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Basic life support. Military background and influence in contemporary teaching of cardiopulmonary resuscitation¹

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Abstract

Cardiopulmonary resuscitation (CPR) is the core component of both Basic Life Support and Advanced Life Support skills. Modern first aid, as a discipline of drills and skills to preserve life and limb, had its genesis in military surgery albeit with a history of barely two centuries. The extension of teaching of first aid skills to members of the lay public was the result of advocacy of military surgeons initially in London in 1878 and subsequently in Australia from 1881. The Australian Defence Force was a foundation member of The Australian Resuscitation Council which was established under the auspices of The Royal Australasian College of Surgeons in 1976, and since that time uniformed members have maintained a significant influence in the sequential development of the policies and practice of CPR teaching in both the military and civilian domains in Australia. This paper reviews the range of high-risk scenarios that may confront any individual, uniformed or civilian, where on-site CPR may be required at any time. The historic and contemporary close links which exist between uniformed health personnel and those of The Australian Red Cross, St John Ambulance Australia and The Royal Life Saving Society are reviewed in this paper. Continued advocacy of "first aid - a skill for all" remains core doctrine for all members of the Defence Health Service Branch within The Australian Defence Force.

Key Words: Cardiopulmonary resuscitation (CPR); Australian Defence Force; Defence Health Service Branch; first aid; military medicine; teaching CPR.

The series of drills and skills that we understand today as cardiopulmonary resuscitation (CPR) has a history of barely two centuries.¹⁻³ The development of the doctrine and the teaching of life support skills owes much to military surgeons. Baron Larrey in the Peninsula Wars, von Esmarch in Prussia in 1851, and Holger-Nielson in Paris in 1943 each developed principles of self-help and buddy help, primarily for sick and injured soldiers, on which the concepts of later twentieth century life support techniques have been built (Table 1, over page).

The best discoveries and inventions will not save lives unless bystanders and first responders are trained in the delivery of the system. The military was the fundamental catalyst that enabled the new discoveries of life support to be disseminated to the general civilian public.

When the Imperial troops were removed from Australia in 1870, six of the States developed their own militia volunteer forces, each responsible independently to the Crown in London. Four of these militia forces developed their own Ambulance Corps.

In Melbourne, Surgeon-Major Robert Robertson delivered four public lectures on military first aid between March 1880 and February 1881.³ His unit, the St Kilda Artillery - established to defend the city of St Kilda in Melbourne - opened its teaching classes (segregated by sex) to the public in a pioneering move that was soon to have repercussions throughout Australia. The first civilian ambulance service in Australasia, The City Ambulance Transport Brigade, was established in Brisbane in 1892,⁴ modelled along the lines of and containing many cross posted positions of the militia Ambulance Corps of the Queensland Defence Force.

1851	Friedrich von Esmarch invented the self-help bandage - an unbleached calico triangle with a base of 40 centimetres; to be carried by all Prussian soldiers in battle. This was the first introduction of the concept of every individual being responsible for his and a colleague's treatment following an injury.
1861	Henry Silvester's development of a "physiological method of resuscitation". ⁶²

1897	Professor Edward Sharpey-Schaefer's further development of a resuscitation method- patient face-down with head turned to the side. ⁶³
1943	Holger Nielson's method- victim placed face-down with elbows bent, with the rescuer applying alternating pressure to the thorax with the raising of the victim's elbows. Holger Nielson was a Danish soldier who served with the German occupying Army in Paris during World War II.
1948	Human heart restarted electrically for the first time. ⁶³
1958	Dr Peter Safar's demonstration, using curarized volunteer medical students, that expired air resuscitation will maintain adequate cerebralation of oxy & enacted blood.
1984	Development of semi-automatic (computerised) defibrillator.
1988	Tore Laerdal developed the concept of "Chain of Survival"-a four-link chain comprising Calling for Help, Basic Life Support, Advanced Life Support, In-hospital Life Support. ⁴⁵

Table 1: A chronology of some milestones in the evolution of best-practice Basic and Advance Life Support.

Subsequently, the evolution of lay teaching,^{2,3} and the development of pre-hospital systems of trauma care,⁶⁻⁸ developed into a history of the lay teaching of CPR which has proved to be as important as that of the technical discoveries and the development of new equipments themselves (Table 2).

