Civilian Legacies of Army Health

John Pearn

WARFARE, OR THE THREAT OF WAR, HAS BEEN THE CATALYST FOR MANY of the greatest advances in medicine. This uncomfortable paradox engenders different emotions in different people.[1] It produces despair in the humanist, perplexity in the ethicist and irony in the pragmatist. To some students of history it engenders hope: the belief that a deeper understanding of the futility of aggressive conflict may reduce the risk of war in the future; and that an analysis of the consequences of conflict may lead to ways in which its benefits can be achieved by other means.

A historical audit of warfare assesses both its credits and debits. To many, the immediate debits of armed conflict are self-evident, especially for the vanquished. However, for both victor and vanquished, any twenty-first century audit must include such long-term legacies as post-traumatic stress disorder (PTSD),[2] intergenerational psychopathology and life-long disasters ranging from the loss of international moral credibility, when the Laws of War are violated,[3] to personal and community tragedies such as the recruitment and use of child soldiers.[4] On the credit side of the ledger, specifically in the medical context, I have chosen to classify the beneficial civilian legacies of war into two groups. The first encompasses specific technical advances, many of which would have accrued independently in the inexorable progress of science but were undoubtedly hastened by the exigencies of war and the survival demands of national security. The second comprises what I have called 'health system advances'æparadigm shifts in the way civilian society is ordered and organisedæwhich have been engendered by armed conflict or its threat.

The subject of the beneficial civilian legacies of armed conflict is not new. In 1878, the British Surgeon-General, Sir George Evatt, wrote that the congruence of Mars and Salus, the god of war and the goddess of health, has resulted in: 'a powerful unification… the combining of the learning and skill of the physician with the organisation, the discipline and the order of the soldier'.[5] This theme has been touched upon in the clinical context of Australian medicine with the publication in the first half of the twentieth century of a range of essays bearing titles such as: 'On the Interaction between the War, the Profession of Medicine and the Practitioner';[6] 'What Medicine Owes to War and War Owes

to Medicine';[7] 'Some Debts of Medicine to the Fighting Services';[8] and 'The Impact of Two World Wars on Medicine in Australia'.[9] In this current analysis I have adopted both an Australian and an international perspective, and looked beyond clinical medicine to the broader health impacts of war, with examples of benefit to the general community.

Technical advances—medicine

There have been an enormous number of technical advances in medicine engendered by the exigencies of war. Many of these developments have in fact been re-active to the ballistic advances in the killing power of projectiles, an irony which nevertheless has had some beneficial legacy in the civilian management of high-energy wounding in our society's all too frequent road trauma and industrial accidents. For example, in 1841 gunsmiths began to rifle or groove the barrels of muskets, a development which in combination with expansive bullets greatly increased the accuracy, range and tissue-destructive power of pistols and rifles.[10] Early lessons were learnt particularly from the American Civil War (1861–65), in which more than 60,000 amputations were performed with 45,000 victims surviving the surgery.[11]

Medical science

The first medical research undertaken on Australian soil was a series of experiments to test different factors which might modify muscle strength. These hypothesis-testing studies were undertaken by a French ship's surgeon and former soldier, François Peron.[12] Born in Cerally, France (1775–1810), Peron enlisted as a young soldier, was wounded in battle at the age of eighteen and was subsequently taken prisoner by the Prussians in the Franco–Prussian War. He then studied medicine at the École de Medécine in Paris and joined Baudin on the *Le Geographe* and *Le Naturaliste* expedition that left Le Havre in 1800. Peron carried with him a Regnier dynamometer and studied the effects of climate, race and diet on human strength.[13] His first recorded measurements were undertaken on Maria Island off the east coast of Tasmania in 1801. The results from those studies, the first hypothesis-testing medical research undertaken in Australia, were published posthumously in 1816.[14]

During the expedition, Peron and the crews from the two French corvettes *Le Geographe* and *Le Naturaliste* were stricken by scurvy. Following much loss of life, they somehow managed to make it to Sydney Cove in 1802, where Peron recorded that 'our scientific

researches received the most valuable encouragement'.[15] While he was in Sydney, Peron, with his training in preventive medicine and military hygiene, wrote about dysentery in ships' crews—*une catastrophe terrible*—about naval hygiene while the ships were in port and about what were, in effect, controlled brothels in Sydney town in which the prostitutes were regularly inspected.[16] Unfortunately, Peron contracted pulmonary tuberculosis, 'the shipmate of naval surgeons everywhere', and returned to Paris where he worked on the description and classification of the zoological and botanical specimens he had collected on the Australian voyage. He died at he age of thirty-five. The epitaph on his headstone read, in part: 'He had great talents, yet had many friends'.[17]

