A short but distant war – the Falklands Campaign

The following account is based on the symposium, held by the United Services Section of the Royal Society of Medicine, on 17 and 18 February 1983 at the Royal College of Surgeons, to discuss the medical lessons arising out of the Falkland Islands Campaign. Sessions were chaired by the Section's president, Mr H H G Eastcott; the Medical Directors General of the three armed services, Surgeon Vice-Admiral Sir John Harrison, Lieutenant-General Sir Alan Reay and Air Marshal Sir David Atkinson; Professor G Slaney; and the President of the Royal Society of Medicine, Sir James Watt.

Introduction

The conflict in the South Atlantic was precipitated by the Argentinian invasion of the Falklands on 2 April 1982, and Operation Corporate got under way after a few days of intensive activity over the Easter weekend with the sailing of the Task Force, led by the flagship *HMS Hermes*, on 5 April. Initially it was conceived as a maritime operation and it has to be borne in mind that the Task Force sailed before the rounds of diplomatic shuttle undertaken by the US Secretary of State, Mr Alexander Haig, and the United Nations peace efforts had even commenced. These endeavours finally broke down on 20 May, but by that time the major troop embarkation in the *QE2* was already proceeding south, and the attempt to retake the Falklands by force of arms was all but inevitable. Eventually 28 000 British men and women of the three armed services, and civilians of the Royal Fleet Auxiliary (RFA) vessels and requisitioned ships were involved in the campaign.

Table 1. Diary of events, 1982

5 April	Task Force sails from Portsmouth. *HMS Hermes* and *HMS Invincible* provide major medical support to Task Force and embark No. 1 SST
9 April	*Canberra* sails from Southampton. 2 SSTs embarked and Medical Squadron of Commando Logistic Regiment
19 April	*Uganda* sails from Gibraltar. Reaches Total Exclusion Zone 11 May
1 May	First British casualty from *HMS Arrow* transferred to *Hermes*
4 May	*HMS Sheffield* hit and medical team sent from *Hermes*
12 May	*QE2* sails from Southampton. Units of 16 Field Ambulance embarked
21 May	*HMS Ardent* attacked and sinks. Bridgehead established at San Carlos
22 May	Ajax Bay Field Hospital set up from units of Marines and Paratroops
23 May	*HMS Antelope* sinks
25 May	*HMS Coventry* sinks. *Atlantic Conveyor* abandoned
28 May	Battle for Goose Green and Darwin
2 June	Mount Kent taken
8 June	Air attack on *Sir Galahad* and *Sir Tristram:* troop carriers at Bluff Cove
12 June	*HMS Glamorgan* attacked
13 June	Mount Tumbledown taken
14 June	Final battle for Port Stanley

From the beginning it was realized that the major problems would be those of communication and logistic support over a distance of almost 8000 miles, with the nearest land base at Ascension Island 3000 miles away from the scene of military activity. Medical planning and its organization for support of the Task Force evolved during the first few weeks until it became a fully 'corporate' effort involving all three services. The initial deployment of the medical manpower and resources and the major incidents, which produced casualties, are shown in the diary of events in Table 1, and the medical facilities made available on and around the Falkland Islands and the main casualty evacuation route, made possible after the Uruguayan government had offered its assistance, are indicated in Figures 1 and 2.

Preparing for war

Medical supply

Medical supply for all three Services is through the Defence Medical Equipment Depot at Ludgershall, Hampshire. The first operational medical equipment to be issued during the campaign was to the Commando Medical Squadron and Royal Navy Surgical Support Teams (SSTs). The hospital ship *Uganda* was supplied in Gibraltar, followed by further equipment flown out to Ascension Island. Supplies were also made in the early days to the Parachute Clearing Troop and to the Army Surgical Teams and Field Ambulance Sections. Subsequently, 5 Infantry Brigade together with 16 Field Ambulance Sections were provisioned for embarkation in the *QE2*.

The difficulties of resupply for an operation of unknown duration, in which casualty figures could only be estimated, were appreciated early and arrangements made for airlift to Ascension Island and thence by sea. The RFAs carried

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AT SEA
Uganda
Hecla, Hydra, Herald
Canberra
Hermes, Invincible

ON LAND
3 Commando Brigade
Commando Medical Squadron
2 × RN Surgical Support Teams
Parachute Clearing Troop
2 Field Surgical Teams