1870	Imperial Troops withdrawn from the Australian Colonies. Six Australian Colonies established their own State Defence Forces. Four of these included a Military Ambulance Corps whose members taught volunteer militia stretcher-bearers the skills of bandaging technique and the elements of resuscitation.
1880	The medical section of the St Kilda Artillery (Melbourne) opened its classes of military first aid drills to the general public. ¹
1883	The first public St John Ambulance First Aid Courses taught- at the Everleigh Railway Workshops in Sydney; and in Melbourne, this latter under the auspices of Dr James Neild(1824-1906). ¹
1892	The first civilian ambulance service established- the City Ambulance Transport Brigade -in Brisbane. ⁴
1892	Several Australian States establish State Railway Ambulance Corps to protect the life of both staff and passengers on State Railways.
1894	Royal Life Saving Society established in Australia - this within three years of its establishment by William Henry in London in 1891.
1907	The Surf Life Saving Association founded, originally termed The Surf Bathing Association of New South Wales. ¹
1914	Australian Red Cross founded within days of the outbreak of the First World War. Terms of Reference included advocacy for international humanitarian law, the protection of prisoners and refugees, the provision of food and shelter to civilians at times of civil and military emergency and the teaching of first aid. ⁶⁵
1976	The Australian Resuscitation Council formed and sponsored by the Royal Australasian College of Surgeons, in Melbourne. ⁶¹ The Defence Health Service of the Australian Defence Force was a Forum Member; and has served as an influential full member since that time.

Table 2: Military Role in the Teaching of First Aid. Some datum milestones in the chronology of teaching Basic Life Support skills to the general Australian public.

All who work in the area of both training and delivery of pre-hospital CPR feel an identity, indeed a justifiable pride, in being a part of this vigorous development for the better preservation of life. An auditor of life support would, however, point out some chastening contemporary facts. Such are the sobering realities of the new millennium:

- Less than 20% of cardiac arrest victims, in developed countries, receive bystander CPR.⁹
- Survival following cardiac arrest due to ventricular fibrillation is only 9%.¹⁰
- Survival rates following cardiac arrest in neonatal septicaemic shock remain zero.¹¹

- Best-practice survival (40%) for cardiac arrest are associated with call-to-shock times of 5.6 minutes; with non-survivors having a mean call-to-shock response time of 6.9 minutes. Yet best-practice, median response times in metropolitan Australia (some of the best professional ambulance responses anywhere) are 9.5 minutes.^{13,14}
- Only 1.5% of Australians are trained in first aid each year.
- First responders, including doctors in hospital,¹⁵ and CPR instructors,¹⁶ do not like performing mouth-to-mouth resuscitation.
- The majority of doctors (UK figures) have received no CPR training in the last five years.¹⁷
- Only 38% (NZ figures) of junior paediatric doctors know that cardiopulmonary arrest in children is almost always due to hypoxia or apnoeic events.¹⁸

What are the portals by which CPR survival can be improved? The military has a major potential role in this field. This paper discusses some approaches to this issue.

Children - An Audit of Preventible Deaths

Children have comprised a significant component of the clinical contacts involving health personnel in Australia's recent over seas deployments. Can child mortality be reduced by a higher rate of better quality, parent and bystander CPR in the community? The overall causes of child mortality in Australia are shown in Table 3.¹⁹⁻²³

• Road trauma ^{19,20,21,24,25}
• Inter-vehicle crashes
• Bicycle trauma ²⁶
• Pedestrian run-downs
• Drowning ^{19,20,21,28-31,27}
• Burns ^{21,27}
• Non-accidental injury, homicide ^{21,57,66}
• Suffocation ^{19,20}
• Accidental poisoning ²²

Table 3: The ranked causes of child trauma mortality in Australia

Any reductions in childhood deaths, using CPR as one engine for improvement, must, therefore, focus particularly on road trauma, drowning, burns and mechanical suffocation.²¹ Although accidental poisoning is common in the 1-3 year age group in Australia and New Zealand, it is very rarely fatal;²² and in the case of the Sudden Infant Death Syndrome (SIDS), which kills 1 in every 700 children in the first year of life, the dead infants are almost always found hours rather than minutes after death,²³ and extensive anecdotal experience suggests that CPR, unlike the preferred face-up sleeping position for infants, will do little to reduce deaths from this enigmatic disease.

