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- Efficacy of RSDL® Kit in the Management of Acute Sulfuric Acid Burns in Rabbits
- Fundamental Inputs to (ADF Health) Capability: Personnel
- Agent Orange Exposure, Cytogenetics, and Clinical Outcomes in Multiple Myeloma and MGUS Patients

The Journal of the Australasian Military Medicine Association

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# Table of Contents

## Guest Editorial


..... 5

Ex-Royal New Zealand Dental Corps Dentist and Korean Veteran turns 100 ..... 6


## Original Articles


Efficacy of RSDL® (Reactive Skin Decontamination Lotion) Kit
in the Management of Acute Sulfuric Acid Burns in Rabbits ..... 8

Fundamental Inputs to (ADF Health) Capability: Personnel ..... 17

Agent Orange Exposure, Cytogenetics, and Clinical Outcomes
in Multiple Myeloma and MGUS Patients ..... 27

Developing an Operational Skillset for Military Critical Care Physicians: A Scoping Review..... 34


## History


Infectious Disease Mortality in Deployed Soldiers during the Spanish American War..... 43


## Review Article


The PACT Act of 2022 Changed my Patient's Life..... 47


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The Australasian Military Medicine Association is an independent, professional scientific organisation of health professionals with the objectives of:

- Promoting the study of military medicine
- Bringing together those with an interest in military medicine
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- Publishing and distributing a journal in military medicine
- Promoting research in military medicine

Membership of the Association is open to doctors, dentists, nurses, pharmacists, paramedics and anyone with a professional interest in any of the disciplines of military medicine. The Association is totally independent of the Australian Defence Force.


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# Guest Editorial

## "For Every Drop Shed in Anguish"

In February this year a new sculpture was dedicated in the grounds of the Australian War Memorial in Canberra.

Its purpose was described as being "a place at the Memorial for those who have experienced and witnessed the ongoing trauma that can result from military service and for visitors to the Memorial to reflect on this experience."

The front cover of this issue shows Army veteran, Ben Farinazzo, speaking at the dedication of the memorial. Ben served in East Timor and some time later suffered PTSD being hospitalised for a period. Upon returning home he suffered a severe mountain bike accident . Over the next three years with the support of his family he overcame seemingly insurmountable odds to win two gold medals at the Invictus Games in 2018.

The commissioning of the memorial followed discussions initiated by family members of those who have served and current and former members of the Australian Defence Force about how best to recognise those who have suffered as a result of their service acknowledging that at the extreme end it can result in death by suicide.

The artist, Alex Seton, said " it was very important that we create a different kind of memorial, not a singular heroic monument but a grouping that acknowledges that there is a wider impact of mental and physical impact".

The large group of spheres allude to the suffering that radiates out from the individual affecting their family, friends and community

"We proudly remember those who have died in war, but too often we overlook those who have survived their service with wounds or injuries or mental illness. Far too many families feel alone and unrecognized for their sacrifices in caring for a loved one who has served. Far too many have died by suicide."

The Assistant Minister for Defence and for Veterans Affairs, the Hon Matt Thistlethwaite spoke at the dedication noting that "the rate of veteran suicide in Australia is a national tragedy, a tragedy that successive Governments failed to act upon. That's why the Royal Commission into Defence and Veterans Suicide is so important."

The Royal Commission was set up in 2021, has held public hearings in cities throughout Australia and received over five thousand submissions.

The three Commissioners were present at the dedication and mingled with the crowd of veterans and family members present. Commissioner Brown commented "the sculpture will hopefully help members of the public reflect on what we ask of Australian Defence Force members and the sacrifices serving members, veterans and their families make in service of their country."

A month later in March 2024 the Royal Commission held the last of 10 public hearings and the Commission will present their report in October this year.

This will be a landmark document and will influence the way we address these problems in Australia. Doubtless there will be lessons that can be learned in other countries who face the same challenges,

**Michael Dowsett AM**
**Commodore RAN Rtd**
**Associate Editor of JMVH.**

**"Each droplet is carved from Australian pearl marble. The marble was selected from marble rejected by the quarry owners because of its impurities. However the artist, Alex Seton, saw the imperfections as a crucial centre piece of the work with the veins of deep rust red and bandings of grey, blue and yellow embodying the scars, seen and unseen, borne by many veterans and their families."**

# Ex-Royal New Zealand Dental Corps Dentist and Korean Veteran turns 100

*P Hurley*

A few years ago, JMVH published an article on the Korean War. The front-page photograph showed a Roya New Zealand Dental Corps officer working in a Field Dental Unit. That officer was Major (Rtd) Alan Cull OBE.

On Thursday 28 March, Alan celebrated his 100th birthday at a dinner hosted by the Manawatu Officers' Club – of which Alan is a Life member. The dinner was a success and involved a theme along the lines of "this is your Life." The mayor of Palmerston North was present, and messages of congratulations were received from King Charles, and the Prime minister among others.

Born in Palmerston North in New Zealand and went to school in Palmerston North. He says that when he started school, it was the time of the great depression, but at the age of 5 he didn't know what depression meant. "a lot of people suffered, but I had resilient working parents!" He was also at school in 1931 at the time of the Napier earthquake and says that he experienced the shake 180 Km away.

After school, he worked at Palmerston North Hospital as a trainee radiographer. He remembers that people were scared that the Japanese would bomb Palmerston North and that there were frequent air raid warnings.

He then studied dentistry at the University of Otago and worked at Wellington Hospital. He joined the army as a reserve dental officer and volunteered to go to Korea. He initially signed on for a year, but then his replacement couldn't relieve him, so he stayed for two years.

He served in the Mobile Dental Unit; the mobile dental unit was attached to a field artillery regiment, and he treated soldiers' dental problems with primitive equipment.

They weren't at the front, but he said they had to be prepared to move in a hurry. "We had a few moments of tension when the Chinese broke through the lines."

The freezing climate was difficult, and his anaesthetic would freeze. "I was most popular during the first very cold winter. All the troops got a rum ration. "I used to have a queue outside the dental tent because I had oil of clove and cloves with rum was a popular drink.".

After the war he came home to Palmerston North and joined a practice in Coleman Place for about 30 years and retired aged 60. Alan used to do a 2 mile walk every day. "I reached 100, so I must have done something right!" he says. Alan also enjoys a whisky – "usquebaugh - the water of life!" It seems to have worked in his case.

**Alan Cull**

He was awarded an OBE by Queen Elizabeth during her visit to New Zealand in 1953.

Alan lives by himself and still maintains his own property in Palmerston North.

The picture below, shows Alan in Korea with his mobile Dental Unit performing dental work on a soldier.

Alan says " I must have done something right – scored a century!"

Attached is also a link to NZ History on line, when Alan was interviewed in 2011

https://nzhistory.govt.nz/media/sound/alan-cull-describes-being-dentist-korea

**Alan Cull in his tent somewhere in Korea**

# Efficacy of RSDL® (Reactive Skin Decontamination Lotion) Kit in the Management of Acute Sulfuric Acid Burns in Rabbits

*V Savransky, P Anantharam, L Cochrane, J Barry, J Mikler*

## Abstract

RSDL® (Reactive Skin Decontamination Lotion) Kit is approved for decontaminating chemical warfare agents and T-2 fungal toxins.

This work aimed to investigate the efficacy of RSDL or water irrigation for sulfuric acid dermal decontamination against untreated control in rabbit models.

Rabbits were randomly assigned to Groups 1 (no decontamination), 2 (water) or 3 (RSDL) and exposed to sulfuric acid (0.1 mL/3-4 $cm^2$) for 30 seconds. Decontaminants remained on-site for 2 minutes.

Decontamination efficacy with RSDL and water were similar. Wound pH was higher and erythema persisted longer after decontamination versus control. Oedema developed by Day 3 and resolved by Day 15 in all groups. Necrosis started by Day 3, and all wounds had necrosis by Day 21. Wound areas following decontamination were significantly smaller than controls. Microscopically, all wounds in all groups had full-thickness epidermal and dermal necrosis.

In summary, RSDL and water were similarly effective in reducing wound size and increasing wound pH by Day 3 compared to controls. Histopathology data demonstrated similar tissue injury across all groups and showed no signs of wound healing after exposure. RSDL was a reliable decontamination method in the absence of immediate access to water.

**Keywords:** RSDL® (Reactive Skin Decontamination Lotion) Kit; sulfuric acid; dermal decontamination; wound healing; water irrigation

## Introduction

Chemical skin burns (also known as caustic burns) differ from thermal burns. They can result from reduction, oxidation, corrosion or desecration of body tissue with/without thermal injury.[1,2] Burn severity is determined by the chemical concentration, quantity, duration of contact and skin penetration of the chemical.[2] The most important aspect of management is the removal of the agent from contact with the individual. Although chemical burns account for only 2%–4% of all burn injuries, they are associated with an increased duration of hospitalisation, particularly if the injury has occurred as the result of an assault.[3] Approximately 5% of individuals with burns presenting to emergency departments require admission.[4] According to the American Association of Poison Control Centers, there were >7000 exposures to acidic substances per year reported in 2016 and 2017.[5,6]

Sulfuric acid is an oily, colourless liquid used to manufacture products such as detergents, soaps, fertilisers, lead-based batteries and some common household cleaners.[7] When splashed on skin (accidentally or intentionally), it produces dermal damage by dehydration, and thermal and chemical injury. Sulfuric acid is also a common acid used for physical assault attacks; the intent of an acid attack is not to kill but to cause permanent disfigurement.[8,9] Many of these acid attacks take place in developing countries, with the highest incidence occurring in the West Indies and Bangladesh, where resources to deal with these scenarios may be limited.[9] Criminal gangs may also use acid attacks as a form of punishment or intimidation.[9] In these attacks, the head is often

targeted and may result in severe deformation of the nose, destruction of ear cartilage or loss of eyelids or lips in survivors. Prompt management and decontamination are essential to reduce the impact of accidental or deliberate use of these caustic agents. The current standard of care for sulfuric acid injuries is to wash the wounded area with water for ≥15 minutes. While this method washes away any remaining acid, the immediate damage to the skin is difficult to prevent. Other decontaminants, such as Diphoterine® (Prevor Ltd.), a polyvalent solution, can be used for the management of acid skin injuries with some studies reporting a reduction in pain and wound healing time.[10,11] However, evidence for the use of Diphoterine is not clearly established, as other investigators have questioned the evidence base and benefits of its use.[12] Other options for immediate management after irrigation or in the absence of water include calcium gluconate gel and hexafluorine; however, the evidence to support their use is limited.[13,14]

The Reactive Skin Decontamination Lotion (RSDL) Kit was originally described by Fentabil et al.[15] It has been shown to effectively remove or neutralise chemical warfare agents (CWAs) from the skin, including tabun, sarin, soman, cyclohexyl sarin, VR, VX, mustard gas and T-2 toxin, and has been well characterised in both in-vitro and in-vivo studies.[15-19] RSDL is typically used as a carry-forward chemical countermeasure by various at-risk agencies (military and emergency responders) for timely use in the event of skin exposure to chemical warfare agents.

As mentioned previously, there is a trend of increasing cases of acid attacks in various parts of the world, which could lead to significant burn injury or even death.[20] This has necessitated additional investigation of the RSDL Kit as an emergency intervention to counteract the consequences of the use of sulfuric acid outside military theatres and accidental spillage or contamination.[21] Regarding emergency measures, immediate extensive irrigation with water and early excision of deep burns are universally accepted primary actions. However, further studies are needed to improve the early treatment of sulfuric acid burns.[22,23] National Health Service guidelines in the United Kingdom recommend early intervention, removing clothing where possible, and continuously rinsing with clean water prior to paramedic arrival and support.[24] However, water is not always readily available or transported in emergencies.

RSDL is alkaline (pH=10.6) and is expected to neutralise acids. A recent in-vitro study reported that the RSDL Kit effectively decontaminated sulfuric acid and hydrofluoric acid to 98.78% and 97.79%, respectively, on a non-porous, painted steel substrate.[25] Therefore, in-vivo studies are warranted to assess the decontamination effect on live tissue injury and lesion healing process.

The current study aimed to investigate the in-vivo efficacy of the RSDL and water irrigation for dermal decontamination of sulfuric acid in a rabbit model compared with untreated control. The rabbit model was chosen based on Organization for Economic Cooperation and Development (OECD) recommendation and data obtained from the pilot study described above.[26]

## Material and methods

### Chemicals

The RSDL (500 mL; lot number 23000933) and applicator sponge were obtained from Emergent BioSolutions Canada Inc. (Winnipeg, Manitoba, Canada). Water used in these experiments was purified using a Barnstead International Inc. (Dubuque, IA, USA) Nanopure Diamond UV Series 1191 ultrapure water system, which purifies water to a resistance of 18 MΩ cm. Water for injection was purchased from MWI (Boise, ID, USA). Sulfuric acid (CAS: 7664-93-9) was purchased from Sigma-Aldrich (lot number SHBF5690V; 96.3% purity).

### Animals

A total of 15 (12 on study with three extra/replacements) male New Zealand white rabbits, which weighed 3.1–3.6 kg and were ≥3 months old at the time of arrival, were received from Covance Research Products (Denver, PA, USA). The study protocol was approved by MRIGlobal Institutional Animal Care and Use Committee in compliance with US guidelines. General procedures for animal care and housing were in accordance with the 'Guide for the Care and Use of Laboratory Animals'. [27]

Prior to inclusion into the study, animals were inspected for health status and quarantined in the conventional animal facility for ≥7 days. Each rabbit was tattooed on one ear with a unique alphanumerical designation by the vendor. All animals included in the study were in good health and free from any signs of clinical disease prior to inclusion.

All rabbits were provided with certified feed (Harlan Rabbit Diet) and fresh tap water (Kansas City Municipality) ad libitum. The rabbits were singly housed in conventional rabbit caging and environmentally controlled rooms with at least 10 air changes per hour. The rooms were maintained at a temperature of 61°–72°F (16.2°–22.3°C) and

a relative humidity of 50% ± 20% with a 12-hour light/dark cycle/day. Room temperature, humidity and light cycles were monitored 24 hours/day throughout this study.

As the corrosive challenge agent was expected to cause pain by inducing caustic wounds, sustained-release (SR) buprenorphine (ZooPharm, Laramie, WY, USA) was given via intramuscular (IM) injection prior to sulfuric acid application and continued throughout the study to ameliorate pain and animal suffering. Analgesic dosages were tailored to each animal based on weight at the discretion of the attending veterinarian. At the conclusion of the study, rabbits were anaesthetised with ketamine (≤60 mg/kg; VetOne, Boise, ID, USA)/xylazine (≤5 mg/kg; VetOne, Boise, ID, USA) by IM or subcutaneous injection prior to euthanasia with Euthasol (≥1.0 mL/4.5 kg; VetOne, Boise, ID, USA) administered by cardiac puncture or intravenously (IV).