5 Infantry Brigade
16 Field Ambulance
2 Field Surgical Teams

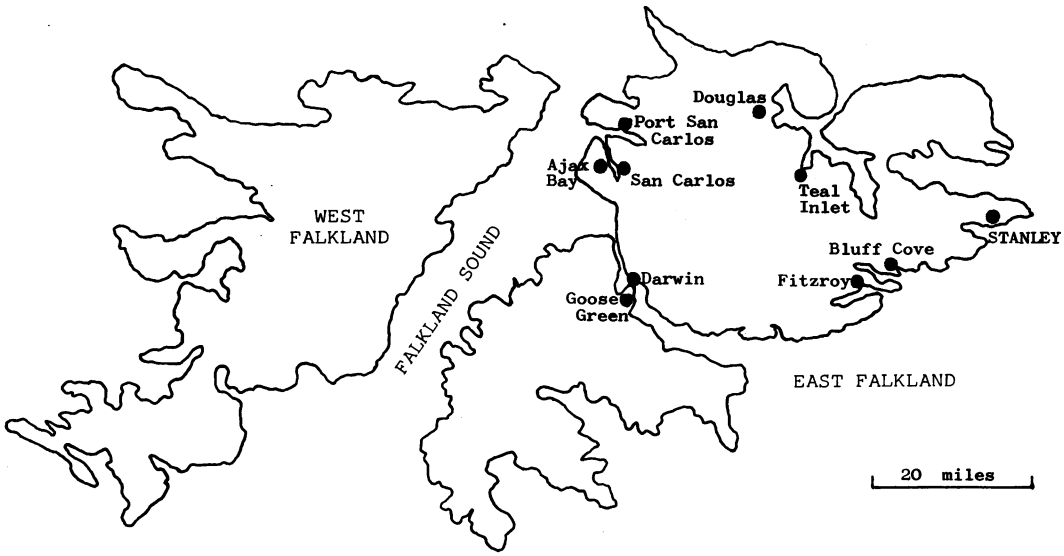


Figure 1. Map of Falkland Islands and medical facilities afloat and ashore

consumable medical supplies and on land a section of the Medical Equipment Depot accompanied 16 Field Ambulance. It was later realized that *Uganda* should have had a capability for resupply at sea. The provision of blood is discussed below.

All of this involved Ludgershall in a tremendous amount of work over a very short period, but in the words of the Director, Brigadier A J Shaw, 'The medical supply system was tested and not found wanting'.

Hospital ship

The *SS Uganda* was requisitioned in Alexandria on 10 April and the holiday of 944 school children was prematurely curtailed when they were landed at Naples, where the RN planning team led by Surgeon Commander R J Leicester joined the ship. Conversion was carried out in Gibraltar in 60 hours. The children's verandah became the operating theatre, the smoke room the intensive care ward and the students' common room a high-dependency care ward. A separate Burns Unit was established in the ship's original hospital where it was possible to control temperature and humidity, and laboratory facilities were set up. The medical team of 15 medical officers led by Surgeon Captain A J Rintoul, 15 nursing officers and 40 nurses and medical assistants joined at Gibraltar and 24 Marine bandsmen, as stretcher-bearers, completed the medical complement. At the height of the conflict there were over 300 casualties on board and medical manpower resources were stretched. More junior doctors and nurses in particular were needed. *Uganda* left Gibraltar on 19 April and became the first British hospital ship since *HMS Maine* in the Korean War. She became fully operational after further supplies had been received in Ascension, and entered the Total Exclusion Zone on 11 May. There she took up station as 'mother hen' with her three 'chickens', the ambulance ships *Hecla, Hydra* and *Herald,* in the Red Cross box, the designated hospital area to the north of San Carlos Water. The first casualty was received on 12 May.

The *SS Canberra* was requisitioned on 4 April and converted in Southampton, sailing on 9 April, embarking troops of 40 and 42 Commando and 3rd Battalion Parachute Regiment, with 2 RN SSTs and the Medical Squadron of the Commando Logistic Regiment. The Principal Medical Officer was Surgeon Captain F R Wilkes. Each SST comprised two surgeons, an anaesthetist, a resuscitation officer, an adminis-

Hospital ship, *SS Uganda*

trative officer and 18 medical assistants and technicians. SST No. 2 was supplemented by a faciomaxillary surgeon and was destined to go ashore with the Marines after the San Carlos landing. SST No. 3 also had a faciomaxillary surgeon, but included a psychiatrist, two additional surgeons, an extra anaesthetist and supplementary nursing staff. The original conception was that *Canberra* would eventually function as a hospital ship after its troop-carrying role had ceased, but this proved to be impracticable and the dual role was never fully realized. Altogether it dealt with 170 casualties, including 90 Argentinians, but it did not function adequately as the second-line medical support originally envisaged and conceded the status of main hospital ship to *Uganda*.

Provision of blood

Adequate provision of blood for transfusion is essential to the logistics of modern warfare. The difficulty lies in anticipating the requirement and its timing.

It has been a NATO requirement since 1979 that all newly entered servicemen be grouped and that this be stamped on their identity discs. Blood groups were checked on the marines bled in *Canberra* and an error of 2.7% was found between the actual group and that stamped on identity discs.

It is the policy for the Royal Navy and Marines to carry their blood stock 'on the hoof', with individual units being self-sufficient. This was not possible in *Uganda*, which under the rules of the Geneva convention proceeded alone to the South Atlantic. Two consignments of 396 units were supplied to the hospital ship by the Army Blood Supply Depot from donors bled in the UK, and a similar consignment went to the *QE2*. Altogether, from all sources, a total of 3262 units were provided.

Ideally donors should be bled 7 to 10 days before the anticipated military action, but in practice there has to be a compromise between this and the storage life of blood. The main anticoagulant still in use for blood for transfusion is acid citrate dextrose, with a maximum storage life of 28 days. This is being replaced by citrate phosphate dextrose with a longer storage life, but very little was available during the campaign. High avidity antisera were available both afloat and ashore and their use permitted more rapid checking of blood groups than freeze-dried antisera.

Of the blood supplied, 605 units were used, giving a usage rate of 18.5%. This low figure is accounted for by the estimated casualties being higher than occurred, blood going out of date, and some stocks being in the wrong place. Central coordination of stocks would have reduced wastage.

Experience in the South Atlantic has indicated the need for central coordination of blood stocks, the desirability of computerized mass grouping, the value of high avidity antisera for grouping, and the need for refrigerated stores for individual surgical teams.

Training of personnel

The long period at sea taken in reaching the Falklands was put to good use by training personnel, familiarizing them with equipment and in establishing simple regimens for casualty reception and evacuation. Units of all three services intensified first-aid training. The value of this preparation was to be proved time and again in the field. First-aid expertise and the fitness of the British troops were the two main factors in limiting casualty mortality.

