Resuscitation and transport by emergency care workers

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Introduction

Survival after out-of-hospital cardiac arrest is linked to the rapid provision of effective external cardiac compressions, defibrillation and appropriate post-resuscitation advanced cardiac life support. Effective provision of these interventions requires strong links in the chain from pre-hospital to hospital based systems. Transport of the patient during resuscitation efforts to emergency departments, and interfacility transfer of patients post-resuscitation for definitive care, have not been demonstrated to increase survival.

This article will explore some of these issues, in a South African, pre-hospital context.

Pre-hospital levels of care in South Africa

Basic Ambulance Assistants (BAA) are accredited to provide basic life support after successful completion of a 4 week training course. BAAs make up about 80% of all emergency medical services (EMS) workers in South Africa at present. Intermediate Life Support (ILS) practitioners are the next level, and account for 20% of EMS workers. They undergo a 4 month training programme, which includes training in defibrillation and intravenous (IV) access.

There are four Advanced Life Support practitioner levels: (i) the Critical Care Attendant (CCA) undergoing 9 months of training, (ii) the Emergency Care Technician (ECT) undergoing a 2 year programme, (iii) the National Diploma: Emergency Medical Care (3 years) and the Bachelor of Technology: Emergency Medical Care (1 - 2 years post-graduate qualification after the National Diploma).

The scope of practice varies between the levels, with the ECT having the lowest level of advanced practice (no endotracheal intubation and limited drugs).

Pre-hospital thrombolysis and rapid sequence intubation are techniques which are currently being rolled out for the BTech: EMC qualification by the Health Professions Council of South Africa (HPCSA). The HPCSA Professional Board for Emergency Care (PBEC) has revised the training process of pre-hospital practitioners, with planned closure of the BAA and CCA registers at the end of 2010, and the ILS register in 2014. The ECT and a new 4 year professional degree, the Bachelor of Science in Emergency Medical Care, will be the two tiers of the EMS system in South Africa in the future.

Resuscitation is practiced most often by basic life support practitioners with the aid of automated external defibrillation for ventricular fibrillation/ventricular tachycardia cardiac arrest. The limited availability of this technology, lack of goal-directed EMS system development to achieve early access leading to significant delays, poor community education and generally poor performance of resuscitation (if undertaken at all) by basic life support practitioners, and limited number of operational advanced life support practitioners, means extremely poor survival rates of patients with out-of-hospital cardiac arrest. The substantial lack of advanced life support practitioners adds to the burden of the BAA and ILS practitioners, forcing them into decision making beyond their training level.

Current state of resuscitation in the pre-hospital environment

It has been well established that the only interventions that reduce mortality rates of cardiac arrest are defibrillation and immediate and effective external cardiac compressions.[1] In a comparison of paramedic versus physician based pre-hospital resuscitation efforts in Norway, no difference was found in survival outcomes.[2] These interventions can furthermore be provided effectively, even by lay people with basic training.

1. The advent of Automated External Defibrillation has opened defibrillation to the lay public. Success with public access defibrillation in the USA using AEDs has been well documented.[3,4,5] Bystander CPR and automated defibrillation demonstrated improved out-of-hospital survival rates of 41% - 74%.[1] AEDs have made defibrillation accessible to basic life support providers who are the backbone of the South African EMS systems – both public and private. Large scale roll out of this technology in Provincial (government / public) EMS has not happened due to the costs involved and a focus on providing basic primary health care without a consideration of emergency care needs of the community. Thus defibrillation is still primarily the domain of the advanced and intermediate life support practitioners creating significant delays from onset of resuscitation to defibrillation. Every minute of delay from onset of VF until defibrillation reduces success of defibrillation by 7-10%.[1]
2. Prehospital thrombolysis during resuscitation for suspected acute coronary syndrome and pulmonary embolism has been practiced in the USA and European countries for the past few years.[6] A meta-analysis conducted by Li et al[7] showed improved rate of return of spontaneous circulation and 24 hour survival.

Böttiger et al[8] in a large randomized double blind study with 1050 patients found no benefit of Tenectaplase over placebo in ROSC, 24hr mortality or discharge with no neurological deficit. Thus the evidence is confusing as to the effectiveness of this practice. This process has not yet been accepted for standard practice in South Africa by degree qualified paramedics.

3. Mechanical devices have been suggested as options for use in prolonged resuscitation such as thrombolysis during CPR where 90 minutes are required for full drug effect to occur. Rubertsson and Karlsten[9] compared standard ECC to the LUCAS (Lund University Cardiopulmonary Assist System) device in pig models – with significantly higher cereb ral perfusion pressures with the LUCAS. de Wilde[10] found no difference in survival at 30 days between standard CPR and LUCAS resuscitation.
4. Krep et al[11] conducted an observation study of patients treated with the Autopulse® during resuscitation. Survival to discharge was 21.8% and 6 month survival was 10.9%. Risom et al[12] presented 2 case studies of prolonged CPR using the Autopulse. Both patients experienced out-of-hospital cardiac arrest with VF. The one patient had a primary cardiac arrest from ACS and the other from hypothermia after falling into a canal in winter. Both patients were discharge without neurological deficit after 48 minutes and 120 minutes of cardiac compressions. Further research is required to demonstrate the benefit versus cost of these devices.