## Study design

Animals were randomly assigned, based on body weight, to one of three treatment groups with four animals in each group. Group 1 rabbits were not decontaminated post-sulfuric acid exposure. These rabbits remained in the chemical fume hood for ≥15 minutes post-sulfuric acid exposure and were then returned to their home cage. Group 2 and Group 3 rabbits were decontaminated via water irrigation or with the RSDL Kit. Each animal was then returned to its single cage for periodic monitoring and sample collection.

### Animal preparation

Prior to Study Day 0, rabbits had an area of approximately 124 $cm^2$ on the dorsal surface of their back (across the dorsal midline) close-clipped. Six sites (three opposite each other) across the dorsal midline were designated for sulfuric acid application, and subsequent biopsies were identified using indelible ink. On Day 1, sulfuric acid (0.1 mL/3–4 $cm^2$) was applied to the anaesthetised rabbits for 30 seconds at all six designated sites.

### Skin decontamination

The RSDL Kit application to the corrosive contaminated dermal sites occurred 30 seconds post-sulfuric acid exposure. The 10×10 cm sponge component of the RSDL Kit was cut into four approximately equal pieces, each placed in a clean weigh boat, and 10 mL RSDL was applied to each piece using a positive displacement pipette. The RSDL-soaked sponge (Kit) was used to rub each site firmly for 10 seconds to lift off the maximum amount of corrosive. Afterwards, the lotion remained on the site for 2 minutes before being firmly wiped off with clean, wet gauze using sterile water.

Water irrigation occurred 30 seconds post-sulfuric acid dermal exposure. A 10 mL syringe filled with 10 mL sterile water was used to rinse each corrosive site for 10 seconds at approximately 1 mL/second. The sterile water was applied to rinse the exposure site and run off the back of the rabbit. The water remained on the site for 2 minutes before removing the excess using clean, wet gauze.

## Clinical observations

Routine clinical observations were performed daily throughout the quarantine and acclimatisation period. Clinical observations were performed just prior to corrosive chemical application and twice daily post-exposure. Abnormal clinical observations outside specified time points were also recorded on appropriate data capture forms.

### Wound observations and measurements

The pH of each wound was tested using litmus paper (GE Healthcare-Whatman, Chicago, IL, USA). For Group 1 (animals not decontaminated post-sulfuric acid exposure), pH was measured immediately after exposure. For Groups 2 and 3 (wounds decontaminated with water or the RSDL Kit), pH was measured immediately post-decontamination, again after the wounds had been wiped with gauze, and on Day 3 after dampening the wounds with sterile water.

Modified Draize Scoring[28] was recorded prior to sulfuric acid exposure and on Days 3, 15 and 21 and included necrosis, erythema and oedema. Scar description was recorded and photographed to include form, size, discolouration and density.

The wound area at each dose site was measured directly after sulfuric acid application and again on Days 3, 15 and 21. Wound length was defined as the most dorsal point to the most ventral point of each wound based on the dorsal-ventral axis of the animal. Wound width was defined as the most cranial point to the most caudal point of each wound based on the cranial-caudal axis of the animal. The length and width were multiplied to calculate the area. Photographs of shaved dorsal sites were captured for all animals prior to exposure and on Days 3, 15 and 21.

### Wound biopsy

Biopsies were performed on Days 3, 15 and 21. Two of the six predesignated sites opposite each other on each animal were biopsied each day, starting with the most cranial sites on Day 3 and ending with the most caudal sites on Day 21. After premedication with SR buprenorphine and anaesthesia, biopsies were performed on Days 3 and 15. The animals were re-shaved if necessary, and a sterile field was prepared by first wiping the area with sterile saline followed by a chlorhexidine scrub (2/rabbit; eight wounds per group). A surgical drape was placed to isolate the biopsy site. Approximately 0.5–1.0 cm away from the wound, healthy tissue was gently grasped using atraumatic forceps. The healthy skin and wound were excised using dissecting Mayo scissors with a 0.5–1 cm margin of healthy tissue. Skin biopsies were placed into a pre-labelled cassette and 10% formalin (10:1 formalin-to-tissue ratio). If necessary, the wounds were closed using sutures, skin stapes and skin glue. The animals were then allowed to recover from anaesthesia. The biopsy wound sites were monitored for the remainder of the study for signs of infection.

On Day 21, biopsies were performed using the same procedures as above. Once the remaining wounds were harvested, the rabbit was euthanised via IV or cardiac puncture with euthanasia solution.

### Histopathology

Collected skin samples were fixed in formalin for ≥72 hours and then shipped at ambient temperature to HSRL, Inc. (Mount Jackson, VA, USA) for processing, followed by slide preparation stained with hematoxylin and eosin (H&E) for conventional light microscopy by Singer & Associates Toxpath Consulting Solutions, LLC (Ponte Vedra, FL, USA). One slide was prepared from each dose site.

A certified veterinary pathologist, blinded to the decontamination methods and treatments, reviewed the H&E-stained slides and provided subjective wound site healing and re-epithelialisation assessments using the scoring criteria of re-epithelialisation, abnormal epidermal cells, basement membrane, hair follicles, vascular proliferation, haemorrhage, dermal necrosis changes and dermal inflammation.

## Statistical analyses

Wound area was analysed using pairwise marginal means estimates, and modified Draize scores were analysed using Type III test for fixed effects analysis of variance performed using SAS Version 9.4 (SAS Institute Inc., Cary, North Carolina) to discern the efficacy of the RSDL Kit and water decontamination procedures versus no decontamination for the treatment of corrosive dermal wounds.

## Results

### Wound pH

The wound pH means in treatment groups are shown in Table 1.

### Modified Draize scoring

All animals exposed to sulfuric acid developed erythema within 3 days post-exposure (Table 3). Erythema persisted until Day 15 for all groups, with Group 1 (no decontamination) having the highest scores (1–3) compared with Groups 2 and 3 (water and RSDL Kit, respectively, range 0–2). Groups 2 and 3 had significantly lower erythema scores on Study Day 15 ($p < 0.05$). By Day 21, only Groups 2 and 3 had erythema scores ranging between 0–1. Scores for Groups 2 and 3 were significantly lower than for Group 1 (Table 2).

**Table 1. Wound pH**

| Group ID | Decontamination | Post-sulfuric acid application | | Post-gauze wipe | | Day 3 post-exposure | |
|---|---|---|---|---|---|---|---|
| | | Mean pH | Std Dev | Mean pH | Std Dev | Mean pH | Std Dev |
| 1 | No decontamination | 0.00 | 0.00 | NA | NA | 3.42 | 0.91 |
| | | Post-decontamination | | Post-gauze wipe | | Day 3 post-exposure | |
| 2 | Water | 1.00 | 0.00 | 1.00 | 0.00 | 5.00 | 0 |
| 3 | RSDL Kit | 1.67 | 0.30 | 1.21 | 0.21 | 4.54 | 0.55 |

**NA, not applicable; RSDL, Reactive Skin Decontamination Lotion Kit; Std Dev, standard deviation.**

**Table 2. Sulfuric acid dermal exposure erythema, oedema and necrosis scores (Modified Draize scores)**

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Erythema scores*** | | | | | | | | | | | | | | | | | | | | | |
| Group | | Day 0 | | | | | Day 3 | | | | | Day 15 | | | | | Day 21 | | | | |
| | | N | 0 | 1 | 2 | 3 | N | 0 | 1 | 2 | 3 | N | 0 | 1 | 2 | 3 | N | 0 | 1 | 2 | 3 |
| 1 | None | 24 | 24 | 0 | 0 | 0 | 24 | 0 | 22 | 1 | 1 | 12 | 0 | 6 | 2 | 4 | 6 | 6 | 0 | 0 | 0 |
| 2 | Water | 24 | 24 | 0 | 0 | 0 | 24 | 0 | 21 | 0 | 3 | 16 | 0 | 12 | 4 | 0 | 8 | 6 | 2 | 0 | 0 |
| 3 | RSDL Kit | 24 | 24 | 0 | 0 | 0 | 24 | 0 | 12 | 12 | 0 | 16 | 1 | 14 | 1 | 0 | 8 | 5 | 3 | 0 | 0 |
| **Oedema scores†** | | | | | | | | | | | | | | | | | | | | | |
| Group | | Day 0 | | | | | Day 3 | | | | | Day 15 | | | | | Day 21 | | | | |
| | | N | 0 | 1 | 2 | 3 | N | 0 | 1 | 2 | 3 | N | 0 | 1 | 2 | 3 | N | 0 | 1 | 2 | 3 |
| 1 | None | 24 | 24 | 0 | 0 | 0 | 24 | 0 | 0 | 24 | 0 | 12 | 12 | 0 | 0 | 0 | 6 | 6 | 0 | 0 | 0 |
| 2 | Water | 24 | 24 | 0 | 0 | 0 | 24 | 2 | 4 | 18 | 0 | 16 | 16 | 0 | 0 | 0 | 8 | 8 | 0 | 0 | 0 |
| 3 | RSDL Kit | 24 | 24 | 0 | 0 | 0 | 24 | 0 | 0 | 24 | 0 | 16 | 16 | 0 | 0 | 0 | 8 | 8 | 0 | 0 | 0 |
| **Necrosis scores‡** | | | | | | | | | | | | | | | | | | | | | |
| Group | | Day 0 | | | | | | Day 3 | | | | | | Day 15 | | | | | | Day 21 | | | | | |
| | | N | 0 | 1 | 2 | 3 | 4 | N | 0 | 1 | 2 | 3 | 4 | N | 0 | 1 | 2 | 3 | 4 | N | 0 | 1 | 2 | 3 | 4 |
| 1 | None | 24 | 24 | 0 | 0 | 0 | 0 | 24 | 20 | 2 | 1 | 0 | 1 | 12 | 0 | 0 | 0 | 4 | 8 | 6 | 0 | 0 | 0 | 0 | 6 |
| 2 | Water | 24 | 24 | 0 | 0 | 0 | 0 | 24 | 24 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 5 | 11 | 8 | 0 | 0 | 0 | 0 | 8 |
| 3 | RSDL Kit | 24 | 24 | 0 | 0 | 0 | 0 | 24 | 21 | 3 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 1 | 15 | 8 | 0 | 0 | 0 | 0 | 8 |

**N = Number of evaluated sites with sulfuric acid application**

***Erythema scoring: 0 = Unchanged from an uncontaminated area of skin; 1 = Mild erythema; 2 = Moderate erythema; 3 = Severe erythema.[28]**

**†Oedema scoring: 0 = Unchanged from an uncontaminated area of skin; 1 = Mild oedema; 2 = Moderate oedema; 3 = Severe oedema.[28]**

**‡Necrosis scoring: 0 = Unchanged from an uncontaminated area of skin; 1 = Focal necrosis (focal area[s] of tissue [is/are] necrotic); 2 = Mild Necrosis (25–50% of the tissue is necrotic); 3 = Moderate necrosis (50–75% of the tissue is necrotic); 4 = Severe necrosis (75–100% of the tissue is necrotic).[28]**

**RSDL Kit, Reactive Skin Decontamination Lotion Kit.**

Oedema developed within 3 days of exposure in all groups. All wounds in Group 1 scored a 2, wounds in Group 2 had scores of 0–2, and all wounds in Group 3 had a score of 2. Oedema had resolved by Day 15 (Table 3). On Day 3, oedema was significantly lower in Groups 2 and Group 3 compared to Group 1 ($p < 0.01$).

Necrosis started to develop in the wounds of Groups 1 and 3 by Day 3. The scores ranged from 0–4 for Group 1 and 0–1 for Group 3. Group 2 did not have any necrosis on Day 3. By Day 15, all wounds in all groups had necrosis (score range 3–4). By Day 21, all wounds in all groups were scored at 4 (Table 3). There were no statistically significant differences between the groups in the context of necrosis.

## Wound area

The results of would area measurements over time are presented in Figure 1. Animals in all groups developed wounds within 3 days of sulfuric acid exposure. Decontamination decreased the level of tissue injury and led to consistently smaller wound sizes in Groups 2 (water) and 3 (RSDL Kit) compared with Group 1 (no decontamination; $P \leq 0.0001$).

Moreover, in Group 3, progressive wound area reduction was demonstrated with time, unlike those without decontamination (Table 3). Post-hoc least squares means tests were performed to determine significant differences between marginal means at each time point for each group level. Pairwise comparisons show estimated differences in marginal group means and adjusted *P* values (Table 3). For the

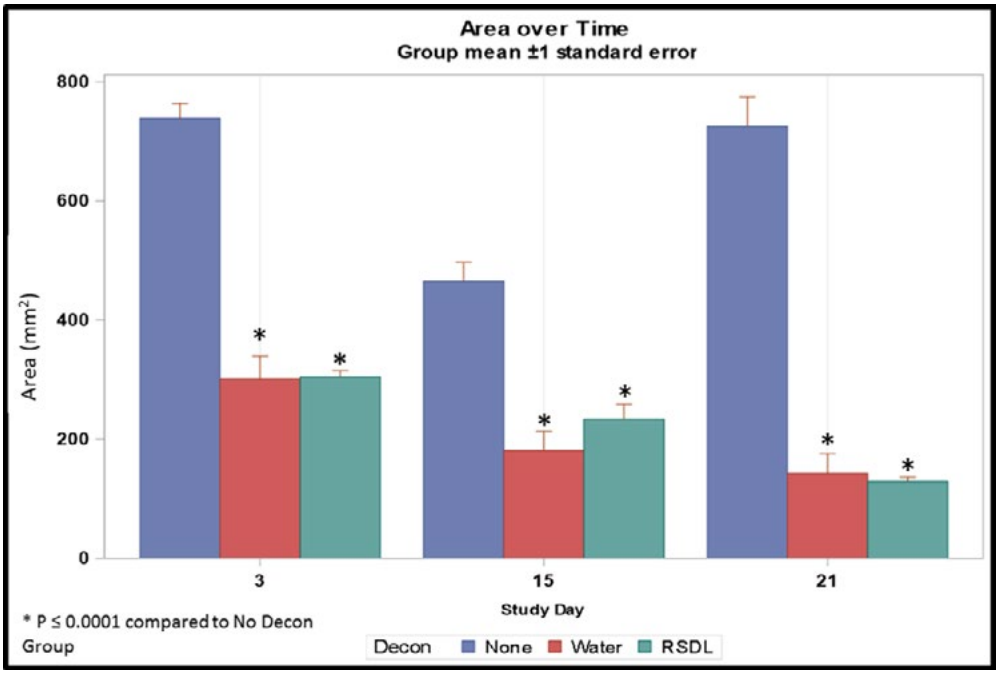


**Figure 1. Dermal wound area post-sulfuric acid exposure with no decontamination, water decontamination and decontamination using the RSDL Kit post-exposure. Decon, decontamination.**

**Table 3. Pairwise marginal means estimates—area**

| Group | | Timepoint contrast (days) | | Difference in wound size | t value | Adjusted *P* value |
|---|---|---|---|---|---|---|
| 1 | None | 3 | 15 | 275.64 | 11.03 | <0.0001 |
| | | 3 | 21 | 34.4522 | 1.05 | 0.5498 |
| | | 15 | 21 | –241.19 | –7.07 | <0.0001 |
| 2 | Water | 3 | 15 | 76.5659 | 3.50 | 0.0025 |
| | | 3 | 21 | 170.09 | 5.94 | <0.0001 |
| | | 15 | 21 | 93.5209 | 3.17 | 0.0068 |
| 3 | RSDL Kit | 3 | 15 | 121.91 | 5.57 | <0.0001 |
| | | 3 | 21 | 161.62 | 5.64 | <0.0001 |
| | | 15 | 21 | 39.7122 | 1.34 | 0.3768 |

decontamination of sulfuric acid from rabbit skin, our data show that RSDL Kit performs similarly to water.