The war at sea

The first British war casualty occurred on 1 May, when a 20-year-old able seaman on board *HMS Arrow* was hit by a fragment of a cannon shell, which lacerated the right lobe of his liver. He was transferred to *HMS Hermes* and operated on by the Principal Medical Officer, Surgeon Commander J Soul. The war at sea, however, really commenced with the sinking of the Argentinian cruiser, *General Belgrano*, on 2 May. This was followed by the Exocet attack, two days later, on *HMS Sheffield*. The single missile failed to explode, but the searing heat generated by its passage through the hull and into the forward engine room was sufficient to set fire to paint, PVC cables and other inflammable materials. Within 15–20 seconds the ship was full of black acrid smoke. Twenty died in this incident. *HMS Hermes* sent a medical team to assist with casualties and 24 were transferred to the flagship

for treatment, suffering from burns and smoke inhalation in equal proportions.

Following the *Sheffield* episode, there was a lull in activity until the intensive air attacks on British ships, which were forming a screen, protecting the establishment of the bridgehead ashore at San Carlos. The most remarkable of these was on *HMS Ardent*, which sank after being on the receiving end of no less than 17 air strikes. There were 22 dead, and 30 wounded had to be dealt with. In the following four days more British ships were lost. Graphic and moving accounts were given by the medical officers on board *HMS Sheffield, Coventry, Antelope* and the container vessel *SS Atlantic Conveyor*. *HMS Coventry* and the *Atlantic Conveyor* were rapidly disabled and were the only two incidents in which survivors had to take to the sea. There were two deaths in the sea from immersion from *Coventry* and most of the 12 who died from *Atlantic Conveyor* were in the water. A number of cases of hypothermia in the life-rafts required treatment. One can almost hear the screams of those trapped by fire in the *Atlantic Conveyor* and can visualize the formidable task of evacuating casualties from its 50-foot-high deck. *HMS Antelope* was hit by bombs and sank after a 1000 lb bomb exploded during an attempt to defuse it. This caused two deaths, and 8 were injured.

Casualties from the above incidents and from the attack on *HMS Glamorgan* on 12 June were all eventually transferred to *Uganda*, but many were initially treated on *HMS Hermes* and *Invincible*. The air attacks on the troop carriers *Sir Galahad* and *Sir Tristram* happened whilst troops were being disembarked and this event is discussed under the land battle. The major casualties, apart from penetrating wounds, were due to smoke inhalation and burns, with a few cases of hypothermia following immersion.

Smoke inhalation injury

Smoke inhalation led to a significant number of casualties during the campaign. This had been anticipated because of previously reported pulmonary damage to personnel exposed to smoke in closed compartments. In response to this the Royal Navy had developed the emergency life support apparatus (ELSA), but there were insufficient of these available to the fleet. Firefighting in *Sheffield* was hampered by this lack, and sets of ELSA were flown in from other ships. The damage sustained to lungs is in part due to hypoxia, but inhalation of carbon monoxide and hydrogen cyanide from plastics and paints also contributes. The use of massive doses of methyl prednisolone had been studied and found to reduce mortality.

Surgeon Commander J M Beeley, Professor of Naval Medicine, gave an account of patients treated on board *Uganda*. Altogether 80 met the criteria of having sustained smoke injury. Methyl prednisolone 2 g was given as an immediate dose and was repeated 12 hourly, as necessary, up to a maximum of 4 doses. It is of interest that 12 patients with severe injury had not received this drug before arriving on *Uganda*, whereas 57 victims from *Sir Galahad* had been treated in this way ashore at Ajax Bay prior to transfer, and there were few subsequent problems amongst them.

Burns

Ideally, severe burns are dealt with by early surgical excision of damaged tissue and resurfacing by split-skin grafting. It is a characteristic of war, however, that delay is inevitable. The *Sir Galahad* incident alone produced 179 casualties taken to *Uganda*, of whom 83 had burns of varying degrees of severity.

On board *Uganda* a simple plan of management had been evolved. Necessary attention was paid to maintaining airway, and analgesia, penicillin and tetanus toxoid were given. Intravenous therapy was instituted when the burns area exceeded 15% of total body surface at the rate of 120 ml per 1% of burn each 24 hours, using equal proportions of compound sodium lactate and polygeline. Silver sulphadiazine cream (Flamazine) was used topically with polythene bag occlusion for hands and feet, and other areas were treated by exposure. Surgeon Commander C Chapman outlined the cases treated on *Uganda*.

Many of the cases had healed by the time of arrival back in the UK, but 46 were evacuated to Queen Elizabeth Military Hospital, Woolwich, under the care of Colonel B C McDermott. All of these had hand burns and 24 required additional surgery, including a few who needed K-wire fusion or reconstruction with silastic prostheses to interphalangeal joints. Most face and scalp burns were superficial, but two needed early grafting of the upper eyelids, and 20 patients had lost tissue from the margins of the pinnas. There were only three full-thickness burns of the trunk or proximal limbs.

The simplicity of treatment in the field was undoubtedly effective, but it was considered that the final results might have been better in some cases had it been possible to apply surgery at an earlier stage.

Sea survival

The problems of survival at sea are generally well understood. Following World War II, when it was found that almost two-thirds of all fatalities at sea were lives lost during the abandonment/survival phase, the Royal Navy put a great deal

of research effort into this field and into the development of survival equipment.