Australia's greatest military–civilian legacy

Undoubtedly, the greatest civilian legacy of Australian army medicine is that of malaria prophylaxis and treatment. Following the Japanese attack on Pearl Harbour on 7 December 1941, the Pacific nations were engulfed in a war fought in tropical jungles and under conditions where malaria was (and remains) universal. After the initial Japanese assault on Rabaul, death and incapacitating morbidity due to malaria afflicted almost all of the Allied troops.[18] Epidemic malaria left Australian soldiers at Milne Bay, and those (especially the 39th Militia Battalion) who had been victorious at the battlefields of both Gona in December 1942 and later at Buna, completely debilitated. Clinical rates of malaria rose to 2.9 attacks per soldier per year.

To combat this threat, in June 1943 the Australian Wartime Government established the Land Headquarters Medical Research Unit (AIF) based at No. 5 Camp Hospital in Sheridan Street, on the northern outskirts of Cairns. This 'splendid experimental group'[19] was led by Colonel (later Brigadier Sir) Neil Hamilton Fairley, Lt Colonel Ian Mackerras and Major Josephine Mackerras, and the latter's team of young soldier–scientists including Captain F. H. S. Roberts and Lieutenants T. H. Lemerle and Q. N. Ercole.[20] Essentially a malaria research unit,[21] this team of doctors, scientists, nurses and 1000 volunteer soldiers generated the scientific knowledge that would finally conquer the scourge of malaria in the military context. Its civilian legacies were to guide the (ultimately unsuccessful) massive World Health Organization's Malaria Eradication Programme of 1962–65.[22]

The significance of the Medical Research Unit's work is perhaps most simply illustrated by a statistic from the New Guinea Campaign. During 1942, the 2/22 Battalion had been decimated by malaria. However, after the army's research which led to the introduction of the anti-malarial drug Atebrin, by June 1945 all battalions of the 6th Australian

Infantry Brigade had weekly malaria rates of less than one case per 1000 troops—even after twenty-one months of continuous operational service.[23] In this latter context, the Medical Research Unit was a crucial link, perhaps the crucial link, in the chain of laboratory and clinical researchers who achieved ultimate success in the control of malaria among Allied troops in the Pacific War. Military historians, in turn, acknowledge this as one of the most significant determinants of the eventual Allied victory in the Pacific.[24]

At the time (1991) of the fiftieth anniversary of the onset of the Pacific War, Professor Frank Fenner, one of Australia's greatest scientists, wrote about the significance of the Medical Research Unit's contributions to military medicine:

> Their results were of great importance to the Australian war effort, since they established a scientific basis for chemoprophylaxis that was eventually to transform into a minor problem what had threatened to be a disease that would totally disable the Australian and United States forces in the field in New Guinea.[25]

The civilian legacies from that research have been immense. Not only were crucial stages in the life-cycle of the *Anopheles* mosquito delineated, but systems for the prevention of malaria—one of the greatest scourges of humankind—were set in place. The principles of malaria prophylaxis, discovered by those clinical and laboratory Australian Army scientists, remain unchanged today.

Health system advances

The exigencies of war have led to improvements in the system by which health is delivered within civilian society. The first and classic example is that of the role of Sir John Pringle (1707–82). In 1742, Pringle was appointed as the physician to the Earl of Stair, the then Commander of the British Army in Europe. His reputation as an outstanding clinician was such that in 1749 he was made physician to the Duke of Cumberland, and in 1774 appointed personal physician to King George III. Pringle followed Sir Joseph Banks as president of The Royal Society, and in that capacity was executive-in-charge of Captain James Cook's 3rd Expedition on HMS *Resolution* in Antarctic and South–Pacific waters. In 1752, Pringle published his broad concepts for the promotion of health in the British Army, in his classic paper entitled *Observations on the Diseases of the Army*.[26] He wrote extensively about various forms of gastroenteritis and dysentery, and appreciated that one of the great epidemic killers of wartime, 'Trench Fever',

was the same disease as the civilian 'Hospital Fever' and 'Jayl Fever'. He was also the first person to coin the term 'influenza'. It was Sir John Pringle who advanced the formal rules for the concept of camp hygiene in military camps, advocating proper drainage, adequate latrines and the avoidance of siting military encampments near the 'pestilence of marshes'. In this context, he was the founder of civilian public health and preventive medicine as that term is understood today.[27]