## Histopathology

Due to opening wounds and insufficient healthy skin to close biopsy sites, one animal in Group 1 (no decontamination) whose wounds opened up after the Day 3 biopsies were removed from the study by Day 7. All remaining wounds for this animal were harvested on Day 7.

Microscopically, all wounds had full-thickness epidermal and full-thickness dermal necrosis, regardless of decontamination procedures. Necrosis continued into the hypodermis, generally with some degree of skeletal muscle necrosis. Based on the necrosis observed in all wounds, there was no evidence of wound healing in any group, regardless of biopsy day. Representative photomicrographs of the dose sites throughout the study are included in Figure 2.

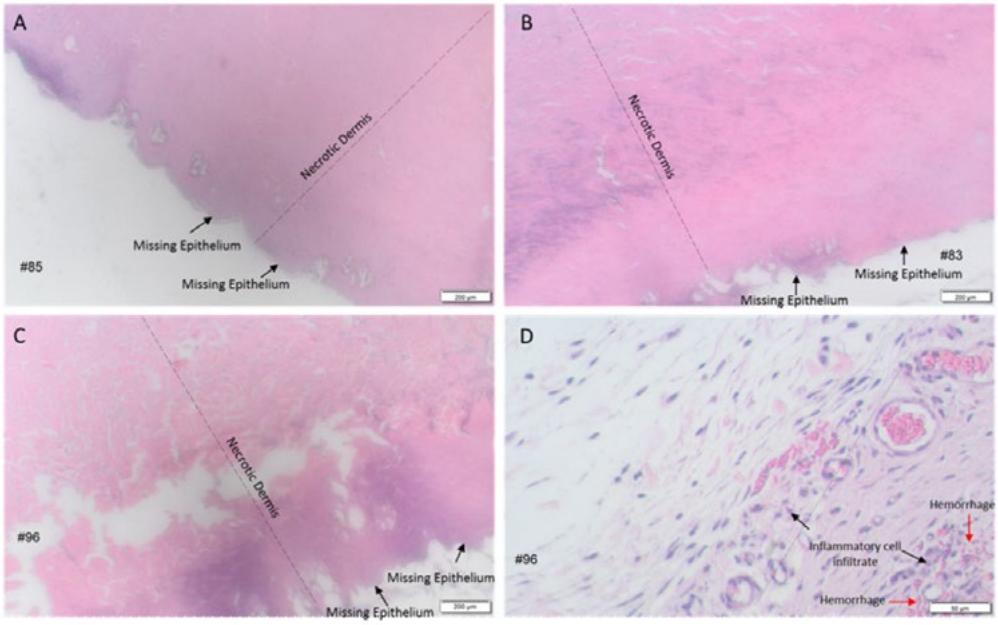


**Figure 2. Representative photomicrographs of wounds exposed to sulfuric acid with no decontamination, water and the RSDL Kit. A–C) 2X images, all wounds had missing epithelium and necrosis from epidermis to hypodermis (not shown) A) wound harvested on Day 7 from rabbit that received no decontamination post-sulfuric acid exposure B) wound harvested on Day 15 from rabbit that received water irrigation post-sulfuric acid exposure C) wound harvested on Day 21 from rabbit that received decontamination using the RSDL Kit post-sulfuric acid exposure. D) 10X image, hypodermis-dermal junction with inflammatory cell infiltrate and haemorrhage in wound harvested on Day 21 from rabbit that received the RSDL Kit decontamination post-sulfuric acid exposure.**

## Discussion and conclusions

This study examined the effect of the RSDL Kit on wound healing compared with no intervention or water irrigation for dermal decontamination of sulfuric acid exposure in the rabbit model. This model accurately predicts severe human skin injury but may have some limitations in distinguishing mild and moderate changes.[29]

Overall results of this study demonstrated that the effectiveness of the RSDL Kit was equivalent to water irrigation treatment with respect to wound size and pH, while the histopathology data demonstrated that all wounds across all groups were similar due to initial strong acid corrosive injury. Though the rabbit model may not fully reflect the human scenario, RSDL appears to have reasonable applicability in managing caustic skin damage without immediate access to water.

Both water (Group 2) and the RSDL Kit (Group 3) were equally effective in managing sulfuric acid skin exposure. Wound areas decontaminated with water or the RSDL Kit were significantly smaller than wound sites without decontamination (Group 1). The wounds in Group 1 continued to worsen during the in-life observations of this study due to the lack of decontamination procedures and did not demonstrate signs of healing or stabilisation of the injury. The pH of wounds in Groups 2 and 3 was higher than in Group 1. Erythema persisted to Day 21 in Groups 2 and 3 compared with Group 1, which had no erythema on Day 21. The absence of erythema together with persistent necrosis/wound area could be evidence of no wound healing, as has been shown for laser burn in nontreated animals.[30] Oedema developed by Day 3 in all groups and resolved by Day 15. Necrosis started in Group 1 and in Group 3 (to a lesser degree) by Day 3, but all wounds had necrosis by Day 15 and 21. Microscopically, all wounds in all three groups had full-thickness epidermal necrosis and full-thickness dermal necrosis. Necrosis continued into the hypodermis, with some degree of skeletal muscle necrosis in all wound sites.

While decontamination with the RSDL Kit (Group 3) and water irrigation (Group 2) effectively reduced wound size and increased wound pH by Day 3, the histopathology data demonstrated that all wounds across all groups were equally damaged after the

strong corrosive acid exposure. In this study, the RSDL Kit was not inferior to standard emergency treatment with water irrigation for decontaminating the burns caused by sulfuric acid. In the absence of immediate access to water, the results of the current study support the use of RSDL Kits as a reliable decontamination method.

This work was performed with some limitations to address specific medical gaps related to the timely and effective removal of acid from the skin at the first point of care and where immediate access to water is not available and not with the expectation of modification of current medical policies. The fully (96.3 %) concentrated sulfuric acid used in this study may have been too caustic to demonstrate any improvement in wound healing with either form of skin decontamination, but concentrations of up to 98% are found in many commercial products, supporting the use of the full concentration in this study.[2,31] Further studies to evaluate the efficacy of the RSDL Kit, water irrigation, and other methods of decontamination on wound healing after exposure to sulfuric acid are needed to develop guidance for the management of accidental or malicious exposure to sulfuric acid and other caustic compounds.

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# Fundamental Inputs to (ADF Health) Capability: Personnel

*N Westphalen*

## Introduction

There has been a longstanding misperception within Defence, government and the general public that the ADF health services only need to provide treatment services. This notion fails to recognise the other two intrinsically linked 'purposes' (what would now be called 'missions') identified by Arthur Graham Butler in his seminal WWI medical history:[1,2] enabling operational capability and facilitating civilian re-integration.

The paper *originally* intended to be first in this new series was intended to provide an overview regarding the Fundamental Inputs to (in this case, ADF health) Capability or FICs per the *Defence Capability Manual* (DCM), which the ADF's health services need to perform the functions and roles required to fulfil their missions (Figure 1). Instead, the previous paper focused on the ADF's health 'organisation' FIC,[3] while this paper analyses the 'personnel' FIC.

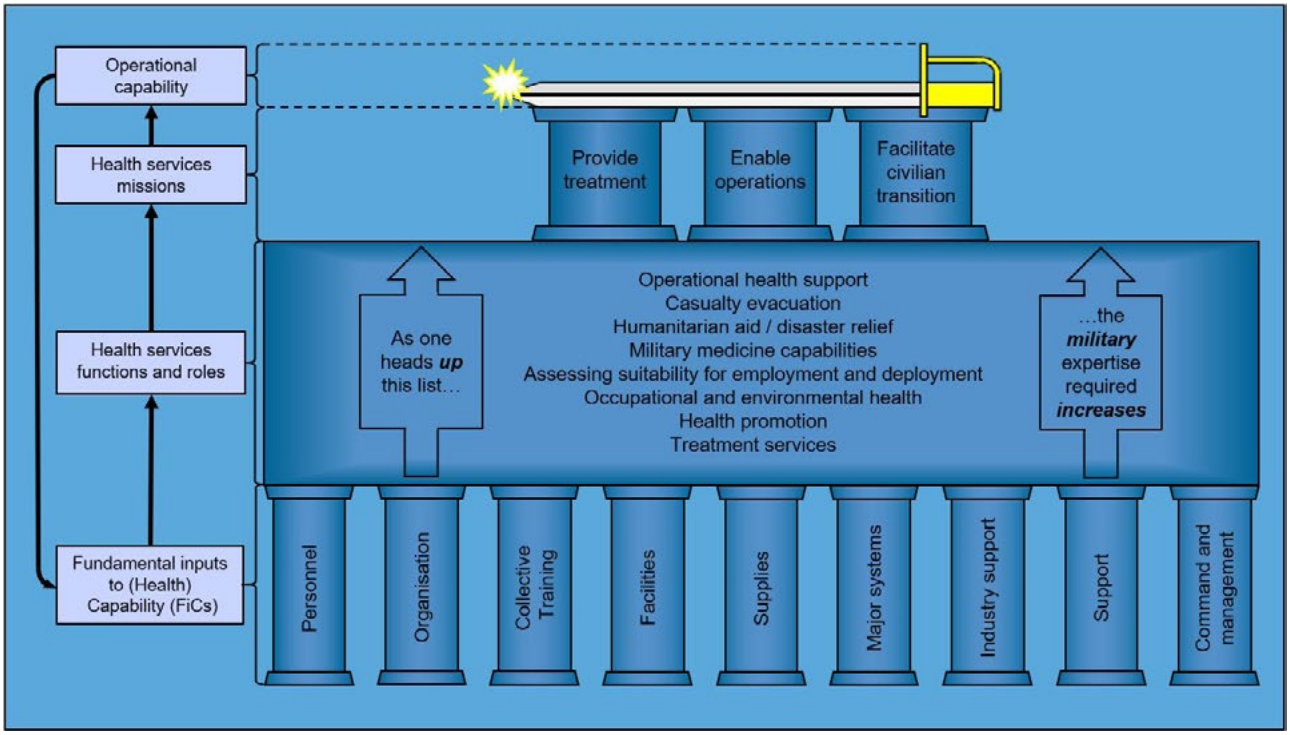


**Figure 1: The relationships between ADF operational capability, and the ADF health services' missions, functions and roles and FICs.**

Although this paper focuses on why and how Medical Officer (MO) recruiting and post-entry *medical* (as opposed to *military*) induction education and training requires elemental reform, many of the same issues pertain to ensuring that *all* ADF health personnel possess *all* the skills they need to play their part in fulfilling Butler's missions via the aforementioned functions and roles.

## Background

Before proceeding any further, it is first necessary to summarise how Figure 1 was derived.

### (Health) FICs

The DCM defines 'capability' as the 'power to achieve a desired operational effect in a nominated environment within a specified time, and to sustain that effect for a designated period'. It then explains how the following FICs generate ADF capability:[4]

- Organisation[5]
- Personnel (the subject of this article)
- Collective training
- Facilities
- Supplies
- Major systems
- Support
- Industry
- Command and management

This series of papers is premised on applying the DCM definition of 'capability' to the ADF health services: the 'desired [health] operational effect in a nominated [health] environment' pertains to fulfilling Butler's missions via the functions and roles over an indefinite period.

### Functions and roles

The author's previous series of papers[6,7,8,9,10,11,12,13,14,15,16] explained the need for better workplace-related illness and injury prevention, not just to reduce the demand on Defence and the Department of Veteran's Affairs (DVA) on their treatment and civilian re-integration services but also their generally avoidable impact on ADF operational capability. To that end, that series developed the following list of military health service functions and roles:

- Military health support
- Casualty evacuation
- Humanitarian aid/disaster relief
- Military medicine capabilities in support of the ADF's aviation, diving and submarine operations, as well as chemical, biological, radiological and nuclear defence
- Assessing health-related suitability for military employment and deployment
- Occupational and environmental health
- Health promotion
- Treatment services

These functions and roles are arranged in priority order: as one heads *up* the list, the level of military expertise required to conduct each one *increases*.

One of the articles in that series[17] also formed the basis of submissions by the Royal Australasian College of Physicians to the 2019 Productivity Commission inquiry into veteran's health, and the current Royal Commission on Defence and Veteran Suicide.[18,19] It explained how reducing ADF workplace injuries would best be achieved by premising its health services on a systems-based occupational health strategic model.

### Butler's missions

Another article in that series[20] explained how and why, despite having since been forgotten or ignored, Butler's history represented 20 years of historical analysis that identified what would now be referred to as the three elemental and enduring missions of military health services. The same article also expanded on the contention that the ADF's health services should be premised on an occupational-health-based systems model, and explained why healthcare for military workforces should be provided by practitioners under military discipline.

Although Butler understandably described them from a post-WWI Army perspective, that article also asserted that, although their implementation may differ, his missions remain relevant today to all three services in both peace and war. Unfortunately, only his 'treatment service' mission is resourced accordingly at present, including how ADF MOs are educated, trained and recruited.

## Population factors driving the ADF health personnel FIC

Another article in the previous series[21] explained why the size and scope of *any* health service should first reflect the demographics of the target population(s) they support. For the ADF population, these include (but are not limited to) being highly medically selected, (still) predominantly male, younger working age, widely geographically distributed and with high geographic mobility and turnover rates compared to the civilian community. Hence, rather than reflecting a typical civilian General Practitioner (GP) dependency, the ADF is, first and foremost, a *workforce* population.

Consideration also needs to be given to the generally *preventable* biological, physical, chemical, ergonomic and psychosocial workplace hazards to which the ADF population is exposed. Although many of these are not unique to the ADF, its personnel are arguably

exposed to the most diverse range compared to other Australian workforces, even in the base setting. Meanwhile, ADF members in the deployed setting are exposed to even greater operational and non-operational hazards, the former including those that are *deliberately* intended to *cause* harm.

These considerations have two implications regarding the ADF's health personnel FIC:

- The demand for clinical services such as paediatrics and geriatrics is eliminated, apart from niche HADR operations where the security situation precludes using non-military health agencies. Furthermore, the demand for other health services, such for age-related chronic conditions, is substantially reduced.[22,23]
- Conversely, the demand for other health services is substantially *increased*, such as those related to workplace- and sports-related musculoskeletal injuries, domestic- and workplace-related mental health issues, and risk-taking behaviours such as driving habits, horseplay, sexually transmitted disease and alcohol and other drug use. In addition, the scope of the women's and men's health services required are likewise affected by these factors.[24]

Hence, these factors drive the imperative to consider the ADF population as requiring bespoke military clinical skills and expertise to fulfil their 'treatment service' mission, in some respects not unlike the Australian indigenous and LGBTIQ+ subpopulations. However, fulfilling the 'operational capability' and 'civilian re-integration' missions also drives an imperative to *prevent* and treat *avoidable* work-related injury and illness in the first instance.