During the Falklands campaign there were few who died during the survival phase following abandonment of ships underway at sea. From the two incidents (*Coventry* and *Atlantic Conveyor*) when survivors were obliged to take to life-rafts or to the water, there were 11 deaths from ships' companies totalling 449. The rapidity of rescue in other incidents by ships and by helicopter minimized the need to take to the sea. Details of life-raft survivors from the *General Belgrano*, who were seen on board the Argentinian ship *Aria Bahia Paraiso*, indicate that of the 71 who were alive at the time of rescue, 69 were suffering from hypothermia and there were 18 dead from this condition. It is not known how many of the 300 or more who were lost from the *General Belgrano* died during the survival phase following abandonment, but it probably accounts for the majority.

Surgery at sea

All the serious casualties which occurred during the campaign were transferred to *Uganda*. The admissions to the hospital ship over a two-month period and the breakdown of battle injuries amongst British casualties are shown in Tables 2 and 3. Over 50% of these casualties were due to penetrating wounds and most were due to high-velocity missiles. Many had received emergency surgery either ashore or in other ships, and only a few needed resuscitation on arrival. Serious injuries, including all thoracic cases, were admitted to the 20-bed intensive care unit. Other patients were distributed to the high- and low-dependency wards. 169 of the casualties came from the *Galahad* incident in a 3-hour period. Of the injuries, 66% were to the limbs and 14% to the head and neck.

Surgeon Commander R J Leicester gave an account of the surgery carried out. In the main it consisted of delayed primary suture and reconstructive surgery, but 80 cases were received direct from the front line in the two-day assault on Stanley, and wound excision and debridement was required in three-quarters of these. There were few formal thoracotomies but basal chest drains were inserted in all cases of penetrating chest injury. The established technique of debridement with delayed primary suture 5–10 days later was employed and few infections were encountered. This was in contrast to some of the Argentinians wounded by high-velocity missiles whose entry and exit wounds had simply been clipped. More extensive surgery was subsequently required. All patients with penetrating wounds were given anti-tetanus toxoid and penicillin. Metronidazole was added for abdominal and head and neck injuries, and sulphadimidine also given in cases of compound head injury.

Table 2. Admissions to hospital ship Uganda, *16 May–13 July, 1982*

Battle-related conditions	666 (91%)
Non-battle-related conditions	64 (9%)
Total	730●

●580 British and 150 Argentines. There were 3 deaths on board

Table 3. Battle injuries in British casualties

Penetrating wounds	270 (52.3%)
Burns	112 (21.0%)
Trench foot	70 (13.6%)
Non-penetrating injuries	43 (8.3%)
Psychiatric	21 (4.1%)

Anaesthetics were administered by Boyle's machines which had been assembled on board, and most consisted of nitrous oxide and oxygen mixture, with intravenous analgesia. In forty continuous days of operating, 420 anaesthetics were given. A total of 61 patients were admitted to the intensive therapy unit and several were ventilated for up to ten days. There were initially two Oxford Penlon ventilators on board, but later two East Radcliffe machines were received and proved to be more reliable. The 3 deaths on board occurred whilst on ventilators. Intravenous feeding was necessary in 4 patients with severe injuries. A few minor blood transfusion reactions were recorded.

The value of an intensive therapy unit close to the front line was considerable but the 'total ITU care' concept, which was applied, could not have been maintained if casualty figures had been greater.

Intensive care ward, *Uganda*

Refrigeration plant at Ajax Bay which became the Advanced Surgical Centre

The war on land

The bridgehead on land was established with the landings at San Carlos on 21 May. Intensive air attacks on the British ships made casualty evacuation to *Uganda* and *Canberra* from ashore uncertain, and an Advanced Surgical Centre – the main 'field hospital' – was set up the following day at Ajax Bay. It consisted of the Medical Squadron of the Royal Marines and the Parachute Clearing Troop of 16 Field Ambulance. The remainder of 16 Field Ambulance was placed under the command of 5 Infantry Brigade, and extra medical personnel were drafted in to replace those committed to Ajax Bay. Half of this unit sailed in *RFA Sir Tristram* and set up the Advanced Dressing Station at Fitzroy on 7 June to support the battle for Stanley. The remainder sailed in *Sir Galahad* and arrived in Bluff Cove on the fateful morning of 8 June, when the ship was bombed by enemy aircraft during disembarkation of troops. There were 50 lives lost in that incident, three of them from the Field Ambulance, including the second in command. A further Dressing Station was later set up at Teal Inlet. All battalions were supported by their own Regimental Aid Posts, which moved with them. Medical personnel carried the medical equipment on the long marches ('yomping' or 'tabbing') and during the ensuing battles.

Advanced Surgical Centre – Ajax Bay

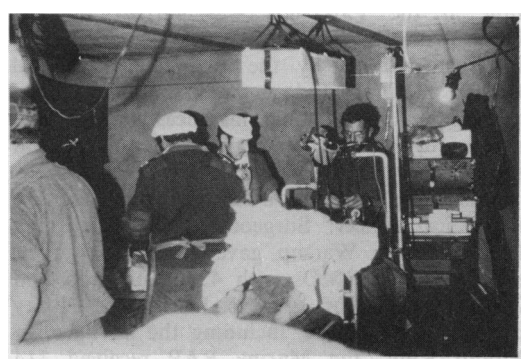
The field hospital at Ajax Bay was commanded by Surgeon Commander R Jolly and was set up in a disused refrigeration plant. This provided plenty of space and protection from the elements, but there was no electricity or water supply and a lack of ventilation.

The previous experience of the senior surgeon and anaesthetist, Lt-Colonels W S P McGregor and R S Knight respectively, in setting up field equipment and operating in similar, adverse circumstances was invaluable.

The hospital itself was bombed, but surgery continued unabated in spite of two unexploded bombs which had to be left where they landed.