As great as Pringle's medical contributions were, however, none was greater than the role he played in ensuring that medical hospitals came to be recognised as sanctuaries that needed to be protected by combatants on both sides in the event of armed conflict. It was his advocacy of this that led, within a century of his death, to the further development of Henri Dunant's concepts of the founding of the Red Cross and the Geneva Conventions which followed.

Medical implications of the Geneva Conventions

It has been said that

> we can divide the history of Mankind into two era[s]: the period preceding the first Geneva Convention (August 1864) and the one following it. From that date onwards, men became a little less animal-like…[28]

At Solferino on 24 June 1859, Red Cross founder Henri Dunant witnessed one of the crudest, bloodiest and most cruel battles of the nineteenth century. Over fifteen hours from 6 a.m., more than 300,000 men fought on a fifteen-kilometre front until the soldiers of Vittorio Emanuele II crushed the 8th Corps of the Austro–Hungarian Army. The battle consisted of artillery barrages, cavalry–cavalry and cavalry–footsoldier combat, bayonet attacks and gratuitous atrocities.[29] The cost of victory was 40,000 dead on the field and another 30,000 severely wounded. Dunant was a faithful chronicler of that carnage. In his *Souvenir de Solferino*, he described how the surgeons of many nations came together, to treat the survivors in the churches, shelters, cottages and barns of the region. They

> cared little for the titles or the glories of war, but those who were able often at the peril of their own lives, worked indefatigably, and merited great esteem for their help and skill.[30]

Dunant's concept that the soldier when injured and *hors de combat* 'is no longer a combatant… but simply a human being in need of medical assistance and loving care'[31] was an epoch-making statement. Both

its specific principles and the more general ethical concepts it espoused have had the greatest influence in defining ethical principles for the practice of medicine since that time.[32]

Triage and hospital care

In the last decade of the eighteenth century, the French military surgeon and surgeon-general Baron Dominique Larrey (1766–1842) developed a system of battlefield casualty evacuation using 'flying ambulances' (*ambulances volantes*).[33] Soldiers wounded in battle were brought to a sheltered collection point, often at dusk, where they were then protected not only from the elements but also from the usual plundering and murder by local villagers. With the French and allied military surgeons thus confronted with large numbers of living trauma victims—some salvageable, some not—Larrey developed a system of priority sortage, which he named after the French verb *trier*, to grade or sort. (It is believed that this word had its origins in the tropical French colonies where coffee was grown, with the implication that *triager* meant the sorting or grading of coffee beans.)

Between 1790 and 1812, Baron Larrey formalised this trauma classification system:

> [E]lse much confusion would have ensued, had I not pursued the order of dressing and arrangements observed by me in all battles… those who are most dangerously wounded must be tended first, entirely without regard to rank or distinction.

Larrey's system of 'methodical succour', and the altruistic ranking of patients 'without regard to rank or distinction', thus holds a special historical place not only in the history of casualty evacuation and of civilian disaster medicine, but also in the evolution of the Laws of War. Triage remains a centrepiece of military emergency medical planning, training, rehearsal and real-life practice. For example, following the most severe Scud missile attack on Al-Khobar in Saudi Arabia during the Gulf War, military triage surgeons reported:

> Our experience confirmed the importance of the principles of planning triage beforehand and open wound treatment with secondary suture. Repeated war rounds [with sequential triage] with reassessment of patients proved beneficial. The ready availability of hospital beds in high-risk situations of regional war highly facilitated the management of mass casualties.[34]

In civilian practice, mass casualty scenes are ones in which despair, desolation, hazardous materials and often snow, ice, fire or earthquake aftershocks are present.[35] The norm for civilian triage is thus one of significant on-site physical difficulty and danger. In this respect, civilian and military triage share many cognate themes. The special case of terrorist bombings or bio-terrorist threats brings with it a further risk to rescuers and medical staff alike. The type of triage practised under these circumstances is such that lessons learned from the history of tending to military casualties are congruent with those of civilian accident-site control.