## MO induction education and training

The need for bespoke *clinical* military induction *training* is well-accepted by the ADF and its health services, as demonstrated by the Emergency Management of Severe Trauma course for all permanent ADF MOs as part of their initial career progression, and the single-service underwater and aviation medicine courses undertaken in Australia and overseas. Military clinical courses are also provided for procedural specialist MOs, such as the Definitive Surgical Trauma Care course and the Definitive Anaesthetic Trauma Course. Non-MO examples include the Dental Officer Initial Course (a module on battlefield facial injuries) and the Definitive Perioperative Nurses Trauma Course. To these can be added the basic and other courses provided for medical sailors, soldiers and airmen by the ADF School of Health and the single-service schools.

However, it should be noted that like the rest of medicine in general, these courses only provide skills-related *training* as to *how* to do certain things, rather than *non*-clinical education as to *why* they need doing in the first instance. Furthermore, there is currently *no* induction training *or* education for ADF medical or other clinicians to fulfil the 'operational capability' or 'civilian re-integration' missions. This paper asserts that such education *and* training should be based on fulfilling all three of Butler's missions via the functions and roles per Figure 1 as follows:

- **'Military health support'**.[25] This need only comprise awareness *education* as to *why* such support is necessary, prior to undertaking *training* as to *how* via the Joint Health Planning Course (typically at the O4 level some years later).
- **Casualty evacuation.**[26] This also only needs to comprise awareness *education* as to *why*, before undertaking *training* as to *how* via the current fixed- and rotary-wing aeromedical evacuation courses.
- **HADR.**[27] This would entail *education* as to why the scope of the ADF's health services regarding HADR should be limited to supporting ADF and other entitled personnel, rather than providing direct treatment services for affected populations.
- **Military medicine capabilities.**[28] This likewise only needs to entail education as to why the need exists for military-specific aviation, underwater and Chemical, Biological, Radiological and Nuclear (CBRN) training. As an aside, it should be noted that the last in-depth CBRN course was conducted in 2012.
- **Assessing suitability for employment and deployment.**[29] This would entail education *and* training regarding:
  - conducting *occupational military* medical, dental and psychological suitability assessments as intrinsic to *every* patient they see, and
  - applying the ADF Medical Employment Classification (MEC) System as a *personnel* rather than a *patient* management tool.
- **Occupational and environmental health.**[30,31,32] This refers to *education* regarding their contribution to putting the 'health' in 'occupational health and safety' (in particular, understanding why, when and how to seek advice), prior to undergoing further training (see below).

- **Health promotion.**[33] This refers to education *and* training regarding *workplace* health promotion activities beyond the healthy lifestyle topics per the Royal Australian College of General Practitioners (RACGP) 'Red Book'[34], especially in—but not limited to—the operational setting.
- **Treatment services.**[35] Although the aim of this topic is not to teach their jobs, MOs still need education as to *why* their *military* clinical practice *must* extend *beyond* history-taking, physical examination, ordering investigations, formulating diagnoses and prescribing treatment, to *also* include:
  - assessing and documenting the work-relatedness of their patient's medical conditions for compensation and post-separation management purposes, and
  - assessing the effect of their condition(s) on their patient's duties and vice versa (i.e., the effects of their duties on their condition(s)).

If nothing else, this topic would also explain why ADF patients are more administratively complex (i.e. bureaucratic) than civilian cases.

In addition, MO induction education *and* training should also include awareness of the health FICs as follows:

- **Organisation.**[36] This is especially relevant to the ADF's reserve health officers, some of whom are unaccustomed to working in environments where healthcare is *not* the primary focus.
- **Personnel.** This refers to expanding the scope of this paper by explaining why and what the ADF seeks from its health officers *besides* their clinical expertise.
- **Collective training.** Although this perhaps is not required until entrants join their first health centre or clinic, it can provide a baseline for them to build on.
- **Facilities.** Although most fixed ADF health facilities are essentially the same as their civilian counterparts, consideration could be given to awareness of the ADF's deployable facilities and their capabilities.
- **Supplies.** This entails education regarding their role (whether medical, dental, nursing, pharmacy or other allied health) with respect to ensuring that the right amounts of the right items (and their spares) are provided to the right place(s) at the right time(s) and that they are in-date, remain sterile, maintained within the cold chain and/or properly serviced.
- **Major systems.** This refers to using the ADF's health information technology systems for tasks such as patient records, telehealth, casualty regulation and medical store management.
- **Civilian industry support.** This refers, in particular, to education as to why as well as how to use the *clinical* expertise that is only available from the civilian health system, *without* abandoning the *military* aspects of *managing* (not just *treating*) ADF patients.
- **Other support.** This only need entail education regarding of the various forms of *non*-clinical health support provided by other ADF elements. Potential examples include providing ship's first aid parties for Navy, and engineering services for deployed Army and Air Force health units.
- **Command and management.** This entails education as to *why* as well as *how* the health command and administrative processes interact with each other, and with the relevant commanders.

This education and training can be achieved by a single albeit highly modularised ADF Health Officer Induction Course (HOIC), which would fill the knowledge gaps in the current and provide a common baseline for subsequent courses. The HOIC should be conducted at the end of the single-service military induction training and should be brief enough (no more than two weeks) to facilitate the greatest possible face-to-face participation by reserve and permanent health officers. It should include common elements for the aforementioned topics, with breakout sessions for the different health professions and single-service groups.

As it should *clearly* explain *why* as well as *how* the ADF health services are a small part of a much larger organisation for which healthcare is *not* its primary focus, the HOIC should be conducted at a Canberra venue such as the Australian Defence Force Academy (rather like the ADF Chaplain's College) rather than a health-only location such as HMAS *Penguin*, Bandiana or Richmond. This would not only allow briefs and lectures by the relevant Joint Health Command (JHC), single-service health directorates and Joint Operations Command (JOC) health staff, but also the relevant *non*-health ADF elements who interact the most with the health services, such as the single-service career management agencies, and commander designate course staff. It would also allow DVA representatives to explain what they need from ADF health personnel, for the latter to fulfil Butler's 'facilitate civilian transition' mission. These *education* components preclude exclusively relying on computer-based training or other forms of distance learning.

## MO recruiting and retention

It should be apparent by now that the clinical expertise that MOs bring to the ADF on entry only constitutes a baseline: besides additional clinical training for the 'treatment service' mission, they also require education regarding the 'operational capability' and 'civilian re-integration' missions. It is therefore unclear how this can be addressed by only addressing their conditions of service per Project DUNLOP,[37] given the ongoing mismatch between what the ADF's *current* MOs *want* to do versus what the ADF *needs* them to do to fulfil Butler's missions. Explaining this mismatch partly pertains to how MOs are currently recruited, requiring some historical background.

The ADF conducted multiple MO recruiting and retention studies from the mid-1970s to the early 2000s.[38] These studies coincided with multiple efficiency and economy reviews,[39,40,41,42,43] which essentially ignored the 'operational capability' and 'civilian re-integration' missions. These studies instead identified a lack of *clinical training* opportunities, in the context whereby entering MOs with *any* postgraduate qualifications into the permanent ADF has continued to average perhaps one per service per 10 years, at least since the 1980s.

Hence, the ADF's current permanent MO recruiting practices have almost exclusively been based on facilitating Primary Health Care (PHC) training via the RACGP and the Australian College of Rural and Remote Medicine (ACCRM).[44] Meanwhile, the ADF's secondary and tertiary specialist clinical requirements were only partly met by reservists, which led to the Medical Specialist Program being introduced in 2014.[45]

Although this model fulfilled *some* of the ADF's 'treatment service' mission requirements, it also continues to target its recruiting efforts on MOs who will leave as soon as possible to pursue civilian clinical careers: this at least partly explains the current post-Return of Service Obligation (ROSO) rate of about 10% per annum (i.e. around one MO per service per year). This is becoming unsustainable as the RACGP places more onerous limitations such that its Defence registrars spend less time seeing ADF patients. Furthermore, besides not meeting *all* the aforementioned PHC 'treatment service' mission requirements the ADF needs, this model fails to enable the *other* functions and roles necessary to fulfil the 'operational capability' and 'civilian re-integration' missions.

Broadly speaking, the ADF has two options to resolve this issue. One is to ascertain how many O4 and O5 MOs it needs to conduct all three missions, accept the current post-ROSO retention rate, and increase the number of PHC MO entrants accordingly. This would mean the ADF would reliably obtain four or five years of employment before they separate, which would increase the deployable MO pool, make it easier to staff base health clinics where finding contractors is difficult and make it worth providing additional *non*-clinical medical education and training such as the HOIC. However, this option still does not facilitate the *depth of expertise* ADF MOs need to fulfil their 'operational capability' and 'civilian re-integration' missions. It is also inconsistent with the current 'garrison' health support model, which for the last 25 years has been premised on employing contract civilian APS and contractors in the base setting rather than uniformed MOs.

The second option would instead entail Defence redirecting its MO recruiting efforts towards *non*-RACCGP/ACCRM candidates. These would still provide primary healthcare alongside their PHC peers to begin with, but move to facilitating the other two missions *as part of their normal civilian career progression* in due course. To this end, the aforementioned ADF population factors explain why ADF patients do *not* always need the full range of GP-level PHC services, and that most of those they *do* need are for *work*-related musculoskeletal and mental health conditions.[46,47] Furthermore, as previously explained, the ADF needs MOs whose PHC roles entail the following skills *additional* to providing clinical treatment:

- Assessing how their patient's job affects their health, and how their health limits or stops them from doing their job as intrinsic to their *routine* PHC for *every* ADF patient they see. This would fulfil their 'operational capability' and 'civilian transition' mission and their 'treatment service' mission.
- Providing—and later managing—workplace-based rehabilitation (thereby fulfilling their 'treatment service' and 'operational capability' missions).
- Facilitating compensation (thereby fulfilling their 'civilian transition' mission).
- Implementing—and later designing—workplace health promotion programs to prevent work-related illness and injury (thereby fulfilling all three missions).

These tasks would, in turn, support systemic health research into work-related illness and injuries to inform ADF health policy development, thereby establishing a feedback loop to make ADF

workplaces—including those in the deployed setting—healthier and safer. Besides providing *targeted* treatment services for a *workforce* population, doing so would also reduce the *preventable* workplace illness and injury costs incurred by Defence and DVA, enhancing ADF operational capability.

Besides the 'general ADF' population, these activities also need to be conducted for its Specialist Employment Classification (SPEC) subpopulations, such as aircrew, submariners and divers, noting these comprise a surprisingly large proportion (about 15%) of the ADF workforce.[48]

Therefore, it seems reasonable to assert at this point that the medical specialties whose civilian career progression is most compatible with *all three* ADF health services missions are Occupational and Environmental Physicians (OEPs) and Public Health Physicians (PHPs). While admittedly simplistic, one of the differences between these two specialties is that PHPs focus on the general population, while OEPs focus on workforces. A more important differentiation, however, is that although both specialities consider the environmental effects—including workplaces—on a target population's health, OEPs *also* consider vice versa, i.e. health-related suitability for workplaces. This explains why the ADF needs to prioritise recruiting potential OEPs.

There are several reasons why this has not occurred: besides the focus on treatment services at the expense of the other two missions, can be added the small size of the civilian OEP and PHP workforces (currently around 500 and 600, respectively, in Australia and New Zealand), and the viability of post-ADF civilian OEP and PHP careers. Even so, the ADF health services do not require large numbers: they only need enough to conduct Butler's missions.

In addition, rather than health administration qualifications (whose scope is generally limited to administering civilian treatment services),[49] the ADF's PHC MOs should undertake postgraduate occupational and public health diplomas at the O3 level and masters at the O4 level as part of their ADF career progression. However, although several tertiary institutions provide Masters of Public Health (MPH) courses, at present, this is not so for occupational medicine. Hence, as an operational capability enabler, Defence should consider funding a university (as it did the Centre of Military and Veteran's Health for some years from the early-mid-2000s) to establish occupational and environmental health diploma and masters courses based on their existing MPH courses.

Although these added requirements may give pause to candidates who only see Defence as a short-term employer en route to their definitive civilian GP career, focusing on recruiting prospective OEPs and PHPs should not only improve overall MO retention but also provide additional skill sets the ADF needs beside those required to treat patients. Ascertaining the number of permanent ADF PHC and OEP/PHP practitioners should be premised on:

- Identifying the number of O5 and O6 OEP and PHP practitioners required to conduct all three missions, which can be used to determine the number of O3 and O4 trainees required to sustain them. Although it will take time to ascertain their retention rate, it seems reasonable to assert that the closer alignment between their service and civilian employment should make it better than their PHC counterparts' 10% per annum.
- Using the current 10% per annum historical PHC MO retention rate to ascertain how many O3 entrants would be required to fill the remaining O4, O5 and O6 PHC MO positions.

Finally, it should be noted that this approach has considerable potential to create synergies between future co-located ADF PHC trainees and practitioners and their OEP and PHP colleagues.

## Conclusion

There has been a longstanding misperception within Defence and elsewhere, that its health services only need to provide treatment services. This fails to recognise the other two missions necessary to support *military workforces* rather than civilian populations: enabling operational capability and facilitating their eventual transition to the civilian community.

The previous series explained why excessive workplace illness and injury rates confirm the need to improve the management of hazards associated with ADF workplaces, with better emphasis on prevention. Figure 1 summarises these papers by showing the relationships between ADF operational capability, the three health service missions that support that capability, the eight health service functions and roles that enable those missions, and the nine FICs they need to conduct those functions and roles. It also demonstrates the extent to which occupational and environmental health is intrinsic to *all* the components of a truly holistic military healthcare system.

This paper explains why the health 'personnel' FIC is not fit for purpose in its current form regarding ADF MOs (and, by extension, other health officers). Besides neglecting the 'operational capability' and 'civilian re-integration' missions, the focus since the late 1990s on recruiting those intent on civilian GP careers has precluded providing *all* the PHC services required for the ADF *workforce*.

Hence, consideration should be given to the following:

- Establishing an ADF HOIC, to *educate* (not just *train*) permanent and reserve members in the functions and roles they must perform to fulfil Butler's missions, and the FiCs that sustain them. As this entails clearly articulating what the ADF *needs* as opposed to what its current health staff *want* (especially given their role within an organisation in which healthcare is *not* its primary focus), this course should be conducted at a Canberra venue, to include the relevant *non*-health headquarters, directorates, and other agency speakers, as well as JHC, JOC, the single-service health directorates, and DVA.
- MO recruiting should be re-prioritised to entice more candidates to undertake the OEP and PHP specialties, thereby enabling the ADF's health services 'operational capability' and 'civilian re-integration' missions as part of their normal career progression. These candidates will still be required to provide PHC services for ADF members during their training.
- MO entrants intent on PHC careers be required to undergo diploma-level population health education, additional to their RACGP or ACCRM training, for promotion from O3 to O4, followed by master's training for promotion to O5. This will require liaising with suitable tertiary institutions to establish the relevant diploma and masters courses in public health and (in particular) occupational medicine.