During the period it was operational, 21 May to 9 June, the Advanced Surgical Centre received casualties direct from the battlefield, from the Advanced Dressing Stations at Teal and Fitzroy, and from ships hit in San Carlos Water. In all, 725 patients were seen and 210 had surgery under general anaesthesia. Lt-Colonel McGregor and Surgeon Lt-Commander P J Shouler gave accounts of the techniques of full debridement of damaged tissue and delayed primary suture. After resuscitation and primary surgery, patients were evacuated to *Uganda*. Most injuries were to the limbs, and it is probably significant that despite the excellent service given by one dedicated Casevac helicopter, only 2% of those admitted had abdominal and 4% chest injuries. It is possible that some of the very serious injuries occurred far from medical help and never reached the dressing stations. Of the casualties seen at the Advanced Surgical Centre, only 2 deaths were recorded. It is also noteworthy that about 40% of the surgery carried out was on Argentinian wounded.

Anaesthesia was administered by the Tri-Service anaesthetic apparatus, which was described by Lt-Colonel R S Knight and proved to be very satisfactory. It had been developed as a simple, easily portable, adaptable and robust piece of equipment. It consists basically of two Oxford miniature vaporizers in series, connected to the patient via elephant tubing and a Laerdal bag. Halothane and trilene were the main anaesthetic agents used, but ketamine and diazepam in combination provided adequate operating conditions for simple procedures and ensured a rapid throughput of patients. It was realized that there was a possible hazard in using



Surgical facility, Ajax Bay

halothane as a first anaesthetic in casualties who might need further surgery, but no cases of hepatitis were seen. Hypothermia and hypovolaemia had been anticipated. Patients with hypothermia were deliberately underdosed with muscle relaxants, and intravenous fluids were warmed in improvised heaters. Additional oxygen was given to anaemic patients. Polygeline was used extensively. Blood was in short supply because the vulnerable *Canberra,* which carried the stocks, had been removed out of the area of action. Argentinian prisoners were persuaded to donate, and this blood was used exclusively for Argentinian casualties. The commonest antibiotics given were ampicillin plus cloxacillin and metronidazole.

Medical organization and casualties in the field

The casualty himself initially has to treat his own wounds as best he can. It is only when armed action has ceased that 'buddy' care can be applied. By and large this worked well and is a tribute to the first-aid training which had been given, but some field dressings were badly applied and in some cases haemostasis was due more to the cold conditions than to effective first aid. Casualty evacuation proved to be the main problem and was generally by helicopters, which could only operate in daylight. Delays in casualty retrieval were inevitable. There were, however, a number of outstanding episodes such as the *Sir Galahad* incident, in which helicopters performed with great skill and daring in rescue work. Transport of casualties on the ground was also hampered by the lack of a lightweight stretcher or casualty evacuation sheet.

Once the casualty has received buddy aid, he is evacuated to a Company Aid Post which is manned by medical assistants who refine the first aid and may initiate intravenous infusion. From there the casualty is evacuated to the Regimental Aid Post (RAP), which is usually located near battalion headquarters. Up to the RAP, evacuation in the Falklands was carried out by bandsmen, cooks and various HQ personnel. The RAP is manned by the Regimental Medical Officer (RMO) and a number of medical assistants, and in some instances was supplemented by medical personnel from the medical squadron or Field Ambulance.

It is at the RAP that a casualty is first seen by a medical officer. Surgeon Lt R Adley and Lt Colonel A Warsop gave accounts of their experiences as RMOs with 42 Commando and 2nd Battalion Scots Guards. During the 31-day period it was ashore, including the advance on Mount Kent, the Marine RAP received 114 casualties. Thirty-six were treated and returned to duty, and the rest, including 24 wounded in action, were evacuated rearward. The others were non-battle injuries and many had trench foot. The 2nd Battalion Scots Guards experienced 12 days of combat, the last 36 hours being a continuous battle to secure Mount Tumbledown. In that action 9 were killed as a result of mortar bomb or high-velocity small arms injuries to head or trunk. A total of 43 non-fatal wounds were sustained, and casualties were initially evacuated to Ajax Bay and later to the surgical facilities at Fitzroy and Teal Inlet.

16 Field Ambulance (including the element at Ajax Bay) was the largest land medical unit. Commanded by Lt-Colonel J D A Roberts, its 202 personnel formed the Dressing Station at Fitzroy, which had a surgical capability provided by 2 Field Surgical Teams and which was also a source of reinforcements for the Army infantry units. It dealt with 439 casualties during the period 7 to 18 June. The total casualties from Operation Corporate are shown in Table 4.

Table 4. Total casualties, Operation Corporate

	RN	Army	RAF	Others	Total
Killed/missing	113	123	2	18	256
Injuries	275	436	8	19	777

Triage

Triage is the initial classification of casualties by priorities, sorting them out on the basis of the need for resuscitation and surgery. Major J M Ryan outlined the principles as applied during the campaign and stressed that triage had to be reapplied at each point in the chain of casualty evacuation from the RAP back through the Dressing Stations to the Surgical Centres. The aim is to ensure that the most serious injuries are received first by the Surgical Centres, followed by those less seriously wounded. It is essential that triage teams are led by experienced officers. At Ajax Bay, Royal Navy and Royal Army Dental Corps dental officers successfully filled this role.

A mass casualty situation is one in which the available medical facilities are overwhelmed by the number of those seriously injured. Under these conditions, conventional triage has to be modified by the principle of providing medical care which will be of the greatest benefit to the largest number of casualties. Such a situation was approached only once during the whole campaign, when the *Sir Galahad* incident resulted in a large number of untreated casualties arriving almost simultaneously at the Advanced Dressing Station.