The use of rotary wing aircraft to evacuate casualties rapidly from the battlefield had its origin in the United States MASH (Mobile Army Surgical Hospital) units in the Korean War, from 1952. Under battlefield conditions of air superiority, this tactical, aeromedical casevac was extensively developed in the Vietnam War (1961–73). Its widespread use meant that gravely wounded service personnel delivered to the triage units of the US and Australian medical units (the latter at the Vampire Landing Zone, Vung Tau) were still salvageable some thirty to sixty minutes after being wounded. At the Vampire helipad run by 2 Australian Field Ambulance in Phuoc Tuy Province in South Vietnam in 1966, for example, no soldier who was still alive at the time of arrival, following hot battlefield extraction, subsequently died from wounds in that unit. Military triage had thus developed to a further stage of sophistication.

The manifest success of military triage led to its adoption by civilian hospitals, especially major civilian trauma centres, from that time. Its adoption was welcomed and developed by many of those reservists, who had been specialists in military medical units receiving multiple severely injured soldiers, when they returned to senior clinical and administrative positions in major civilian hospitals after the war. By 1970, the majority of large Australian civilian hospitals had adopted the drills and skills of military triage, albeit in a modified form to suit local conditions and the availability of civilian emergency resources.

Triage is a non-discretionary duty thrust on the first responders to multi-casualty disasters. The process of triage passes progressively to more senior clinicians or officials as they arrive at the disaster scene. The personal, ethical, moral and clinical pressures are great, and involve not only questions of relative clinical urgency. Those performing the triage are also subject to inescapable pressures of importunity and insistence from others involved in rescue, retrieval or transportation, from by-standers and sometimes from relatives. Civilian triage, with its origins in warfare and the medical response to battlefield carnage, has these extra demands. Nevertheless, when conducted with professionalism and courage, triage produces ‘civilian winners who are the [oth-

erwise non-salvageable] survivors, particularly survivors with intact brains and salvaged limbs'.[36]

First aid and pre-hospital care

The civilian disciplines of ambulance first aid skills, pre-hospital care and paramedic specialty skills had their origins in battlefield first aid. Formal first aid can be traced back to techniques as diverse as the barrel-rolling methods employed to resuscitate the near-drowned in the Royal Navy, and the fracture-stabilisation taught by the Prussian military surgeon von Esmarch.[37] Johan Friedrich August von Esmarch (1823–1908) was one of the first to develop a formal doctrine for the on-site treatment of battlefield casualties, whereby first aid was administered by the victims themselves or their fellow soldiers. He also came up with the concept of the triangular bandage, a bandage of unbleached calico with a base approximately 40 cms in length, which would be carried by every soldier and used as a multi-purpose dressing, bandage, ligature or splint-stabiliser. Von Esmarch's system was greatly developed in 1870 during the Franco–Prussian War. It was also von Esmarch who first coined the term 'Erste Hilfer' or 'first treatment'. The English term 'first aid' came into use in 1878, the result of combining 'first treatment' with 'national aid'.[38]

First aid and the skills of pre-hospital care, which are today universal in the civilian world, have their origins in the work of two nineteenth-century British military officers—Surgeon Major Peter Shepherd and Major Francis Duncan—based at the Woolwich Arsenal on the south bank of the Thames in London. Shepherd (1841–79) graduated from Aberdeen University in 1864 and joined the Army Medical Department. There he served with a number of other old Abderdonians, one of whom was to become a pioneer in modern battlefield surgery, Sir James Cantlie, FRCS. As the garrison surgeons, Shepherd and Duncan developed the (then) heretical concept of teaching the skills of military stretcher bearers to voluntary members of the lay public.[39] Shepherd had first taught what was later to be called 'first aid' when he had served as an Assistant Surgeon to the 99th (Lanarkshire) Regiment, on service performing garrison duties in 1866 near Grahamstown, South Africa.