Road trauma kills children as occupants of cars,^{24,25} as the result of bicycle trauma,²⁶ and as victims of pedestrian run downs. An extensive autopsy analysis of Australian child road trauma victims, undertaken in my own research unit, has shown that better accident-site maintenance of the airway will save perhaps an extra 8% of such victims.²⁴ In this study, 48% of 1,369 children killed on the road had significant facial trauma and 33% of these had aspirated blood or foreign material prior to cardiac asystole. Similarly, a recent study of fatally burnt children, as part of the Brisbane Child Trauma Study, has shown that 5% could probably be salvaged by airway clearing and maintenance in the pre-hospital phase.²⁷

It is in the area of accidental drowning that the greatest window-of-opportunity exists for further CPR-driven mortality reduction. Drowning in Australia continues to cause a third of all deaths in the 0-4-year-old group;²⁰ and the rate, always high in the past two decades, continues as one of the highest by international comparison.²⁶

My own research in the Brisbane Drowning Study has shown that 30% of toddler drowning fatalities can be turned into survivors, simply by the first responder having been trained in CPR.^{29,30} I believe the reason for this is not simply the better technical CPR delivered by a trained first responder (almost always a parent, grandparent, sib, neighbour or childcarer), although such is very important. I believe such improved survival is due also to the fact that trained first aiders are more likely to initiate CPR earlier than those who have never attended a basic life support course. A number of those resuscitators, accidentally "on-the-spot", were ADF or ex-ADF personnel who had been trained in first aid. The difference between potential fatality on the one hand and salvage on the other is a brain hypoxic time of less than 5 minutes in this age group.^{30,31}

Timely and skilled CPR not only saves lives, but it saves brains in survivors. Although 97% of near-drowning survivors do not have hard neurological signs,^{30,32} one third have some impairment of the islets of higher intellectual functioning. Such chronic hypoxic damage is measured by wide subscale disparities on formal psychometric testing of survivors.³³ The "urgency of immersions", as a major preventable cause of toddler mortality and morbidity, remains topical in all tropical and subtropical countries of the developed world, as the new millennium commences.³⁴

Children - Cardiopulmonary Arrest

Almost all paediatric cardiopulmonary arrests are due to hypoxia,^{11,18} irrespective of whether such arrests involve neonates, infants or older children.¹¹ Cardiac dysrhythmias are rare and account for less than 5% of cardiac arrests that affect neonates who require CPR;^{11,15} and less than 8% of children up to the age of 15 years who suffer cardiac arrest.³⁵

The principal causes of cardiac arrest in children are SIDS, drowning and asthma. Studies of 12,490 persons with cardiac arrest treated by the Ambulance Service of New South Wales have shown that in the case of children under 5 years of age, defibrillation for ventricular fibrillation (VF) comprises less than 0.02% (9 of 5,047) of all cases of VF. In current practice, even with high rates of pre hospital paramedic-administered defibrillation, young children with VF have zero survival.³⁵

A summary of realistic salvage by improved first-responder CPR, which involves child victims, is shown in Table 4.

		Potential Extra Salvage (Percent)
Road Trauma	Airway clearance	8% 24
Drowning	Skilled CPR	30% 29-32, 36, 58
Burns	Airway clearance	5% 19, 27
Non-Accidental Injury		0% 66
Sudden Infant Death Syndrome (SIDS)		0% 23
Electrocution, suffocation		3% 19
Accidental poisoning		0% 22

Table 4: An estimate of the percentage of extra children salvaged, by improved accident-site Basic and Advanced Life Support, if lay first responders are trained in first aid.

How can these potential improvements be translated into practice? How can motivation or legislative requirements for CPR be improved? Two obvious suggestions are (a) current first aid certificates should be a requirement for the issue of all new driving licences, and (b) a current first aid certificate should be held by all owners of swimming pools. Such requirements have long been suggested,³⁶⁻³⁹ but one maintains an unapologetic advocacy concerning their desirability. The young heart is a great substrate for CPR. In the case of neonates who have suffered a cardiac arrest precipitated by an acute and reversible event, 64% will survive CPR to leave hospital.¹¹ Our analyses as part of the Brisbane Trauma Study suggest that the corresponding figure for infants and older children exceeds 35%, and that more than 95% of these will have intact brains.

Seven of the last ten of Australia's international operational deployments have involved humanitarian health care of indigenous children in Africa, Asia and Papua New Guinea. All servicemen and women - not just military doctors, dentists, nurses and medics - need to be skilled in paediatric CPR, just as they are in adult life support skills.