Preventive medicine

The aim of preventive medicine in the field is to minimize casualties from illness and environmental factors. 16 Field Ambulance was supplemented by a hygiene team and Major K N A Millar outlined the factors to which the troops had been exposed.

Heat injury had occurred in a number of cases due to over-enthusiastic training in the tropics on the way south, and malaria prophylaxis was required when *QE2* called in at Freetown. Proguanil (Paludrine) tablets were issued loose, and were taken inconsistently because they were lost or damaged during the conflict.

Medical standards as applied to personnel entering the three Services appeared to be adequate.

Ashore, on the Falklands, the troops were exposed to cold and damp and many suffered from cold injury. The boots issued to British servicement have come in for a great deal of criticism. Rather ironically in the circumstances, dehydration was a problem due to lack of drinking water, and predisposed to exhaustion and cold injury. The Millbank filtration bag was used together with water purification tablets, but freezing conditions on occasions limited the usefulness of the filtration bag. Similarly, there were problems of sanitation and personal hygiene. Latrines dug in frozen ground rapidly filled up and overflowed when it thawed, and the Argentinian positions, which were eventually over-run, were heavily 'mined' with excreta. A few cases of diarrhoea and vomiting – 'Galtieri's revenge' – occurred.

In the heat of battle ear defenders were not commonly used, and measurements are underway to assess noise injury in artillery and infantry troops.

Non-freezing cold injury

With an average daily temperature of $0 \pm 0.5°C$ and wind speeds of up to 40 knots, conditions ashore were ideal for the production of non-freezing cold injury. Many cases occurred in the troops involved in the land battle, presenting the opportunity to study this condition.

Surgeon Commander F St C Golden described the features of non-freezing cold injury and gave the following graphic account of the cold injury sustained by some of the Royal Marine troops:

'In general, they had a dry landing in the San Carlos area on 21 May, following which they were billeted initially in slit trenches – many partially flooded – for about 7 days. No sleeping-bags were available for the first 24 hours, but the weather at this stage was relatively kind, i.e. it was crisp and dry. Nevertheless, their feet were almost perpetually wet and cold.

'After a week, highlighted by air-raids during the day and cold at night, there began the now famous "yomp" to Port Stanley, carrying 50–60 kg weight on their backs, over terrain that varied from marshy bog, to grassy hummocks, to rocky scree. If one fell it was a major effort to get up, which involved the assistance of several comrades who themselves were struggling under their own appalling loads. They "yomped" all the first day and half that night before they took a break. The following morning they set out again, but this time left behind their "Bergens" and took only food and ammunition.

'That night they reached their objective – the settlement of Douglas, but without the benefit of sleeping-bags on a bitterly cold night; many could not sleep because of the cold, despite their exhaustion. The ambient temperature was below 0°C. At this stage some noticed numbness of their feet with paraesthesia on weight-bearing. Most had blisters.

'After 2–3 days, during which "recce groups" surveyed the surrounding countryside, feet began to recover and they "yomped" to Teal, again carrying the heavy loads on their backs. Light snow was falling at this stage. At Teal some feet were given the opportunity to recover, but the majority of men were billetted in defensive positions around the settlement. Some went forward to Mount Kent where conditions were appalling – driving rain with high winds (60 knots): survival conditions. After several days of these horrific conditions, with fluctuating temperatures, precipitation and wind speeds, many lost all sensation in their now white toes, and paraesthesia made it difficult for some to sleep at night. For these, weight-bearing first thing in the morning was frequently particularly painful.

'The weather improved, in that it stopped raining, but froze instead. On a night with a thick hoar-frost on the ground and an ambient temperature of about $-4°C$, they carried out the assault on the Argentinian defensive positions on the Two Sisters mountains.

'Most assaults involve periods of high activity interspersed with relative inactivity. The clothing worn by the individual must obviously be compatible with the ease of movement required for fighting, but as the adrenalin is always flowing freely on these occasions, peripheral vasoconstriction will be pronounced and consequently the peripheral tissue temperatures are likely to fall considerably. After the capture of Two Sisters they were obliged to defend it against counter-attack; again a period of relative physical inactivity with high catecholamine flow. A few nights on, Two Sisters was followed by the assault on Sapper Hill – again the weather changed dramatically and they found themselves once more without sleeping-bags on a bitterly cold night; they were obliged to keep walking around in a figure of eight all night in order to keep warm. Thereafter it was relatively plain sailing – "yomp" into Port Stanley, shower and clean up, and guard duties before transiting home, courtesy of P & O or Royal Fleet Auxiliary.

'In summary then, all experienced cold wet feet for most of the 24 days of the campaign. Numbness began to develop after about 7–10 days. At night, in their sleeping bags, the numbness would be replaced by paraesthesia, or pain, or both – described by some like electric shocks running up the legs from their toes. In

some cases this pain was severe enough to keep them awake. On weight-bearing in the morning, the pain was sometimes almost unbearable for the initial 5 or 10 minutes, but would then gradually wane and once again be replaced by numbness on re-exposure to cold. Some – particularly those with very severe nocturnal pain – found their feet had swollen to such a degree in the morning that they had difficulty in putting on their boots; or if it had been necessary for them to sleep with their boots on, they had difficulty in tying their laces. The 70 most severe cases were transferred to the hospital ship *Uganda*. The majority, however, out of a sense of loyalty to their comrades and a desire to be "in at the kill", persevered with remarkable fortitude, although some were hobbling at the end. It is considered that enlisted men would not have continued under these conditions.

