688 AEDs and has used them 34 times. Examples of current schemes include:

- provision of AEDs and first aid facilities at public events;
- first responder schemes successfully run on West Country beaches by the Royal Life Saving Society; and
- provision of training in AED use for security staff in Scottish shopping centres by the St Andrew's Ambulance Association.

Undoubtedly they are a valuable first responder resource but need better coordination, and perhaps the BHF HeartStart Scotland liaison group might take on a coordinating role.

Mr Ron Williams, Coordinator, Broughton First Responders discussed community defibrillation first responders.
Cumbria is the least populated county in England and the Broughton First Responder group was set up to cover two villages in a remote area of the county in order to improve on long response times. The scheme was set up with the full support of the Cumbria Ambulance Service. There are 18 volunteers who carry pagers and one AED is situated in a central site. All members undergo regular six monthly re-training.

Ms Sian Davies, National Project Manager, Defibrillators in Public Places then explained the plans for increasing defibrillators in public places.
The recent government White Paper *Saving Lives: Our Healthier Nation* had five requirements regarding AEDs:

- introduction of AEDs into public places;
- equitable deployment of AEDs;
- ensure all AEDs are accessible;
- provide training and retraining for potential users; and
- ensure the cooperation of other agencies.

In response to this, a Defibrillatory Advisory Committee was formed in September 1999 and a national project manager was appointed. To date, 250 AEDs have been deployed in 62 sites. The sites selected are known to be cardiac arrest 'hot spots' and include airports, bus and railway stations and shopping centres. The aim is that an AED should be able to reach a victim within two minutes and 'time-trials' are performed at sites to dictate positioning of the AEDs. This two minute target necessitates more than one AED at all sites and many AEDs at large sites (e.g. 92 at Heathrow Airport). To date, there have been 34 deployments and two survivors discharged from hospital.

Dr Janet M. McComb, Consultant Cardiologist, Freeman Hospital, Newcastle upon Tyne presented 'Implantable defibrillators – what can we do for the survivors?'.
Currently, very few patients are resuscitated from sudden cardiac death, and fewer than half are discharged from hospital alive. Sudden cardiac death also remains a risk in the survivors, causing half of the deaths in the two years following initial resuscitation. The majority of patients suffering from sudden cardiac death have underlying ischaemic heart disease but it is clear, both in Scotland and elsewhere in the UK, that only a minority of these patients receives appropriate investigation and treatment.[11] In particular, those patients who have a cardiac arrest in the absence of acute myocardial infarction seem to undergo minimal investigation and have a very high subsequent mortality.

Appropriate investigation should include an assessment of left ventricular function and the potential for myocardial ischaemia with a view to revascularisation. Risk factor modification and consideration of aspirin, beta blockers and ACE inhibitors are essential. Following management of any underlying ischaemic heart disease, consideration should be given to the implantation of an implantable cardioverter defibrillator (ICD) as recommended by the National Institute for Clinical Excellence (NICE) (see Table 1). The evidence supporting the use of the ICD in these patients is of the highest order, derived from prospective randomised controlled trials [13-15] Antiarrhythmic drugs do not have any primary role in these patients, although they may be used as adjunctive therapy.

TABLE 1

NICE guidelines for ICD implantation[12] (*includes acute myocardial infarction).

1. In the absence of a treatable cause* for patients with:
   - resuscitated VF/VT;
   - VT with haemodynamic compromise and/or angina; and
   - haemodynamically well tolerated VT with EF <35%.
2. In patients with ischaemic cardiomyopathy (EF <35%) and non-sustained VT with inducible monomorphic VT at EP study.
3. In patients with a familial cardiac condition which carries a high risk of sudden cardiac death.

In a recent audit at the Freeman Hospital it was estimated that if these guidelines were implemented then the ICD implant rate would increase to 102/million/year, which is a 12-fold increase on current Scottish implant rates. However the reality of the situation is that few patients even see a cardiologist, let alone undergo appropriate investigation of their underlying ischaemic heart disease, and even fewer are considered for ICD implantation.

SYMPOSIUM SUMMARY

The shocking truth is that only around seven per cent of patients are discharged alive after a cardiac arrest occuring in the community. The symposium examined ways to improve this. Undoubtedly, the first step is primary prevention with attention to coronary heart disease risk factors.

From there, the focus is on the two critical elements of the chain of survival, i.e. early CPR and prompt defibrillation. Other areas of the world, notably Sweden and Seattle, have shown that large scale public CPR training programmes are possible and can make a significant overall impact in decreasing such death. Similar initiatives have begun in the UK and Mr Ronnie Downie, Emergency Life Support Coordinator, Argyll & Clyde

Health Board outlined one such scheme. The consensus was that the schools were the best place to begin the training.

There is controversy as to the best and most cost-effective mechanism(s) to reduce defibrillation times. Data from the HeartStart Scotland database suggests that increasing the number of first responders might save most lives. Efforts in this regard have already begun with four fire brigades having appliances equipped with AEDs and a joint BHF/ambulance service/fire service committee has been formed to take this forward. Mobile on-call GPs, the voluntary life saving organisations, the Armed Forces charity 'First Response' and community groups will have an important role as additional first responders equipped with AEDs. However, there will have to be close coordination and audit of performance of these various groups. The government has spent large sums of money looking into the alternative strategy of PADs and a pilot scheme has just started. Its results are eagerly anticipated.

One final shocking truth is the evidence of gross under-treatment of the seven per cent who do manage to survive to hospital discharge.

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