On 10 January 1878, *The Kentish Independent*, a local London newspaper, informed its readers that on the previous Saturday night a public meeting had been held at the Presbyterian Schools, New Road, Woolwich, for the purpose of establishing classes to be held by the St John Ambulance Association 'for the gratuitous impartation of instruction in the treatment of injured persons'. The detailed syllabus

of that first civilian first aid course was developed by military surgeon Major Falwasser, who was based at London's Chelsea Barracks, with Shepherd teaching the classes. The initial decision to offer first aid training to members of the general public was taken with some trepidation. Matters of propriety, particularly in the context of the Presbyterian hall where the first classes were to be taught, were all important and classes were segregated by gender. Shepherd proposed that the volunteer students, all adult members from the local Woolwich community, would be

> taught about the circulation of the blood; the position of the principal arteries; how to stop haemorrhaging; a knowledge of the long framework of the body and the injuries bones were liable to; the relative position of the internal organs such as the heart, lungs and liver; a knowledge of sicknesses daily met with such as fainting, epilepsy and drunkenness; and the means of removing the sick and wounded by stretchers and wheeled vehicles.[40]

Shepherd's philosophy was that the proposed courses

> would be entirely practical, and it was intended that those who were present at accidents would be able to render immediate assistance in cases which directly or indirectly might become fatal before a surgeon could arrive.[41]

Soon after Shepherd helped establish those first civilian first aid classes in London, he received a posting to Natal in South Africa (August 1978), where he was a member of the Zululand invasion force under Lord Chelmsford. Before he left London, Shepherd gave his colleague Dr Mitchell Bruce an unpublished manuscript entitled 'Handbook Describing Aids for Cases of Injuries or Sudden Illness'. It had as a subtitle 'Pro Utilitate Hominum'. Surgeon Major Shepherd never returned from South Africa. As principal medical officer with Chelmsford's Third Column, he was caught up in the massacre at Isandhlwana on 22 January 1879, when a huge Zulu *impi* of some 20,000 routed and massacred the 1700 members of the British force. Shepherd, as the surgeon based at his regimental outpost, had remained in his camp; but as the survivors attempted to flee the massacre he went to the aid of a stricken soldier and was himself cut to pieces.[42]

It transpired that as Shepherd had voyaged with his unit to South Africa in 1878, on board the *Conway Castle*, he had written a pocket-sized *aide memoire* to be used as a first aid text for the troops. This small work contained instructions for the stopping of haemorrhaging, how to splint broken bones and notes on stretcher drill. It also instructed soldiers how to cope with such conditions as: 'Ague, Apoplexy, Bites

by snakes and mad dogs, Burns, Colic and diarrhoea, Dysentery, Drunkenness, Delirium Tremens, Drownings, Emetics and Fainting'.[43] Shepherd never lived to see the outreach of his work. Within a year of his death, 100,000 Certificates for First Aid had been awarded by the St John Ambulance Association. Within a decade, a million St John certificates had been issued in centres as far afield as Barbados in the Caribbean, Dunedin in New Zealand and Brisbane, Australia.[44] Today, in developed nations such as the United States, Canada, New Zealand, Australia and the European Union one in every thirty civilians possesses a current first aid certificate.[45]

Logical and self-evident as the tenets of first aid are, audits of its success rates indicate that progress has been modest at best. Following coronary occlusion, even with best-practice first aid delivered in the context of witnessed cardiac arrests, the survival rate does not exceed 10 per cent. When such first aid skills are supplemented by on-site defibrillation, there is evidence to indicate that salvage ratesæmeasured in the terms of discharge from hospital with an intact brainæmay rise to 40 per cent.[46] The big challenge for both civilian and military authorities is to promote the concept that first aid is a necessary skill for all, irrespective of rank or position; and that with the provision of simple and reliable equipment many lives can be saved. Research indicates that when first aid is required, in more than 60 per cent of cases the person administering it is a partner, parent, child, workmate or fellow team member of the sick or injured victim. In the military world, when first aid is required, if possible, it should be given by a 'buddy'. Such was von Esmarch's original concept when he developed the simple universal calico bandage to be carried by all soldiers. If needed, it was to be applied by anyone on site, irrespective of occupation or rank.

Blood transfusion outreach

Blood transfusion became a practical possibility in 1901 after Carl Landsteiner's discovery, in Austria, of the ABO blood groups. In 1914, the anticoagulant sodium citrate was found to prevent freshly drawn blood from clotting, a discovery that ushered in the potential for indirect blood transfusions.[47] Blood was occasionally transfused during World War I, with battlefield transfusions undertaken directly, person-to-person, from a donor's vein via a hand-activated rotary pump to the vein of the recipient. The stimulus of war surgery led to much experimentation, as a driven necessity, of the storage potential of blood.[48] The 'continuous drip method', by which stored blood was collected and then transfused into a recipient under gravity flow, was not introduced until 1935 at the Middlesex Hospital in London.