'The area of pain, numbness, and paraesthesia spread proximally, slowly, and it wasn't until they embarked on the ships to come home that many really had time to notice they had a problem. Sensation gradually recovered during the voyage home and most had had a full return of sensation by the time the *Canberra* docked, or by the end of their leave in early September.'

At the end of Operation Corporate a random sample of Marines were examined at the Institute of Naval Medicine and it was confirmed that many had suffered demyelination of medial and/or lateral plantar nerves of one or both feet. Plethysmographic and infrared thermographic studies suggested a residual cold sensitivity, with a tendency to marked vasospasm to moderate cold stimuli. The vasoconstriction is relatively resistant to rewarming, when compared with a control group. These studies are still proceeding, but already raise the question of whether cold-injured troops can ever be used again in a cold environment.

Psychiatric casualties

It had been anticipated that up to 15% of the troops deployed could become casualties, and that 10–60% of these would be neuropsychiatric. Figures from *Uganda*, however, show that only 4% of the casualties were psychiatric.

Surgeon Commander M O'Connell outlined the concept of the mental health team, which to be effective needs to be as near the front line as possible. It had been expected that civilian members of the ships' crews would be the most vulnerable group in the Task Force to psychiatric illness, but this preconception was not fulfilled. There were a few cases of battleshock and very few psychoses. Some problems related to survival were encountered, with varying emotions such as rage, grief and guilt being displayed.

Air operations

The Royal Air Force were involved early in the campaign carrying supplies and personnel to Ascension Island, using Hercules and VC10 aircraft. Harriers were also flown non-stop to Ascension Island, where they and their crews joined *HMS Hermes* and later used the air-strip at San Carlos in support of the land offensive. A Chinook helicopter was also used. The first offensive on Argentinian positions came on 1 May, when Harriers and Vulcan bombers attacked Port Stanley airfield, sorties which were repeated on a number of occasions. Later the RAF had a heavy commitment in aeromedical evacuation of casualties from Montevideo to the UK via Ascension Island (see below).

The main problem encountered with air operations was the long-range missions. The return flights from Ascension to the Falklands were 6800 miles long, took up to 28 hours and imposed changes in work and rest patterns on the crews concerned. It was also evident from an early stage that duty hours would be prolonged in excess of the recommended guidelines for aircrew. There would inevitably be sleep difficulties, and hypnotics were made available. The essential profile required of a hypnotic for aircrew is that it should be effective when given at any time of day, and leave no residual effects. Previous research at the Institute of Aviation Medicine had indicated that the 1,4-benzodiazepine, temazepam, was suitable and this drug was used extensively, producing no untoward effects. It was recommended that it be taken at least 8 hours before a flight, but crews found that they could fly without impairment 6 hours after taking a dose. Group Captain A N Nicholson gave an outline of the factors involved in long-range operations, which are discussed in detail earlier in this issue (p 933).

Casualty evacuation to UK

It was apparent from the beginning of Corporate that casualty evacuation from the South Atlantic was going to be a major problem. This was eased to some extent when the Uruguayan government offered the use of Montevideo as a staging post for this purpose. The majority of casualties came back via the route shown at Figure 2. Patients were transferred from *Uganda* to the ambulance ships and thence to Montevideo by sea. At Montevideo they were transported by the Uruguayan authorities to the airport and picked up by the RAF, flown to Ascension and then on to the UK. A number of casualties, however, came home in the troopship *QE2*.

Ambulance ships

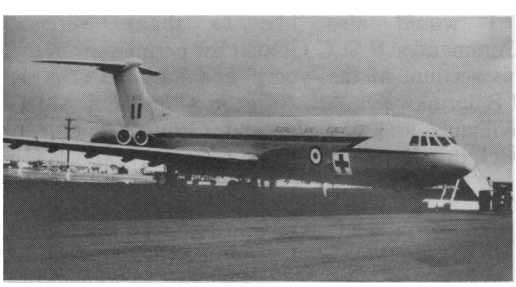
The ocean survey ships *HMS Hecla, Hydra* and *Herald* became the ambulance ships and displayed the Red Cross. Surgeon Lieutenant M Henley, the medical officer on board *Herald*, described his experience and the role played by his ship. One hundred camp beds and bedding

Ambulance ship

were embarked and 50 of the ship's company of 117 were assigned to casualty care duties. A training programme was established and the ship joined *Uganda* in the Red Cross box to the north of West Falkland. *Herald* made two trips to Montevideo and carried a total of 163 casualties. The sea passage took four days. In the first trip 63 were taken and were mainly casualties from Goose Green. Pain from brachial plexus injuries and phantom limbs presented some problems. A frequency generator normally used for testing radio equipment was adapted to give pain relief, with some success. On the second trip 15 serious burns cases from *Sir Galahad* were embarked and burns-trained SRN nurses accompanied them to assist with the time-consuming dressings.