Pre-Emptive Action - Early Recognition of Symptoms

Cardiopulmonary resuscitation will be inevitable for many potential adult victims of cardiac arrest. One way of improving the success of CPR is to delay those factors that precipitate its necessity from out-of-hospital sites to a place where skilled techniques with on site defibrillation are available. This apparently cold-blooded, but realistic approach means better education of the public about premonitory signs and symptoms of diseases that will progress to cardiac arrest. Dr Ian Banks, chair of the [U.K.] Men's Health Forum, notes that: -

"Survival figures from heart attack could be trebled if people knew how to recognise the symptoms and act appropriately... heart attacks are not always dramatic events and the early symptoms often go unrecognised or are explained away as indigestion or tired ness".⁴⁰

The [UK] Doctor Patient Partnership has joined forces with the Men's Health Forum and the British Heart Foundation to launch the campaign entitled "Chest Pain: What men should know". Clinical details in lay-friendly language have been placed in the Angling Times and in the programmes of four premiership football games. Currently, on-site defibrillation teams of St John Ambulance Australia personnel who support the public at the Australian Football League (AFL) in Melbourne have highlighted the particular risks of football-crowd excitement to the cardiac arrest-prone group. Successful resuscitation rates for VF, exceeding 45%, have been achieved and long-term survival follow-up rates are awaited with great interest.

A similar approach - first aid training to promote the earlier recognition of symptoms before out-of-hospital cardiac arrest occurs - offers a hope of reducing the need for CPR, and of increasing post-CPR survival rates for children with cardiac complication of bacteraemic shock. First aid classes offer an important portal of teaching about the natural history of serious illness in all age groups. Currently, in-hospital CPR success rates for children who sustain cardiac arrest in bacteraemic shock remain close to zero.

High Risk Adult Patients

One obvious stratagem to ensure that first responders are trained in CPR is to target the families of high-risk patients. Although such seems obvious,⁴¹ in practice the students in first aid classes tend to be younger adults or those in the occupational work force. Training needs to be targeted to those who are most likely to be bystanders at a cardiopulmonary arrest.⁴²

A good place to start is with doctors themselves, whose relatively poor performance of CPR skills has been described in several studies.⁴³ General medical practitioners and hospital doctors are frequently called upon to perform CPR, usually on patients in the GP's surgery, during therapy sessions or sometimes in X-ray departments.⁴⁴ The initial survival rates from such are high,⁴³ a testament to the value of early bystander CPR, a factor independent of quality reperfusion of the hypoxic brain and heart.

One area where high-risk patients occur in a closed environment is that of international air travel. In-flight and in-terminal incidents requiring first aid are not uncommon.⁴⁵ In 1995, 1.5 billion passengers flew on the world's commercial airlines; and of these four million suffered sudden illness or were injured and required first aid.⁴⁶ The number of air passengers is expected to double by 2005.⁴⁶ Currently, 1,000 lives are lost annually, in-flight, from cardiac arrest on the world's commercial aircraft.⁴⁷ Until Qantas' pioneering use of in-flight semiautomatic defibrillation,⁴⁸ most US and Australian carriers diverted to the nearest airport after in-flight cardiac arrest. In spite of this (expensive, disruptive but altruistic) policy, no passenger survived asystole or idioventricular rhythm (IVR). Within five years of the introduction of in-flight semiautomatic defibrillators (with flight attendants trained in their use) by Qantas in August 1992, the monitoring defibrillator had been used in 46 cases of cardiac arrest which had occurred in-flight or at an airline terminal. Twenty-three of these had VF, and of these 6 (26%) have

been long term survivors.⁴⁸ My personal experience with St John Ambulance Australia courses for defibrillation is that a major benefit is the window-of-opportunity which is opened to reskill the drills of airway clearance, expired air resuscitation (EAR) and external cardiac compression (ECC). Military personnel in uniform, travelling in the air, have an inescapable duty to help with in-flight emergencies.

Matching potential patients together with potential resuscitators, the latter equipped with automatic defibrillators, is a challenge to all charged with the community training of CPR. The St John Ambulance Australia programme, "Every Parent a First Aider", exemplifies this point.⁴⁹⁻⁵¹ The most obvious group for targeting for improved CPR training comprise the partners of older subjects who are at high-risk for cardiac arrest. Research has shown, however, that motivation to learn CPR skills is not naturally or spontaneously high in this group of "at-risk relatives".⁴¹ This is probably because of ego defence mechanisms of denial of the potential risk of death in a loved one, or for aesthetic reasons, or perhaps because of a fear of potential failure should one's skills be insufficient to save the life of a loved one. Whatever are the reasons, the potential matching of high-probability resuscitators with their CPR instructors remains an unmet challenge the contemporary Australian community.