It is suggested these proposals are consistent with the meaning of the word 'joint' as described by the then CDF in 2017, as applied to the ADF health setting:

*'I look at where we've come to now from back then [1999] and we are well ahead, with a far better understanding that joint isn't doing everything the same. Joint is about bringing the best of the three services and the public service together to get the best combination you can for that particular operation.'* [underlining added].[50]

## Disclaimer

The views expressed in this article are the author's and do not necessarily reflect those of the RAN, the ADF or any other organisations mentioned.

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# Agent Orange Exposure, Cytogenetics, and Clinical Outcomes in Multiple Myeloma and MGUS Patients

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## Abstract

**Background** While considerable research has examined transformation from monoclonal gammopathy of undetermined significance (MGUS) to multiple myeloma (MM) and the association of Agent Orange (AO) with MM, adverse cytogenetics are understudied.

**Purpose** To evaluate associations between AO and adverse cytogenetics or other poor prognostic factors such as abnormal light chain ratio in aged veterans with MM.

**Materials and methods** Vietnam-era Veterans diagnosed with MM or MGUS at a Veterans Health Administration site were identified. Chart review abstracted presence of 17p13, t(4;14), t(14;16), t(14;20), and Gain 1q by FISH (dubbed FISH-5) and q13/13q14 deletion, kappa/lambda ratio <.03 / >32 for MM (<.256 / >1.65 for MGUS), and bone marrow plasma cell percentage for MM.

**Results** Among 238 veterans, 70 had MM and 192 MGUS; 24 had both diagnoses (transformation). In MGUS, AO was not associated with transformation, although kappa/lambda ratio was. In MM, Hispanic veterans had more AO exposure. Survival was unassociated with AO or adverse cytogenetics, while Hispanic veterans experienced increased mortality.

**Conclusion** Our study explored cytogenetics in MM among surviving Vietnam Veterans with and without AO exposure. Although Hispanic veterans were more likely to have AO exposure, Hispanic ethnicity but not AO was associated with poorer survival.


## Introduction

Multiple myeloma (MM) is a cancer of mature plasma cells in the bone marrow. MM accounts for 1–2% of cancers worldwide. Monoclonal gammopathy of unknown significance (MGUS) is typically the precursor to multiple myeloma, with approximately 1% of MGUS cases transforming to MM every year.[1]

Agent Orange (AO) exposure has been investigated as a risk factor for the transformation of MGUS to MM among Vietnam Veterans,[2–5] although a recent large Veterans Health Administration (VHA) database review found no association.[6] President John F Kennedy authorised Operation Ranch Hand in November 1961, which led to the US Air Force's herbicide program during the Vietnam War. Twenty million gallons of various chemicals were sprayed in Vietnam, eastern Laos and parts of Cambodia to defoliate rural land, depriving guerrillas of concealment in their support base and operations. AO was one of these chemicals; it was a mixed herbicide contaminated with traces of dioxin, a compound that has caused significant health problems among exposed individuals.[2]

Cytogenetics investigate chromosomal structure and function to discover potential treatment targets for specific diseases. Five major chromosomal mutations are associated with poor prognosis in patients with MM: 17p deletion, t(4;14), t(14;16), t(14;20) and gain of 1q. No study has evaluated the association between AO exposure and adverse cytogenetics or other poor prognostic factors, such as high bone marrow plasma cell percentage and abnormal light chain ratio in patients with MM. We hypothesised that AO exposure would be associated with adverse cytogenetics and that both AO and adverse cytogenetics would be associated with poor prognosis.

## Methods

We reviewed the medical charts of Vietnam Veterans diagnosed with MGUS and/or MM in the Central Texas Veterans Health Care System to evaluate AO exposure, adverse cytogenetics, transformation from MM to MGUS, and overall survival. Inclusion criteria were active-duty military when AO was used (1961–1971) and MGUS or MM diagnosis at our site between October 1, 2009 and September 30, 2015 (prevalent cases FY2010–FY2015). Cases were excluded if there was illogical death data, missing data on age, race, ethnicity, or prior-year diagnostic data, or if MM/MGUS diagnosis could not be confirmed during chart review. Follow-up death data were available through April 1, 2020. Historical treatment data were unavailable. Regulatory review approval was obtained, and informed consent was waived.

MM was identified by ICD-9 diagnosis codes 203.00, 203.01, 203.02 and MGUS by code 273.1. Patients diagnosed with MM and also MGUS (at least three months apart) were considered 'transformation' patients. The presence of 17p13, t(4;14), t(14;16), t(14;20) or Gain 1q by fluorescence in situ hybridisation (FISH) defined high-risk cytogenetics (hereafter, 'FISH-5').[7–9] We also analysed 13q/13q14 deletion in addition to the above five aberrations.[7] A summary indicator of FISH-5 and/or 13q/13q14 deletion was also constructed ('FISH-6'). Poor prognosis per serum free kappa/lambda ratio was defined for MM patients as <0.03 or >32 K/L (high-risk K/L-ratio[10]), while kappa/lambda ratios <0.256 or >1.65 were considered potentially high-risk among MGUS patients.[11] Bone marrow plasma cell percentage being 60% or higher (hereafter, 'marrow-%') versus lower identified another biomarker of interest in MM.[12] Other measures included age at index date, gender, race, ethnicity, VHA Priority status (a value 1–8 summarising why the veteran qualified for VHA care such as military service-connected disability or very low income) and AO exposure per VHA enrolment and disability records. Assessment for AO exposure in the VHA is optional, so AO-exposed was contrasted with unexposed/undetermined.

Chi-square analysis or Student's t-test determined bivariate associations between AO and clinical indicators—transformation, FISH-5, FISH-6, q13/13q14 deletion, K/L ratio and marrow-% for patients with MM—as well as for age, Hispanic and Black. In a multivariable logistic regression, associations with transformation among MGUS patients were reported as odds ratios with their 95% confidence intervals (OR). Finally, a Cox proportional hazards model estimated associations of clinical and demographic variables with mortality among MM patients as hazard rate ratios with 95% confidence intervals (HR; criterion alpha 0.05) for AO status, age, race/ethnicity, transformation and cytogenetics.

## Results

Among 238 veterans with MM or MGUS, four veterans were female, the average age was 65 years (SD: 5), 29% were Black and 11% were Hispanic. MGUS was diagnosed in 81%, MM 29%, and transformation 10%. Two-thirds of the cohort (64%, n=153) had documented AO exposure. AO status did not vary by Black race (65% of Black patients were AO-exposed vs 64% of non-Black patients; p=0.93) or Hispanic ethnicity (76% of Hispanics vs 63% of non-Hispanics; p=0.20) (see Table 1). FISH abnormalities were rare, with 6 MM patients having FISH-5 (32% of 19 with valid data), 8 having q13/13q14 deletion (42% of 19), and 11 having either or both (58% of 19). Nearly half (45%) the patients died by end of follow-up on April 1, 2020, more commonly those with MM (73% MM vs 34% MGUS-only). These two groups did not differ on age (MM with or without transformation 65.4 years (SD: 5.6) vs MGUS-only 64.9 years (SD: 4.5; t=0.61, df=107.5, p=0.54).

Among the 70 MM patients, Hispanic veterans were more likely to have had AO exposure (87.5% of Hispanic MM patients versus 46.8% of non-Hispanic MM patients, chi-square=4.7, df=1, p=0.03). AO was not associated with Black race or age, nor with FISH-5 nor with q13/13q14 deletion or their composite measure, FISH-6. Similarly, the transformation was unassociated with AO among MM patients (Table 2). Among MGUS patients (n=192), the K/L ratio was associated with transformation (OR=6.2, 95% CI 2.2–17.6; Table 3). In the multivariable survival model for MM patients (N=70), Hispanic ethnicity was associated with higher mortality (HR=10.5; 95% CI 1.1–97.2), while AO was unrelated (Table 4).

## Discussion

Among Vietnam-era Veterans, ethnicity was a mortality risk factor, while AO was unrelated to survival. Our chart review sample did not reveal associations of cytogenetic abnormalities with survival, although low power may explain this result. Furthermore, the preliminary data on q13/13q14 deletion are intriguing although, again, clearly sparse and beg further examination. In our study, with 5–10 years of follow-up after cohort entry, these aging veterans experienced a 50% mortality rate. It may be useful to continue examining these cytogenetics in larger samples or samples with other toxic exposures, for example, among veterans exposed to burn pits.[13, 14]

**Table 1. Characteristics of 192 MGUS patients and 70 MM patients, including 24 with both MGUS and MM (N=238)**

| | MGUS† | MM† |
|---|---|---|
| **Characteristic** | **N (%) or Mean ± SD** | **N (%) or Mean ± SD** |
| Age (54-77) | 64.79 ± 4.79 | 65.38 ± 5.62 |
| Charlson Comorbidity Index minus cancer (0-8) | 1.61 ± 1.66 | 1.27 ± 1.33 |
| Survival in years (0.17–11.5) | 6.97 ± 2.78 | 4.95 ± 3.07 |
| Survival status | | |
| Alive as of April 1, 2020 | 119 (62.0%) | 19 (27.1%) |
| Died during study period | 73 (38.0%) | 51 (72.9%) |
| Gender | | |
| Female | 4 (2.1%) | 1 (1.4%) |
| Male | 188 (97.9%) | 69 (98.6%) |
| Race/Ethnicity | | |
| White | 107 (55.7%) | 44 (62.9%) |
| Black | 61 (31.8%) | 15 (21.4%) |
| Hispanic | 19 (9.9%) | 8 (11.4%) |
| Other races | 5 (2.6%) | 3 (4.3%) |
| Marital status | | |
| Married | 123 (64.1%) | 46 (65.7%) |
| Divorced/separated | 53 (27.6%) | 21 (30.0%) |
| Single | 6 (3.1%) | 1 (1.4%) |
| Widow(ed) | 10 (5.2%) | 2 (2.9%) |
| VHA Priority Group | | |
| Group 1 50–100% disability | 113 (58.9%) | 45 (64.3%) |
| Groups 2/3/4 disability | 41 (21.4%) | 11 (15.7%) |
| Group 5 low income | 38 (19.8%) | 14 (20.0%) |
| Agent Orange exposure | 131 (68.2%) | 36 (51.4%) |
| No Agent Orange exposure | 43 (22.4%) | 11 (15.7%) |
| Agent Orange exposure undetermined | 18 (9.4%) | 23 (32.9%) |
| Transformation (overlap of MGUS + MM) | 20 (10.4%) | 24 (34.3%) |
| High-risk cytogenetics per FISH among MM patients (missing: 51) | | |
| FISH-5 † | - | 6 (31.6%) |
| FISH-6 (FISH-5 or q13/13q14 deletion) † | - | 11 (57.9%) |
| q13/13q14 deletion | - | 8 (42.1%) |
| Bone marrow plasma cell among MM patients (missing: 19) | | |
| 0-59% | - | 39 (76.5%) |
| 60-100% | - | 12 (23.5%) |
| MGUS: K/L Ratio† is <.256 or >1.65 vs Other Status | 86 (44.8%) | - |
| MM: K/L ratio is <0.03 or >32 vs Other status | - | 26 (37.1%) |

**† FISH=fluorescence in situ hybridisation; K/L=serum free kappa/lambda; MGUS=monoclonal gammopathy of undetermined significance; MM=multiple myeloma**

**Table 2. Associations with Agent Orange exposure in patients with multiple myeloma (n=70)**

| Characteristic * | AO-exposed† (n=36) | Non-AO-exposed (n=11) | Undetermined AO (n=23) |
|---|---|---|---|
| Transformation (MGUS+MM) † | 14 (39%) | 5 (45%) | 5 (22%) |
| High-risk K/L ratio† | 15 (42%) | 5 (45%) | 6 (26%) |
| High-risk cytogenetics: FISH-5† (missing: 51) | 2 (18%) | 1 (33%) | 3 (60%) |
| High-risk cytogenetics: q13del† (missing: 51) | 5 (45%) | 1 (33%) | 2 (33%) |
| High-risk cytogenetics: FISH-5 or q13del (missing: 51) | 5 (45%) | 2 (67%) | 4 (80%) |
| Bone marrow plasma cell 60%+ (missing: 19) | 7 (25%) | 1 (9%) | 4 (33%) |

*** No significant associations per chi-square analysis**

**† AO=Agent Orange; FISH=fluorescence in situ hybridisation; K/L=serum free kappa/lambda; MGUS=monoclonal gammopathy of undetermined significance; MM=multiple myeloma; q13del=q13/q1314 deletion**

**Table 3. Logistic regression on transformation among 192 Patients with MGUS**

| Characteristic | Odds ratio | 95% Confidence interval | p-value |
|---|---|---|---|
| *Demographic correlates* | | | |
| Agent Orange exposure | 0.62 | 0.26–1.49 | 0.281 |
| Age | 0.96 | 0.87–1.05 | 0.342 |
| Hispanic | 0.82 | 0.17–3.96 | 0.801 |
| Black | 0.99 | 0.38–2.55 | 0.982 |
| *Adding K/L ratio* | | | |
| Agent Orange exposure | 0.53 | 0.21–1.35 | 0.184 |
| Age | 0.96 | 0.88–1.05 | 0.376 |
| Hispanic | 0.69 | 0.14–3.49 | 0.650 |
| Black | 0.81 | 0.30–2.20 | 0.678 |
| K/L ratio – MGUS * † | 6.15 | 2.15–17.60 | 0.001 |

*** 95% confidence interval excludes 1.0**

**† K/L=serum free kappa/lambda; MGUS=monoclonal gammopathy of undetermined significance**

**Table 4. Predictors of mortality among 70 veterans with multiple myeloma**

| Characteristic | Hazard rate ratio | 95% Confidence interval | p-value |
|---|---|---|---|
| Agent Orange exposure | 2.23 | 0.60–8.19 | 0.23 |
| Age in years | 1.06 | 0.95–1.19 | 0.29 |
| Hispanic * | 11.02 | 1.18–103.00 | 0.04 |
| Black | 0.43 | 0.08–2.29 | 0.32 |
| Transformation | 1.46 | 0.32–6.74 | 0.63 |
| FISH-5† | 4.91 | 0.34–70.27 | 0.24 |
| FISH-q13del† | 1.18 | 0.19–7.17 | 0.86 |

*** 95% Confidence interval excludes 1.0**

**† FISH=fluorescence in situ hybridisation; q13del=q13/13q14 deletion**

While the FISH-5 cytogenetic mutations appear to confer an overall poor prognosis, studies have identified chromosome 13 mutations (in particular, chromosome 13 monosomy and 13q deletion) as factors in haematologic malignancies. Yet, there is no consensus on their value in clinical application. Binder et al. suggest that the presence of chromosome 13 monosomy denotes a poorer prognosis with shorter overall survival, whereas 13q deletion confers a favourable prognosis with relatively longer survival.[7] This is the only study delineating monosomy 13 and 13q deletion effects and associations in MM. Previous studies report a poor prognosis with any chromosome 13 abnormalities.[15, 16] Furthermore, Zojer et al. describe the clinical application of 13q14 deletion in MM and note a poor prognostic relationship, with an overall increase in proliferation of myeloma cells with this mutation.[17] Still, other studies describe an overall poor prognosis associated with 13q deletion more in association with typically concomitant high-risk genetic mutations (e.g., the FISH-5) in patients with MM.[16–18] In our study, 4% of veterans had a 13q deletion mutation. Given the rarity of this abnormality in our sample, its role as a causative factor cannot be supported or disputed. Given our centre's limited FISH and cytogenetic data, we could not distinguish between patients with monosomy 13 and 13q deletion abnormalities. These mutations merit further evaluation in patients diagnosed with MM.