Aeromedical evacuation

Wing Commander J A Baird outlined the organization of aeromedical evacuation and Group Captain C A B McLaren described in-flight medical problems. Dedicated VC10 aircraft, bearing a Red Cross, picked up casualties from Montevideo. Up to 3 August there were 37 flights, 11 from Montevideo via Ascension to Brize Norton, and 26 from Ascension to Brize Norton. A total of 564 patients were transported from Montevideo and a further 116 direct from



VC10 used for aeromedical evacuation

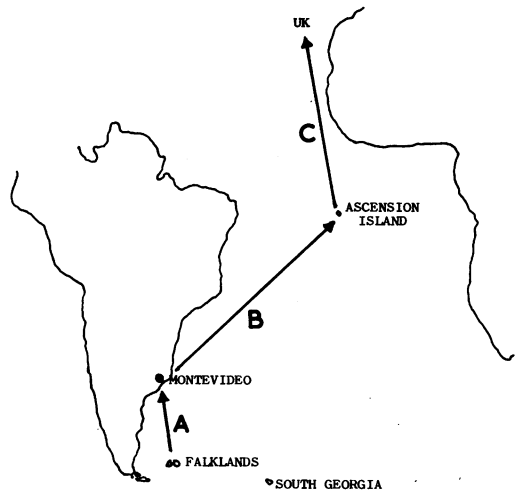


Figure 2. Main casualty evacuation route. A, *Uganda* to Montevideo by ambulance ship (4 days); B, Montevideo to Ascension by RAF VC10; C, Ascension to UK by RAF VC10

Ascension. The trip took 8½ hours to Ascension and another 8–9 to Brize Norton, where casualties were initially admitted to Princess Alexandra Hospital, RAF Wroughton for assessment, before going on to other Service hospitals. A few Hercules aircraft were used for casualty evacuation from Ascension, but are not ideal for this purpose because they are noisy and have humidity problems.

The main concern in transporting injured personnel by air is that air in body cavities may expand. Minimal use was made of the medical facilities in Montevideo, but chest and abdominal X-rays were obtained in patients who had suffered penetrating chest or abdominal wounds, to minimize the risk. CAT scans were also available for serious head injuries.

In-flight medical teams were made up of a surgeon and an anaesthetist, 6 nursing officers and 6 nursing assistants. Up to 60 patients, including 20 stretcher cases, were carried on each flight. There were no in-flight deaths and the major treatment required was analgesia for patients with burns and trench foot.

Medical lessons

There were few new medical lessons learned during the Falklands conflict, but many old ones were relearned and their values reinforced. In particular, the value of physical fitness in troops and training in first-aid were underlined. These two factors more than anything else helped to minimize casualties and mortality.

Logistics, the supply of equipment and material to troops in the field, are vital to the success of any military expedition. Supply problems were accentuated by the distances involved in this campaign, which applied equally to medical supply and resupply as to the other logistics of war. *Uganda* was fitted out on the same basis as an Army Field Hospital. It ought to have had a resupply capability for other units at sea and ashore. An adequate supply of blood for transfusion is essential in the management of casualties. Much was unusable because it was out of date or in the wrong place when it was needed, emphasizing the requirement for central control of blood and the provision of refrigeration facilities for all surgical units.

The hospital ship was successful as the major medical facility in the campaign. The presence of an intensive care unit close to the front line was invaluable but the concept of total intensive care, which was applied, could not have been maintained if casualty figures had been higher, and the hospital ship ought to have been staffed with more junior doctors and more nurses. *Canberra* had a dual role and, therefore, did not come under the protection of the Geneva Convention. It was not fully able to realize its medical potential, and it was probably a mistake to site a major medical capability in a troopship.

The vulnerability of ships to modern weapons was amply demonstrated. The rapidity with which flame and smoke spread through a ship was appalling, and poses problems in ship design. The value of simple treatment of burns was shown, but better long-term results might have been obtained in some cases if it had been possible to treat them surgically at an earlier stage. It appears that the early treatment of smoke inhalation injury by large doses of steroids helps to limit lung damage, and this is a useful lesson learned. A larger number of casualties might have been rescued from smoke-filled compartments if more ELSA kits had been available.

Survival at sea did not present a major problem, mainly because of the speed of rescue. Helicopters did a sterling job in this respect, but although they performed manfully ashore there were insufficient of them to evacuate all casualties, and lives may have been lost because of delay. The remarkably low mortality figures for both the Advanced Surgical Centre at Ajax Bay and *Uganda* indicate that the more severely injured died before they reached definitive surgical aid. This contrasts with the US medical experience in Vietnam, where casualty retrieval from the field was very efficient and hospital mortality figures consequently higher. There is a case for having helicopters dedicated to casualty retrieval. There is also a need for the infantry to have a lightweight stretcher.

Triage was applied at all points in the casualty evacuation chain, and dental officers successfully filled the role as leaders of triage teams in the Field Hospital. Difficulties in its strict application were encountered on only one occasion following the *Sir Galahad* incident.

On land the troops were exposed to cold, wet and windy conditions and trench foot was common. Most had cold, wet feet for the duration and the boots issued have come in for much criticism. A great deal was learned about non-freezing cold injury, and research into this condition continues. Already, however, the question has been raised as to whether individuals who have suffered cold injury can be used in the same conditions again. If this were to be so, the implications would be considerable.

Air operations were noteworthy for the length of flights involved in the early air attacks on Port Stanley and for the sleep pattern disturbance of aircrew. A short-acting hypnotic was valuable in this respect and produced no untoward effects. The RAF have long established air medical evacuation procedures and these proved their worth to the considerable numbers who were evacuated from the South Atlantic.

The war was a short one and produced fewer casualties than anticipated, but overall, and to paraphrase Brigadier Shaw's pronouncement – the medical capability of the Armed Services was tested and not found wanting.

Acknowledgments: I would like to acknowledge all who presented papers at the Symposium. Without their contribution it would not have been possible to write this account. A number have been mentioned in the text. Others on whose contributions I have drawn include: Surgeon Commanders J D Buchanan and J G Williams; Surgeon Lieutenant-Commanders D J Baker, I F Geraghty, O M Howard and T R D Riley; Surgeon Lieutenants G J Brooks and J Ramage; Lieutenant-Colonel J Anderson; Major J A East; Captain S J Hughes; and Squadron Leader P K L Coles.

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