Elitism and CPR

There is an attitude abroad that the drills and skills of CPR are somehow the province of the medical domain, rather than being a skill of equal validity and status for every citizen; and for every serviceman and woman. Such an attitude also exists in some groups within the Defence forces. Studies have demonstrated consistently that it does not matter who administers CPR.^{12,47,52,53} Paramedics achieve the same or better survival results when compared with doctors, and trained fireman and police have the same success rates as ambulance officers. In doctor-lifesaver teams on the Australian beach, trained surf life savers act with equal validity as the principal with the doctor as assistant.⁵³

In the Brisbane Drowning Study one-third of rescuers were older children;^{29-31,33} and in two instances in which I was professionally involved, it was pre-adolescent sibs who had been coincidentally trained in Royal Life Saving Association classes at school, who unquestionably successfully resuscitated apnoeic and pulseless victims whom they had pulled from the water. The need for CPR training in secondary schools, long advocated,^{30,54} remains the exception rather than the rule. An exception are the splendid rescue and resuscitation training programmes conducted by the Royal Life Saving Society of Australia. Video and multi-media self-training CPR programmes have the potential to reach some individuals unlikely to participate in traditional classes.⁵⁵ Peter Safar, the founder of expired air CPR in 1958, has noted 40 years later that it is the motivation and skill acquisition of all members of the public which has the current highest priority - higher even than some of the minutiae of the hands-on CPR techniques themselves.⁵⁶

Prevention

In one sense, the need for CPR is a failure - a failure of preventative approaches. In that CPR offers a second chance for life itself, it offers afresh a second chance of effective prevention. This applies as equally to the potential victims of myocardial infarction as it does to the apparently drowned child pulled from a back garden swimming pool. In the context of severe trauma there are three portals for primary prevention:

- education and public media campaigns;³⁷
- better ergonomic design to reduce potentially fatal hazards in the environment;³⁶ and safety legislation.⁵⁷

First aid and improved systems of pre hospital care are a fourth portal of prevention. Such is secondary prevention; and from the purist point of view of public health, in one sense such attempt to shut the stable door on death after the spark of life has all but bolted.

If one takes childhood drowning as an example, we have been able to identify 16 potential links in the drowning chain of any individual child.³⁵ Such start with a toddler wandering into the vicinity of an unprotected water hazard and end with a non-responding hypoxic heart in asystole in the emergency room of the local hospital. This

"hypoxic march" can be reversed at any step between the moment of voluntary breath-holding to the final point of irreversible hypoxic brain damage.³⁰ Effective and timely bystander operated CPR does not prevent the drowning episode in the first place; but, from the victim's point of view, recovery with an intact brain is all that matters. If this is achieved through secondary prevention – good CPR - then that is all that matters.

Preventive First Aid

CPR as secondary prevention of death or hypoxic brain damage is a concept distinct from that of preventive first aid. This latter term,⁵⁹ first coined in 1989,⁶⁰ has as its fundamental ethos the philosophy that a component of all CPR and first aid courses should contain an explicit, preventative module. There are as yet no reported studies to show the preventive effectiveness of CPR courses that would withstand the audit of the contemporary demands of evidence-based medicine. However, experience of injury reduction following saturation first aid courses in the mining industry in Tasmania and in the timber industry in Canada are very encouraging indeed in this regard. Many volunteers who attend courses of first aid are by their nature caring and concerned individuals who have already recognised the risks; and are by nature just the sort of person who will take steps to reduce hazards which might lead to the necessity for CPR. In other words, there may not be a direct cause-and-effect relationship between CPR training and subsequent reduced rates of illness and injury. Much research needs to be undertaken in this area. Currently, Rotary International in Australia is promoting a triennium of research that will offer an opportunity to study further the preventive power of CPR. That body, together with the 16 organisations which comprise the Australian Resuscitation Council,⁶¹ do much to reduce the need for CPR in the first place. The Australian Defence Force is one of these component organisations which acknowledges that life-support skills, when needed, respect no rank, corps, posting or status. For those who are confronted with an apnoeic or pulseless casualty, skilled resuscitation offers the wondrous opportunity of reigniting the spark on which we all depend.

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