War surgery experience gained by both expatriate and Spanish surgeons in the Spanish Civil War of 1936–39 led to the establishment of the first blood transfusion service. The classic paper of Duran-Jorda entitled 'Blood Transfusion at the Front' marked a milestone in the history of war surgery.[49] Following this, the first civilian blood banks were established in 1937 at Cook County Hospital in Chicago[50] in Britain from 1938[51] and in Melbourne later that year.[52] The rate of transfusion reactions remained relatively high, however, both in the civilian and the military domains. It was not until 1940, and the discovery of the Rhesus blood group complex,[53] that blood transfusion became the safe procedure it is today.

Blood transfusion units were established within the British Army at the outbreak of World War II in September 1939, and in Australian and American military units in the South-West Pacific theatre of operations following the Japanese attack on Pearl Harbour. In late 1939, Major Noel Gutteridge, AAMC chaired a committee that led to the establishment of the Red Cross Blood Transfusion Service in Queensland. In December 1942, Captain Eric Shaw, AAMC was appointed as pathologist to the Australian 110 General Hospital based in Perth, where he became heavily involved in blood transfusion work. Knowledge about the importance of colloidal osmotic pressure, as measured by plasma proteins, and the significance of the assessment and treatment of patients needing massive transfusions dated from that time. Captain George Kelsall, a director of the West Australian Red Cross Blood Transfusion Service, was associated with the Australian 110 General Hospital from 1943. On 18 December 1945, the collaboration between Shaw and Kelsall would lead to the first exsanguination transfusion in Australia, and one of the first in the world, for Rhesus incompatibility.[54] This technique of total blood replacement of kernicteric neonates remains the treatment for severe neonatal hyperbilirubinaemia today.

War-time so often brings together experts who would otherwise never have met, with the exigencies of war transporting specialists 'to the right place at the right time'. Another pioneering 'first' occurred in Mareeba Hospital in northern Queensland in 1942, where one of the first successful 'top up' transfusions for haemolytic disease of the new-born was performed by Captain Frederick Silverman, a young US Army paediatrician. Silverman had graduated in medicine prior to the outbreak of World War II. He decided on a career in paediatrics and was in the third year of his speciality training when the bombing of Pearl Harbour took place. At the time of this attack, he was in the second half of his Paediatric Pathology Fellowship at the New York Babies' Hospital.

In March 1941, Levine *et al.* had published their milestone paper 'Isoimmunization in Pregnancy; Its possible bearing on the etiology of erythroblastosis foetalis'.[55] Silverman, working with neonates in New York at the time of Levine's research, was familiar with this new theory. Later as an army captain, Silverman was posted to No. 2 Station Hospital, a small medical unit of four doctors and twelve enlisted men attached to the 19 Bomb Group. This was the US Air Force unit of B-17 Bombers that had carried General Douglas MacArthur to Australia from the Philippines. By July 1942, this small US medical unit was operating in Mareeba in tropical north Queensland. It was at Mareeba that Fred Silverman was called to see an infant dying from haemolytic disease of the new-born: 'We were asked to see another one of those yellow babies before it died'. From his close association with Levine's work in the United States, and his work in paediatrics, Silverman knew that he was Group 'O rhesus negative'. Thus, he arranged for his blood to be taken and given as a transfusion into the scalp vein of the infant, who did very well after that pioneering 'top up' transfusion. The first case of using the umbilical vein, as the access route for 'top up' transfusions for babies with haemolytic disease of the newborn, was not undertaken until 1944 and its results not published until 1946.[56]

After the discoveries in 1914 of the means to group (ABO) and anticoagulate blood,[57] the demands of twentieth-century warfare greatly accelerated the science of blood transfusion. It required a further three decades, and the 1940 discovery of the Rhesus blood group, for blood transfusion to be safe. The ingenuity of the doctors caring for Allied prisoners of war on the Burma–Thailand Railway (1942–45) rapidly showed the robustness of blood transfusion in the field, even under conditions of appalling privation. Doctors working in the prisoners-of-war hospitals at Chungkai and Makom Patom used defibrinated blood, which was harvested, treated and re-transfused using ingeniously improvised equipment including the most primitive of preciously conserved reusable needles.[58] Thus, does the cycle of military–civilian–military invention roll on.