Resuscitation on scene versus transportation – evidence

The ability to perform effective external chest compressions (ECC) within a moving ambulance impacts on the decision to move a cardiac arrest patient from the scene of collapse to the hospital. It has been standard practice in the American paramedic system to continue resuscitation efforts until the patient has been attended to and evaluated by a physician in an Emergency Department.[13] The South African paramedic system allows for termination of resuscitation efforts without the need for assessment by a physician, and more recently allows paramedics to declare patients dead on the scene of cardiac arrest.[14] In 2003, ILS practitioners have been authorized to declare a patient dead without resuscitativ e procedures being undertaken.[15]

Rapid transportation of a critical patient has been recognized as having associated risks. These include the increased risk of vehicular collisions, injury of unrestrained personnel in the patient compartment of the ambulance and communicable disease exposure through contaminated needle-stick injuries.[13,16] Coupled with this are concerns that poor resuscitation efforts may be linked to extremely low survival rates in patients with ongoing CPR in the ambulance.[17]

Roberts[18] and Stone and Thomas[16] concluded that standard CPR was suboptimal during both manual transportation and movement in an ambulance. Stapleton evaluated a number of variables influencing CPR performance including different types of ambulances and different methods of CPR under various road conditions and speeds. He concluded that both vehicle type, speed and road conditions (movement of an ambulance) were significant contributors to suboptimal performance of standard manual ECC during ambulance transportation.[19]

Sunde and co-workers showed an increased depth and rate of compression beyond the recommended range, as well as a shorter compression time during ambulance transportation.[17] Braunfels and co-workers compared ECC performance on the ground with ECC performance in an ambulance on various types of stretchers. There was an overall reduction in ECC performance and increased effort by providers in performing ECC in the ambulance in comparison with on the ground.[20] Ochoa and co-workers demonstrated a significant decrease in quality of compressions due to fatigue after the first minute. This effect was shown to be independent of age, gender, weight, height or rescuer's profession. It was also demonstrated that there is a significant delay in the actual versus perceived rescuer fatigue.[21] It was also demonstrated by Braunfels and co-workers, that an increase effort was required to perform CPR on a stretcher in the back of an ambulance as compared to the ground.[20]

A retrospective cohort study of 15 years of data from patients brought in to the hospital while resuscitation was in progress was conducted by Eisenburger et al.[22] In their study, the ambulance service was primarily physician staffed and thus the decision to transport was physician based. The study had a 6% overall survival rate with favorable neurological outcome – the highest survival rate in such studies. Hypothermia and intoxication had higher individual survival rates (10% and 11% respectively) although their incidence was low overall.

Transportation of post-resuscitation patient

1. Post resuscitation care of patients with return of spontaneous circulation has been linked to long term outcome.[1] Certain of the recommended ICU based therapies to improve outcome have been trialed in the prehospital environment.
2. Transportation to the nearest appropriate facility is the routine practiced by South African EMS systems. Unfortunately the nearest facility often is not the most appropriate facility to manage the post resuscitation patient. Spaite et al in a registry study noted that longer travel intervals were not associated with worse outcomes in patients with ROSC.[23] Their study is not conclusive as the average travel time was only 4 minutes – thus not demonstrating that prolonged travel to a suitable centre is a safe option.
3. Therapeutic hypothermia has been linked to improved outcomes following cardiac arrest and resuscitation.[24,25,26] Cooling can easily be achieved in the prehospital phase by administration of 30ml/kg of cold 0.9% saline or Ringers Lactate.[27] Alternatively the use of icepacks in the groin, armpits and neck will achieve this outcome as the post resuscitation patient is often cold.[28] Currently this practice is not routinely used in South African EMS systems and need to be explored further to improve post cardiac arrest patient outcomes.

Conclusion

1. South Africa has a three tiered EMS system with fragmentation of the Advanced Life Support providers. There are also a large proportion of practitioners with only basic life support

skills and limited technology to implement early defibrillation. Defibrillation and effective external cardiac compressions are the only interventions documented to improve survival from cardiac arrest. AEDs have opened the field of defibrillation to basic life support providers as well as the lay public. There is limited availability in South Africa due to cost.

2. Prehospital thrombolysis and mechanical CPR assist devices are being researched to help improve survival from cardiac arrest. No conclusive evidence has been produced and neither are routinely used in South Africa. CPR during transportation has been shown to reduce the effectiveness of cardiac compressions and may increase the risk to providers. Survival rates remain poor amongst patients transported with resuscitation in progress.
3. Transportation to the nearest facility may not benefit the patient if the available resources are inadequate to provide the required care. The benefit of bypassing facilities to transfer patients to tertiary facilities has not been conclusive demonstrated either.
4. Therapeutic hypothermia has been shown to improve the outcome after cardiac arrest. Its routine use would be possible in the prehospital environment but it is not practiced in South Africa.
5. Reviewing the international evidence on improving patient outcomes during and post resuscitation will provide direction for South African EMS systems development. Improving patient survival from cardiac arrest requires a systems development approach by both hospital and prehospital agencies in South Africa.

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