The association of high-risk kappa/lambda ratio among MGUS patients with transformation to MM confirms the value of this marker of poor prognosis. Currently, we use the kappa/lambda ratio in conjunction with other markers to stratify patient risk of transformation to MM. A deeper study of the identified risk levels (<0.256 or >1.65), rate of change in kappa/lambda ratios, or alternative cut-points and their correlations with novel markers could enhance the clinical value of the kappa/lambda ratio as personalised medicine expands.

Previously, Black patients were shown to have twice the incidence of MM with a poorer prognosis, attributed to racial disparities and socioeconomic status; this is especially important to recognise given new data suggesting Black individuals have a lower prevalence of FISH-5 mutations, specifically 17p deletion and have a higher prevalence of the protective t(11;14) mutation.[19, 20] Conversely, our data showed that Hispanic individuals had more AO exposure and overall higher mortality. Kaur et al. suggest that Hispanics have a higher incidence of MM compared to non-Hispanic whites and have a higher comparative incidence of renal dysfunction but with similar survival to their White and Black counterparts given equal access to therapy.[19, 21] Buradagunta et al. propose that higher mortality in Hispanic individuals may be driven by comorbidity associated with socioeconomic factors.[22]

## Limitations

Our chart review was limited to a single site with a small sample size with scant data on marrow-%. Nevertheless, it provides preliminary evidence of how cytogenetics could be used to inform clinical status in patients with complex disease profiles.

## Conclusion

Continued study is merited to fully recognise what predisposes MM development following AO or other cytotoxic exposure and whether novel military exposures are engendering this and other cancers of the lymphatic system. Scarcely half a million of the three million American military personnel who served in Vietnam from 1954–1975 are alive today. Their experiences have fuelled many medical inquiries and innovations, leading to better care in the field and rapid evacuation for Gulf War and Global War on Terror Veterans.[23–25] We suspect that continued exploration of cytogenetic and epigenetic factors in disease aetiology will continue to advance our ability to care for today's veterans and those who served 50 years ago.

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# Developing an Operational Skillset for Military Critical Care Physicians: A Scoping Review

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## Abstract

**Introduction** There is an increasing recognition of the need for deployed intensive care physicians (intensivists) with the changing nature of conflict. Required capabilities of military intensivists are determined by the operational context and is different to those of the civilian work environment. We sought to identify an operational clinical skillset for military critical care physicians.

**Methods** To answer the research question, we performed a literature review to identify existing intensive care competency frameworks and define the scope of practice for a deployed intensivist. Quantitative and qualitative research articles of any design were eligible for inclusion if the context included intensive or critical care medicine in a deployed environment. Articles were identified on PubMed, Medline, EMBASE, Google Scholar and EBSCO and included in the review if they met inclusion criteria.

**Results** Several quantitative studies described battle injury patterns and identified predominant mechanisms of injury. Deployed intensivists frequently have to manage patients with non-combat injuries and medical conditions. Paediatric patients also require ICU care in a deployed environment with high injury severity and in-hospital mortality.

We identified a subset of qualitative articles that described the general characteristics of military critical care patients; important considerations related to infections in a deployed environment and ethical and legal decision making.

Several articles discussed training and equipment considerations (including ICP monitoring, ultrasound and renal replacement therapy) in preparation for potential peer-on-peer conflicts.

**Discussion** The reviewed articles allowed us to identify the skills a deployed intensivist requires beyond the baseline civilian clinical skillset. We used this information to propose a core operational clinical skillset for deployed intensivists. This intends to help individual clinicians and commanders identify training pathways to prepare competent clinicians who are adequately prepared for military deployments.


## Introduction

Military health services aspire to provide best-practice care to those who become ill or wounded on operations. Historically, since the Vietnam War, military health support has prioritised rapid surgical intervention followed by early transport to definitive care. The application of damage control principles from the start of the 21st century led to recognising the need for intensive care physicians (intensivists) in forward hospitals to manage patients who cannot access timely retrieval, and to allow optimal management of high acuity disease non-battle injuries (DNBI).

The capabilities required of military intensivists are determined by the operational context, duration of deployment, retrieval system and specialist supports, among many other factors; however, it is likely that in many cases, the exigencies of deployed healthcare will call upon intensivists to work in unfamiliar ways. While work has been done to understand the training gap between civilian and military clinicians in surgical specialties,[1] similar work for intensivists is less progressed. We, therefore, aimed to derive an operational clinical skillset (OCSS) for deployed intensivists to inform the maturation of the specialty in the military context.

## Methods

The population of interest for our review was defined as military intensivists, and material relating to intensive care practitioners from other specialties was included. Only English language papers relating to developed world militaries that addressed the deployed setting were reviewed. Any study design was acceptable, including expert commentary. We used the search strategy outlined in Figure 1 to identify relevant articles in PubMed, Medline, EMBASE, Google Scholar and EBSCO.

Each paper was reviewed for relevance by two reviewers, with a third reviewer involved to resolve disagreements. Following inclusion, material of interest was entered into a research database. This material included content relating to (1) case-mix and case load for deployed intensivists, (2) required competencies of deployed intensivists, (3) required skills of deployed intensivists, (4) proposed training programs for deployed intensivists, or (5) pre-deployment training of military intensivists.

## Results

All quantitative studies describing case-mix and procedures in deployed ICUs were observational, retrospective analyses of medical records. Most focused on the conflicts of this century in Afghanistan and Iraq, although some reports addressed deployments in other conflicts, peacekeeping, and humanitarian assistance and disaster response (HADR). Studies are summarised in Table S1 (supplementary material).

### Battle casualties are commonly caused by blast and gunshot wounds (GSW)

Several papers exclusively considered battlefield injury presentations to deployed hospitals. Reports were heterogeneous; however, a consistent finding was that blast injury and GSW were common. Widespread use of body armour has resulted in a higher proportion of severe pelvic, head and peripheral injuries.[2] While most injuries treated in deployed facilities are minor (AIS=1; 74% minor injuries only; fatality rate 4.6%), patients with severe injuries frequently require critical care (e.g. 12% intubated and 4.6% requiring thoracostomies).[3]

In the Iraq war, 87% of casualties suffered blast injuries (49% to extremities and 36% to the head and neck).[4] Similar rates of blast injury have been reported in Afghanistan.[5, 6] Among blast casualties, primary blast lung injury (PBLI) was noted in approximately 10% of patients, often requiring mechanical ventilation in the ICU prior to transfer.[7]

Penetrating trauma remains common in military ICU patients, both from GSW and secondary blast injury.[5,6,8,9] Civilians and children are particularly prone to penetrating head injury.[6, 9]

Motor vehicle accidents (MVA) made a variable but significant contribution to presentations (2–19%).[5, 8]

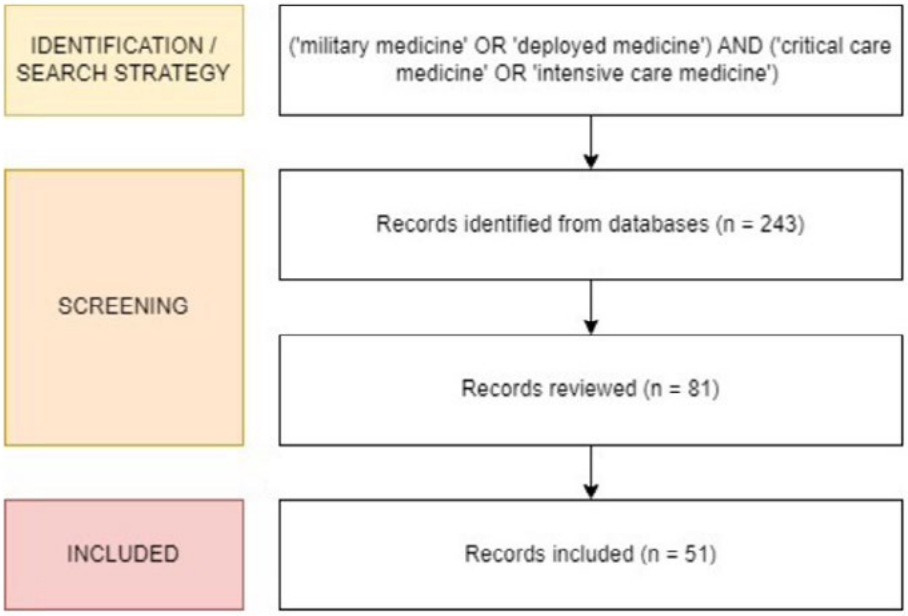


**Figure 1: Search strategy and identification of relevant records**

### ICUs in warlike settings must anticipate disease non-battle injury (DNBI) admissions

DNBI in warlike settings was investigated in two studies set in Iraq. A US study found a 6.1% ICU admission rate for patients presenting with DNBI to a Role 3 hospital,[10] while a British study looking at presentations to a Role 3 facility with heat illness (n=622) described 15 patients who required ICU admission.[11]

Two studies investigated military and DNBI presentations together. Of patients presenting to a German Role 3 hospital in Croatia, 0.7% required ICU admission; 54% of these were for surgical indications and 46% for medical conditions.[12] A more recent British study set in Iraq found that 27% of inpatients required ICU admission, and trauma was most common (83%); the medical ICU admissions were diverse and included similar presentations to what would be expected in a civilian ICU.[13]

DNBI presentations are diverse; deployed intensivists have reported management of myocardial infarcts, strokes, acute leukaemia, Guillain-Barre syndrome, Stevens-Johnson syndrome and exacerbations of chronic disease.[14, 15] Complications of supplement use and alcohol-related illnesses may also be more common in deployed ICUs.[14, 16]

Presentations of pulmonary disease are emphasised in several papers. These include those routinely managed in civilian units and also location-specific infections (haemorrhagic fevers and clusters of Q-fever, *Bordetella pertussis*, Chlamydia, Mycoplasma and Acinetobacter), chemical and other inhalational injury, and clusters of acute eosinophilic pneumonia.[17]

### The majority of ICU admissions during HADR are for non-traumatic presentations

Three studies specifically investigated HADR. An Israeli hospital deployed following an earthquake in Türkiye reported a 5.2% ICU admission rate, predominantly for medical illness (55.6%); only 7.9% were due to trauma.[18] Similarly, of only two cases admitted to ICU in a UK hospital deployed in South Sudan, both were for infectious diseases.[19] A hospital deployed following the Houston floods had a 3.2% ICU admission rate, although the nature of admission was not published.[20]

### Infection and sepsis are common complications in deployed ICUs

Intensivists may face unfamiliar organisms and drug-resistance patterns, including biological weapons and potentially increased iatrogenic infection rates.[14,16,17,21-25] Multi-drug-resistant organisms are a common cause of combat wound infections.[2, 26] This is complicated by the challenge of reduced diagnostic and drug concentration monitoring capability in deployed facilities.[27]

### Deployed ICUs treat diverse patient populations and paediatric admissions are common

Military intensive care patients are generally younger and fitter than in civilian hospitals.[16] However, in both warlike and non-warlike settings, non-military patients are commonly admitted to deployed ICUs.[15,16,21,22,25,27,28] Presentations of local elderly and obstetric patients can also be expected.[15, 16]

A review of 9 years of data from Iraq and Afghanistan identified almost two-thousand paediatric ICU admissions to coalition hospitals, primarily for explosive (45%) or firearm (21%) injury.[29] Inwald et al. reported that 14% of admissions to a UK-deployed ICU were aged under 16.[30] Acuity of paediatric presentations to military hospitals is high. Of children presenting to a military emergency department in Afghanistan, 63% required admission to ICU.[31] Another reported that 144 of 955 children (15.1%) presenting to deployed hospitals in Iraq and Afghanistan with thoracic injuries died.[32] Further, Spinella et al. reported that 11% of patients requiring mechanical ventilation were children, and the in-hospital deaths for children were significantly higher than those for adults (5.4% vs 1.3%, respectively).[33]

A review of paediatric burn casualties that presented to US-deployed hospitals in Iraq and Afghanistan identified 549 patients. Just under a quarter (23.8%) had severe burns (TBSA 39-89% or 29% to 79% if age < 5 years). In this group, ICU utilisation was significant, with no ICU-free days (IQR 0-22) and six ventilator-free days (IQR 0-29) for survivors (52.7%).[34]

### Military intensivists must be able to function in austere and hostile environments

While civilian intensivists are trained to work in situations of stress and high clinical acuity, the deployed intensivist must be able to provide care in the face of threats to personal safety, extreme fatigue and psychological stress.[15,25] There is also a need for military intensivists to contribute to triage and multi-casualty management.[15,16,35]

Deployed ICUs must operate in an environment characterised by reduced staffing, consumables, space, lighting, power, water and infrastructure.[16] Diagnostic technology will not be equivalent to

civilian institutions.[39] Oxygen will not be unlimited; clinicians must be familiar with low-pressure oxygen equipment.[15] Retrieval resources may also be limited, leading to long primary and secondary retrieval times and a higher proportion of patients affected by hypothermia, hypovolaemia, sepsis and psychological sequelae of prolonged field care.[16]

### Deployed intensivists must allocate limited resources in accordance with established ethical and legal frameworks

Austerity also dictates that deployed clinicians must make decisions regarding the use of limited resources, including withholding care from severely injured casualties.[15, 16, 28, 40] International humanitarian law and medical rules of eligibility determine which patient groups can access the military health system, clinicians must balance the needs of the wider military organisation with those of the individual patient.[28, 39, 41] Treating severely injured local casualties poses ethical dilemmas regarding eventual discharge to the local health system, the ongoing management of newly diagnosed diseases, and the risk of creating a dependence on the military facility.[14,25,28,39-41]

### Civilian intensive care fundamentals remain important in the deployed setting, but military intensivists may need to adopt additional roles

In the deployed setting, fundamentals of routine ICU care remain essential, including DVT prophylaxis, nutrition, infection control, and cardiovascular and respiratory support.[2,15,21] However, specialised military knowledge may also be required; for example, in many deployed environments there is a tangible CBRN threat and several papers advocate for formal CBRN training for deployed intensivists.[16, 42, 43]

Likewise, while civilian intensivists must attain competence in transfusion medicine, the deployed intensivist must have a detailed understanding of military blood stocks and supply chains, including products that may not be routinely available in their civilian practice, such as whole blood. They must also be able to make appropriate use of military-specific transfusion practices, such as the walking blood bank.[14, 39, 44]

Specialist imaging support may be limited, and point-of-care ultrasound, including focused abdominal sonography of trauma (FAST) and echocardiography, was identified as an important skill in several papers.[14,35,39,45]

Similarly, while ICP monitoring was considered an essential skill by some authors,[14] neurosurgical support may be remote or unavailable. Experience in rural UK civilian hospitals has shown that intensivists can be trained to insert ICP.[39,46]

### Prolonged care in deployed ICUs may necessitate additional clinical capabilities

Many treatments commonly employed in civilian ICUs are not used as often in the deployed setting due to resource constraints and the availability of timely evacuation.