Armed conflict brings out both the best and the worst in men and women, societies and nations, while the exigencies of war and training for war focus the inventive mind. This selective audit of history reveals that such a focus may be addressed to bench-top problems of basic medical research, or to implement systems that reduce mortality among the sick, injured and wounded. Most significantly, when all attempts at peace have failed and nations are locked in combat, there yet remain the examples of history where higher levels of altruistic human thought and behaviour are no longer a hope but a reality.

University of Queensland

1. J. H. Pearn & W. Ramsey, 'Between Two Camps: An analysis of some themes of medical ethics inescapable for those who practise in the dual professions of medicine and of arms', *Revue Internationale des Services de Sante des Forces Armées*, vol. 73, 2000, pp. 148–52.
2. J. H. Pearn, 'Traumatic Stress Disorders: A classification with implications for prevention and management', *Military Medicine*, vol. 165, no. 6, 2000, pp. 434–40.
3. J. H. Pearn, 'The Geneva Conventions and Military Service', *Paulatim [Journal of the Royal Australian Army Medical Corps],* vol. 1, 1997, pp. 9–13.
4. J. H. Pearn, 'Children and War', *Journal of Paediatrics and Child Health*, vol. 39, 2003, pp. 166–72.
5. Surgeon-General Sir George Evatt, Army Medical Organisation, unpub. treatise (1878) held in Muniment Room, Royal Army Medical College, Millbank, London [unpag].
6. R. S. Skirving, 'On the Interaction between the War, the Profession of Medicine, and the Practitioner', *Medical Journal of Australia*, vol. 2, 1919, pp. 547–51.
7. R. M. Downes, 'What Medicine Owes to War and War Owes to Medicine', *Medical Journal of Australia*, vol. 1, 1936, pp. 73–80.
8. S. F. McDonald, 'Some Debts of Medicine to the Fighting Services', *Medical Journal of Australia*, 2, 1940, pp. 589–95.
9. A. S. Walker, 'The Impact of Two World Wars on Medicine in Australia', *Medical Journal of Australia*, vol. 1, 1951, pp. 32–5. Dr Allan Walker (d.1958) was the Australian medical war historian in World War II.
10. J. Figg & J. Farrell-Beck, 'Amputation in the Civil War: Physical and social dimensions', *Journal of History Medicine and Allied Sciences*, vol. 48, 1993, pp. 454–62.
11. Kate Cummings, *Hospital Life in the Confederate Army of the Tennessee*, John P. Morton, Louisville, Kentucky, 1866, p. 20.
12. J. H. Pearn, 'Ring the Bell and Win a Cigar. Some early experiments on the measurement of human strength in Port Jackson and Van Diemen's Land', *Medical Journal of Australia* vol. 2, 1978, pp. 167–9.
13. J. H. Pearn, 'French Doctors at Sydney Cove. Gallic contact in the second decade after Phillip', in J. Pearn & C. O'Carrigan (eds), *Australia's Quest for Colonial Health*, Amphion Press, Brisbane, 1982, Chap 5, pp. 45–62.
14. Pearn, 'Ring the Bell and Win a Cigar…'.
15. Pearn, 'French Doctors at Sydney Cove…'.
16. ibid.; and also Pearn, 'Ring the Bell and Win a Cigar…'..
17. Pearn, 'French Doctors at Sydney Cove…'.
18. Tony Sweeney, *Malaria Frontline, Australian Army Research during World War II*, Melbourne University Press, Melbourne, 2003, pp. 5–7.
19. E. Ford, 'Mabel Josephine Mackerras [Obituary]', *Medical Journal of Australia*, vol. 1, 1972, pp. 604–06.
20. M. Spencer, 'Malaria and the Land Headquarters Medical Research Unit, 1943–1946', *Medical Journal of Australia*, vol. 161, 1994, pp. 78–80.
21. Frank Fenner, 'Malaria' in J. Pearn & L. Powell (eds), *The Bancroft Tradition*, Amphion Press, Brisbane, 1991, pp. 57–9.
22. J. Pearn, *The Global Eradication of Disease*, Amphion Press, Brisbane, 1999, pp. 8–10.
23. Sweeney, *Malaria Frontline*, p. 245.
24. ibid., pp. 5–7.
25. Fenner, 'Malaria'.
26. J. H. Pearn, 'Sir John Pringle MD, PRS (1707–1782)', in *A Doctor in the Garden: Australian Flora and the World of Medicine*, Amphion Press, Brisbane, 2001, pp. 308–10.
27. ibid.
28. P. Vanni, R. Ottaviani, E. Guerin, D. Vanni, Henry Durant & Norman Bethune, *Vesalius—Acta Internationales Historiae Medicina*, vol. 8, 2002, pp. 30–5.
29. ibid.
30. Henri Dunant, *Un Souvenir de Solferino*, International Committee of the Red Cross, Geneva, 1950–2004.
31. Vanni, *et al., Vesalius…*
32. J. H. Pearn, 'Medical Ethics Surveillance in the Armed Forces', *Military Medicine*,