One example of this is renal replacement therapy (RRT).[39] However, higher casualty rates and longer evacuation times anticipated in future warfare may necessitate field RRT,[47] including pumpless solutions such as arterio-venous filtration and peritoneal dialysis.

Similarly, enteral nutritional support is less commonly instituted in deployed ICUs, and parenteral nutrition is generally unavailable.[39,48,49] As the availability of rapid evacuation cannot be assumed in future conflicts, the provision of more definitive nutritional support would be required.[37]

### Deployed intensivists may encounter highly specialised interventions that are not a routine feature of their domestic practice

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) has been used in deployed hospitals, and a training package is described for its use.[50,51] Likewise, while Extracorporeal Membrane Oxygenation (ECMO) is not routinely available in deployed ICUs[39] the Lung Assist arterio-venous ECMO device has been successfully used to stabilise and retrieve combat casualties.[14,52]

REBOA and ECMO are likely to be used infrequently and these capabilities are expected to be facilitated by an external specialist retrieval team. Nonetheless, several case reports relating to these capabilities suggest that intensivists deploying to specified operational contexts should have a working familiarity with these interventions.

### Specific training in intensive care is associated with improved patient outcomes in the deployed setting

A retrospective observational cohort study of a deployed military ICU found that the presence of a trained intensivist was associated with reduced mortality, duration of mechanical ventilation and ventilator-associated pneumonia.[14,53] Sattler

**Table 1. Skills that may be required of deployed military intensive care physicians. (ICP: intracranial pressure: RRT; renal replacement therapy; eFAST: extended focussed sonography of trauma)**

| |
|---|
| **General intensive care management** |
| Manage nutritional support |
| Manage infection control precautions |
| Initiate and manage cardiovascular support |
| Initiate and manage invasive and non-invasive respiratory support |
| Manage pain arising from surgery, trauma or medical conditions |
| Prepare patients for retrieval and interhospital transport |
| **Trauma patient management** |
| Manage blast injuries, including primary blast lung injury |
| Manage burns, including severe burns |
| Manage penetrating and blunt traumatic brain injury |
| Manage ocular trauma |
| Manage thoracic trauma |
| Manage extremity trauma |
| Manage pelvic injury |
| Manage complications of trauma (e.g. hypothermia, coagulopathy, sepsis) |
| **Medical patient management** |
| Diagnose and manage a broad range of acute and chronic medical illnesses |
| Manage heat injuries |
| Manage alcohol- and other drug-related illness and intoxication |
| Manage supplement use and contaminant toxicity |
| Manage sepsis, including: |
| multi-resistant organisms |
| tropical diseases (such as malaria) |
| region-specific diseases (such as haemorrhagic fevers, Q-fever, *Bordetella pertussis,* Chlamydia, Mycoplasma and Acinetobacter) |
| diseases of potential pandemics |
| AIDS and AIDS-defining illnesses |
| Manage ischaemic heart disease and cardiac arrhythmia in the absence of interventional cardiology support |
| Manage inhalational and chemical injury and acute eosinophilic pneumonia |
| Manage CBRN exposures and casualties |
| **Postoperative management** |
| Manage patients post-trauma and non-trauma surgery |
| **Special patient groups** |
| Manage paediatric patients, especially: |
| burns |
| trauma (blast, burns, GSW) |
| ventilation support |
| Manage obstetric patients and complications |
| Manage elderly patients |

| |
|---|
| **Leadership, personal and ethical decision making** |
| Work in stressful situations |
| Lead others in stressful situations |
| Work in austere and low-resource environments |
| Triage and manage multi-casualty incidents |
| Prioritise patients for secondary retrieval/strategic aeromedical evacuation. |
| Crisis resource management |
| Ethical and lawful decision making, including: |
| Resource utilisation, including at end-of-life |
| Manage host nation casualties appropriately in the context of the local health system |
| Apply humanitarian assistance practices |
| Apply Australian military and civilian law, international humanitarian law, laws of armed conflict and rules of eligibility |
| Adaptable to international teams/cultural humility |
| Implement clinical governance, including methods for continuous quality improvement, critical incident review, root cause analysis and scope of practice review |
| Supervise general duties of medical staff augmenting the medical capability of the deployed ICU |
| **Procedural skills** |
| Perform routine ICU procedures, including: |
| central line insertion |
| arterial line insertion |
| endotracheal intubation |
| wide-bore venous cannulation |
| interosseous cannulation |
| thoracentesis |
| intercostal catheter insertion and management |
| lumbar puncture |
| Perform additional procedures, including |
| ICP monitor insertion and management |
| paracentesis |
| arterial limb tourniquet placement |
| resuscitative thoracotomy |
| Initiate and manage improvised or deployable RRT |
| Perform point-of-care ultrasound, including: |
| echocardiography |
| eFAST |
| Manage deployed blood transfusion, including damage control resuscitation, resource management and walking blood bank management |
| Oversee the operation of a deployed pathology laboratory |

describes an educational program to train deployed intensive care medical officers (not necessarily qualified intensivists) in identified critical skills. Of these, most would be considered routine intensive care procedures in Australia, the exceptions being paracentesis, tourniquet placement, ocular trauma management, splinting, laceration suturing, abscess drainage and mass-casualty management.[35]

## Discussion

This review sought to identify the training gap between the skillset of a conventionally trained Australian civilian intensivists and that desired of a deployed military intensivist.

In Table 1, we propose a core operational clinical skillset (OCSS) for the deployed intensivist based on our analysis of the historical case-mix and published expert opinion. Most of these skills would be fundamental to the deployed intensive care skillset, such as general intensive care patient management, blunt and penetrating trauma injuries management and the ability to perform common procedures. Specialised procedures would be performed by the intensivist only in the absence of other more experienced providers, for example, ICP monitor insertion. Additionally, some procedures identified in our review, such as REBOA and ECMO, have been excluded from the core OCSS because their use is infrequent and skill maintenance is likely impractical and cost-prohibitive. They may be employed in specific circumstances by smaller subspecialty teams.

The other side of the training gap is the baseline skillset of civilian intensivists. Most intensivists benefit from a comprehensive training program. This training program includes core skills, including the management of presentations commonplace in developed countries, a range of routinely performed procedures, and the management of advanced respiratory, haemodynamic and renal supports.

Other skills may be somewhat familiar to civilian intensivists, but their increased frequency or complexity on deployment may justify upskilling; for example, treatment of tropical diseases, trauma management and crisis resource management. Even core skill domains such as transfusion have unique military considerations, including the use of walking blood banks and frozen blood modules. Finally, several skills would be almost entirely unfamiliar and would require substantial training, such as peritoneal dialysis and ICP monitor insertion. Likewise, while many intensivists are familiar with ultrasound and echocardiography, they may require upskilling in eFAST.

Notwithstanding the core domains of practice addressed by ICU training, the experience and skillset of intensivists vary significantly. To ensure competence and confidence in the deployed setting, each practitioner must identify individual learning needs after reflecting on the gap between their experience and the proposed OCSS. Additional gaps may exist if a deployed ICU is to be staffed with clinicians who have not completed specialist training in intensive care medicine.

Unsurprisingly, this review has identified trauma as being a common cause of admission to deployed ICUs. However, widespread use of body armour has somewhat reduced thoracic trauma, resulting in higher proportions of head, neck and extremity injuries. Burns are also more common than in most civilian units. A further important finding was that DNBI admissions are common in both warlike and non-warlike deployments. Several medical presentations were more common on deployment than expected; managing tropical and region-specific diseases may require significant upskilling for many Western-trained intensivists. Management of inhalational injury and CBRN casualties may be similar examples.

Despite military hospitals being intended to treat adults, paediatric ICU admissions were common across several studies. Intensivists who work in adult units may require refresher training on paediatric medicine. While equipment provision was not a focus of this paper, this finding has obvious implications regarding the equipment that a deployed ICU may require.

Finally, non-technical skills, including ethical and legal decision making, leading teams in high stress situations, and multi-casualty management, are areas where upskilling would be required for many intensivists. While some of the skills are fundamental to ICU practice, the specific scenarios, laws and ethical considerations encountered on deployment are likely to be unfamiliar to a civilian intensivist.

The authors were surprised by the lack of one result in particular. In our experience, the intensivist is often called upon to manage medical presentations that do not need intensive care but do not fall within the specialty domains of other deployed medical officers (in the absence of an internal physician). Management of acute coronary syndromes would be a typical example.

With the intensive care OCSS defined, the next task is identifying pathways by which individuals can achieve competence prior to deployment. Solutions may include hospital placements with

specialty practice areas, such as trauma, burns and paediatrics. Even within trauma centres, Australia has low rates of penetrating and blast trauma presentations, so overseas placements may be effective. There may be a role for specialty courses, such as tropical disease intensives and ethical decision-making scenario training.

*Limitations*

There are two key limitations of this study. Firstly, there was significant heterogeneity between studies, presumably due to regional variations in practice. ICU admission rates varied significantly. Similarly, among the qualitative papers, assumptions regarding baseline skillsets of intensivists may have varied depending on the system in which the authors trained and worked.

Secondly, most of the papers identified in this review examined experiences from the Iraq and Afghanistan wars. These conflicts were characterised by low-tempo asymmetric warfare, relatively small numbers of severely injured casualties, and coalition air superiority, allowing rapid evacuation. Future wars may not share these characteristics; severely injured casualties may be more frequent and unable to be moved rearward in a timely manner.[36, 37] Even communication and telehealth, heavily relied upon in recent conflicts, may not be available in the next.[38]

## Conclusion

This review has allowed us to derive a preliminary OCSS for intensive care. This document will allow individuals to prepare themselves more effectively for their deployed role, and allow commanders and managers to weigh the risks and benefits emerging from the decision to employ non-specialist intensive care providers in specific operational contexts. Future work should seek to map out operational clinical readiness pathways that support individuals in closing the gap between their civilian experience and the demands of deployed intensive care.

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# Infectious Disease Mortality in Deployed Soldiers during the Spanish American War

*G D Shanks*

## The Spanish–American War

In 2014, the US Army deployed 2500 soldiers into Liberia, West Africa, as part of a global response to an Ebola outbreak. Despite the fear of viral spread from civilians, no cases of Ebola occurred in US or UK military members, and very few febrile soldiers were seen with other complaints.[1] The ADF declined the invitation of its USA and UK allies to participate in the 2014 Ebola mission for many reasons, primarily geographical. However, fear of lethal infection by a haemorrhagic fever virus was undoubtedly a contributing factor. Advanced diagnostic means were field deployed to assist in the public health efforts to break the chain of infection, particularly within the deficient health care system.[2] Many more civilians likely died of malaria than Ebola as the health system failed to deliver even simple medications.[3] An analogous, but certainly not identical, set of events occurred during the Spanish–American War at the end of the 19th century, where fear of yellow fever, another highly lethal haemorrhagic fever, distracted from the leading cause of mortality, which was typhoid fever due to a breakdown in field sanitation in recruit camps. Laboratory tests proved crucial to convincing medical officers that what they were clinically diagnosing as malaria was, in reality, caused by *Salmonella enterica* serovar Typhi. Eventually, disease control was instituted, but not before the end of the war and several thousand preventable soldier deaths. Therefore, the fear of yellow fever distracted from the preventable typhoid fever deaths, misdiagnosed as malaria due to inadequate laboratory methods.

The small US Army (n=25 000) grew by a factor of 10 after war was declared against Spain in 1898, and masses of raw volunteers moved into military training encampments that were rapidly thrown together. Microbiology was a cutting-edge science driven by the Pasteurian revolution and the personal interest of bacteriologist and Surgeon-General Sternberg. Unfortunately, clinical medicine had not caught up with the new findings that malaria was caused by blood parasites spread by mosquitoes and typhoid fever was an enteric infection caused by *Salmonella enterica* serovar Typhi. Thousands of contract surgeons hired to expand the tiny US Army Medical Corps (n=332) had little knowledge of field hygiene. Few officers of any rank had personal experience with large bodies of soldiers since the US Civil War >40 years previous to the events that saw an amphibious expeditionary force assembled and launched at Cuba in a matter of few weeks. Thousands of men were infected by typhoid fever in camps with only rudimentary sanitation facilities that were usually ignored by ill-disciplined volunteers anxious to get to the fighting before the war was over. In the absence of any laboratory means, the epidemic was widely proclaimed as being malarial. The US Army Medical School (established in 1893 by Sternberg to train military medical officers and later became Walter Reed Army Institute of Research) graduates were brought from Washington to show there were no blood parasites. The Surgeon-General eventually concluded, 'Without any doubt, many of the deaths ascribed to "malarial fevers" were in fact due to typhoid infection'.[4]

What the soldiers and medical officers were afraid of was not typhoid but an epidemic of yellow fever. This infamously lethal haemorrhagic fever spread from the tropical Caribbean into the Southern USA in the summer before abating during cooler weather.[5] Yellow fever had destroyed a previous French effort to form an American Empire and seemed likely to disrupt the United States' attempt to displace the old colonial power Spain. Yellow fever did start to kill US soldiers in Cuba after the brief combat phase was over, causing a politically driven campaign to get the now redundant soldiers back 'home' before they were decimated by disease in Cuba. By a remarkable coincidence, the same military medical commission formed to stop the typhoid epidemics in USA recruit camps was now employed in Cuba to study yellow fever. The tremendous scientific success of the group led by MAJ Walter Reed in defining yellow fever epidemiology should not overshadow their previous unglamorous work on field sanitation in filthy recruit camps.[6]

That typhoid was the leading killer of soldiers can be seen in Figure 1, which reconstructs the mortality rates from the Surgeon-General's reports.[7] The regular soldiers (1A) were less affected by typhoid and more subject to yellow fever than the volunteers (1B) because they were deployed first to Cuba. They were likely more disciplined and stayed out of the septic recruit camps. All disease mortality fell rapidly in the next year due to the institution of important hygienic reforms and volunteer demobilisation. A comparison of Cuba (where there was yellow fever transmission) to the Philippines (where yellow fever does not exist) is useful to see the high background mortality, which was not dissimilar to the USA, where 1% disease mortality was expected annually at the beginning of the 20th century.[8]