vol. 165, 2000, pp. 351–4. See also J. H. Pearn, 'The Geneva Conventions and Military Service', *Paulatim [Journal of the Royal Australian Army Medical Corps],* 1997, pp. 9–13.

33. J. H. Pearn, 'Basic Life Support: Extending and integrating teaching in the Australian community', *Australian and New Zealand Journal of Surgery*, vol. 70, 2000, pp. 3–5.

34. J. H. Pearn, 'Improving Survival: A multi-portal approach to improving cardiopulmonary resuscitation outcomes', *Resuscitation*, vol. 42, 1999, pp. 3–9.

35. J. H. Pearn, 'Preface', in J. Pearn *et al.* (eds), *The Science of First Aid. The Theoretical and Experimental Basis of Modern First Aid Practice*, St John Ambulance Australia, Canberra, 1996, pp. xvii–xviii.

36. ibid.

37. J. H. Pearn, 'The Earliest Days of first Aid', *British Medical Journal*, vol. 309, 1994, pp. 1718–20.

38. Murdoch Wales & John Pearn, *First in First Aid*, St John Ambulance Australia (Qld), Brisbane, 1998, pp. xxvi–xxxiii.

39. ibid.

40. ibid.

41. ibid.

42. Pearn, 'The Earliest Days of First Aid'.

43. Wales & Pearn, *First in First Aid.*

44. Pearn, 'Children and War'.

45. Pearn, 'Improving Survival…'.

46. ibid.

47. R. Rous & J. R. Turner, 'The Preservation of Living Red Blood Cells in Vitro', *Journal of Experimental Medicine*, vol. 23, 1916, p. 219.

48. O. H. Robertson, 'Transfusion with Preserved Red Blood Cells', *British Medical Journal*, vol. 1, 1918, p. 691.

49. F. Duran-Jorda, 'Blood Transfusion at the Front', *Proceedings of the Royal Society of Medicine 1938 [Part 1],* vol. 31, p. 685.

50. B. Fantus, 'The Therapy of the Cook County Hospital: Blood preservation', *JAMA*, vol. 9, [Part 1], 1937, p. 128.

51. J. L. Hamilton-Paterson, 'Use of Stored Blood for Transfusion: An interim report', *British Medical Journal*, vol. ii, 1939, p. 908.

52. M. Bick, 'The "Blood Bank": The first four years' practical experience', *Medical Journal of Australia*, vol. 1, 1945, pp. 241–8.

53. P. Levine, E. M. Katzin & L. Burnham, 'Isoimmunization in Pregnancy; its possible bearing on the etiology of erythroblastosis foetalis', JAMA, vol. 116, 1941, pp. 825–7. See also C. T. Javert. 'Erythroblastosis Neonatorum. An obstetrical–pathological study of 47 cases', *SurgGynecObstet*, vol. 74, 1942, pp. 1–20.

54. J. Pearn & P. Flecker, 'Northern Exchanges—Some Queensland 'firsts' in the fight against haemolytic disease of the newborn due to Rhesus incompatibility', in J. Pearn (ed.), *Outback Medicine*, Amphion Press, Brisbane, 1994, Chap. 17, pp. 299–320.

55. Levine, *et al.*, 'Isoimmunization in Pregnancy…'.

56. H. Allerstein, 'Treatment of Severe Erythroblastosis by Simultaneous Removal and Replacement of the Blood of the Newborn Infant,' *Science*, vol. 103, 1946, p. 583.

57. Rous & Turner, 'The Preservation of Living Red Blood Cells in Vitro'.

58. E. E. Dunlop, 'Blood Transfusion', in *The War Diaries of Weary Dunlop. Java and the Burma–Thailand Railway 1942–1945,* Viking Books, Melbourne, 1989, pp. 323, 355.