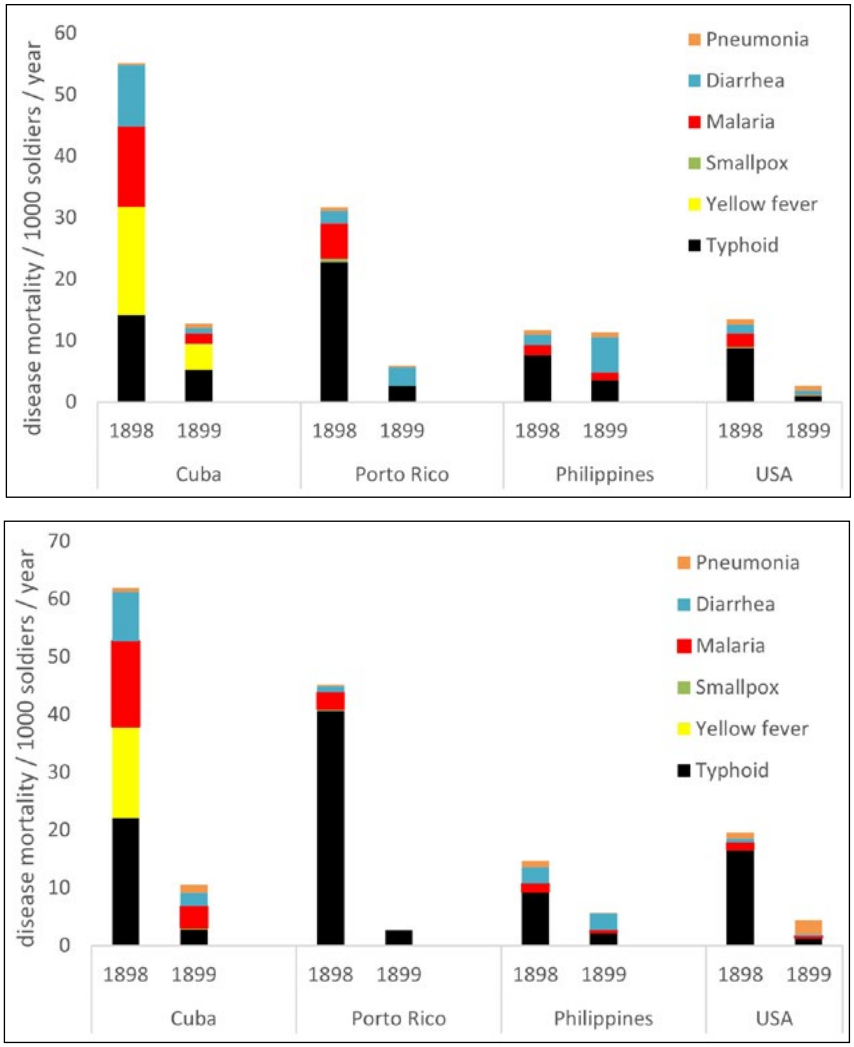


**Figure 1: Infectious disease mortality in US Army soldiers during the Spanish–American War, both in USA and on three islands involved in the expeditionary forces (Cuba, Porto Rico, Philippines) from both 1898 (first column) and 1899 (second column) based on Annual Reports of the Surgeon-General.[7] A. Regular soldiers (n=25 000) and B. Volunteer soldiers (n=200 000) raised in 1898 for the conflict with Spain.**

The real solution to typhoid fever in the military still lay in the future with an effective British Army vaccine, which was only then being devised by work during the South African (Boer) War under Sir Almoth Wright.[9] Although crude by modern standards, a phenol-killed bacterial culture of *Salmonella enterica* serovar Typhi contained enough endotoxin to produce sore arms and some protective immunity. MAJ Frederick Russell was sent to study the British Army's vaccine, where he introduced a US Army version, which had become compulsory by 1911. The results in disease and mortality reduction

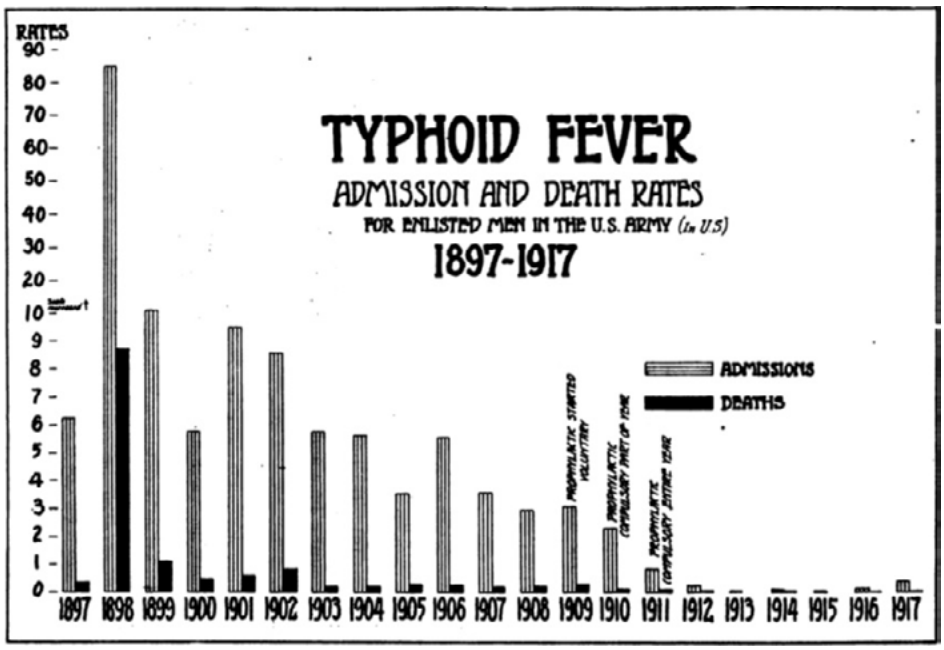


**Figure 2: Typhoid fever morbidity and mortality rates in US Army enlisted men in the USA from 1897–1917 as shown in a figure taken from 1918 Annual Report of the Surgeon-General. Typhoid fever fell precipitously once field sanitation had been established in camps (1899) and immunisation introduced (1910).[8]**

are clearly shown in the figure reproduced from the 1918 Surgeon-General's report shown in Figure 2.[8] The live, attenuated yellow fever vaccine, which is still in use today, would have to wait another generation for Max Theiler of the Rockefeller Institute to figure out how to grow viruses in eggs. Although the vaccine was used widely during World War II, primarily due to concern that the Imperial Japanese Army would use yellow fever as a biological weapon, its protective effect was overshadowed by the unintended consequences that produced an enormous, iatrogenic epidemic of hepatitis B from a contaminated vaccine component.[10]

The US military conducted successful deployments during both the 2014 Ebola epidemic and the 2020 coronavirus pandemic despite neither vaccine being available when the mission started. The ADF must consider the theoretical risk of Nipah/Hendra virus infections during regional deployments, knowing that fruit bat avoidance measures are likely to succeed even without a registered vaccine. The analogous but contrasting experiences during the Spanish–American War with both typhoid and yellow fever are sobering and instructive. Fear runs ahead of science and often does not correlate with what is causing casualties. Common infectious diseases are more important to military operations than those that are more newsworthy because of their higher lethality. It remains challenging to introduce new immunisations after an epidemic event has begun; great uncertainty applies to how long it will take to develop a new vaccine, and compulsory immunisation is required to deliver an effect to the entire force. The Spanish–American War is likely the most disrupted USA war by infectious disease. Our duty remains to see that future military operations do not have to re-learn the same difficult historical lessons concerning the rapid expansion of military forces into a tropical area of operations.

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# The PACT Act of 2022 Changed my Patient's Life

*D Bittleman*

*To: President Biden and all who wrote and passed the PACT Act of 2022 to help veterans.*

*From: David Bittleman, MD, Primary Care Internal Medicine Doctor at VA San Diego, CA.*

*Date: August 7, 2023*

J.W. a soft-spoken, Vietnam War Navy veteran has been my patient at the VA San Diego for about 10 years. I've helped him with diabetes, high blood pressure and other medical problems. A nagging question that I had was: Could his diabetes and other medical problems be service-related? Before the PACT Act, I looked up criteria, and it didn't look like it fit his service record. I asked repeatedly, and he replied that he didn't think so. He had spent his Navy career "scraping paint off of decks." I looked at his tired eyes and wanted to do more for him. He had risked his life for our country. He is a kind man. We share stories about our families and pets. I really feel a connection to him.

In 2016 he suffered a stroke and had residual balance problems. Even then, we didn't believe that the problems were service-related. He is a proud man, and he said that he was just doing his duty during the war. He did not think he deserved any more money for his service. He again told me that he didn't spend time on the ground or in the inland waterways of Vietnam. "I just scraped paint and swabbed the deck, Doc." We both figured he didn't qualify for any agent orange associated disease disability payments.

After his stroke, I told him he should think about retiring, but he said he wanted to keep working. Work gave him purpose. He also confessed that he needed the money. I offered to help him get social security disability, but he wasn't interested.

Late in 2022 he came to see me for a new golf ball sized mass in his right breast. I knew this was serious. He was quickly diagnosed with Large B cell lymphoma, Stage IIE (a Non-Hodgkin's Lymphoma) and started to receive chemotherapy. At this point, I wanted to clarify his military service. Breast tumors are rare in men. I continued to wonder: Could it be service-related? We returned to the VA website. Things had changed. The PACT Act expanded the criteria of who may have been impacted by agent orange: "Veterans will have presumptive agent orange exposure if between January 9, 1962, and May 7, 1975, the veteran served for any length of time in a vessel operating not more than 12 nautical miles seaward from the demarcation line of the waters of Vietnam and Cambodia."(1)

J.W. looked at me. "Doc, I served on the Guided Missile Light Cruiser the USS Oklahoma from 1970-1971 and on the USS Dubuque from 1971-1972." He remembered watching the shore bombardments of North Vietnam. They also made stops in Danang Harbor. At that moment I knew that he was within 12 nautical miles of the shores of Vietnam. (2) I wrote a nexus letter linking his military service with presumptive agent orange associated non-Hodgkin's lymphoma and had him bring it to an AMVETs service representative who helped him file a claim. It took about about a month for him to have a compensation and pension evaluation and in July 2023 he received the letter from the Veterans Benefits Association telling him that he was awarded 100% service-connected disability for agent orange associated lymphoma.

I saw him follow-up August 7, 2023. He feels financially more secure. He was amazed at the thousands of dollars he had received and will continue to receive. He is thrilled to finally be able see a dentist for the first time in years.

I went into medicine to help people. There is no greater joy than reducing suffering and helping people with their problems. The PACT Act of 2022 has brought joy to my practice and improved the lives of my patients. Thank you, President Biden and those lawmakers who championed this important legislation that helps veterans.

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# Does DVA fund emerging treatments?

## Can DVA fund this treatment?

This is a question regularly asked of DVA. The treatments in question are usually ones that are; not covered under the Medicare Benefits Schedule (MBS), have been showing some early promise in literature, and are costly for the individual.

The answer to this question is not a simple yes or no. It depends on what published evidence is currently available about the safety and efficacy of the treatment, and the specific circumstances of an individual.

Legislation governs the types of health services DVA is able to fund. DVA funds health services available under the MBS. However, DVA legislation also allows funding for services that are outside of the MBS provided there is; a clinical need, an appropriate health provider delivers the treatment, and it is at a reasonable cost. There is a caveat on this: services cannot be provided if they are considered experimental or not supported as safe and effective by extensive clinical trials.

This gives DVA the ability to consider funding treatments shown to be effective, but are not yet covered by Medicare. Along with this ability comes the responsibility as funder to ensure safe and effective care.

DVA does not support the veteran population being targeted for experimental treatments that should be undertaken in clinical trial conditions with appropriate ethics approval and oversight. People who have difficult to treat conditions are particularly susceptible to promises of new and improved treatments. DVA needs a reasonable level of assurance that funding emerging treatments will benefit the veteran and be of reasonable cost.

To support veterans' access to reasonable evidence-based treatments, DVA puts considerable effort into identifying and evaluating emerging treatments, with a focus on treatments for the most common conditions accepted by DVA as being related to service.

This includes reviewing literature, guidance from peak bodies and talking with experts. It has also included commissioning a rolling evidence analysis (REA) of emerging and adjunct treatments for common mental health conditions affecting veterans. More about this REA review can be found on the DVA website.

## So how much evidence IS needed?

DVA's treatment related legislative instruments are known as the Treatment Principles. The Treatment Principles state that health care services funded by DVA cannot be experimental and "demonstrated to be effective and safe by extensive clinical trials". Under this legislation, emerging treatments are considered on a case-by-case, prior approval basis.

For treatments that are "emerging", that is, not yet mainstream, the evidence develops over time. In the early stages, evidence may be limited to a small number of reasonable quality clinical trials and apply to a small group of patients with strict parameters around who may benefit. At this stage, DVA will consider funding treatment only for individual veterans who are closely aligned with the patient population from the available trial data.

As a treatment starts to be used more widely, and additional evidence from trials and real world experience is obtained, expert groups such as specialist colleges may start to provide guidance about use of the treatment. DVA will then consider funding individuals in line with the guidance.

As the treatment becomes more established, it gets incorporated into publications that review evidence such as "UpToDate" or evidence based clinical best practice guidelines published by various professional bodies and groups, such as the Australian Therapeutic Guidelines. Incorporation into clinical guidelines can take significant time. Even so, emerging treatments often appear in guidelines prior to being funded under the MBS and DVA will use these to inform treatment funding decisions.

When assessing prior approval requests for emerging treatments, DVA considers if there is enough evidence for the treatment in a similar clinical situation to the individual involved, and if it is clear that usual treatment has been trialled. A current example is DVA funding the use of ketamine or esketamine treatment for individual veterans with depression that is not responding to reasonable trials of standard treatment. The evidence for ketamine treatment for PTSD is being closely watched.

Where there is evidence of harm, this needs to be balanced by evidence of clear benefit to support a positive risk-benefit assessment.

Where there is limited evidence to guide decision making, DVA will talk with Australian experts in that area. DVA has a Mental Health Expert Advisory Group that provides advice on mental health treatments. In addition, DVA may reach out to professional colleges for expert recommendations.

## What if it is the only treatment left to try?

For emerging treatments, like all healthcare, the risks of treatment need to be weighed against the risks of not treating or alternative treatments.

Generally, this means that DVA will take into consideration a life-threatening or significantly debilitating condition.

DVA will also consider if existing alternative treatments have been exhausted or are unsuitable. As emerging treatments are considered on a case-by-case basis, this may lead to one person being funded for a specific treatment and another person having funding declined for the same treatment, depending on what has already been tried or is otherwise suitable for the relevant individual.

**Sources used to determine if a treatment should be funded by DVA**

PUBLISHED EVIDENCE
EXPERT OPINION – PEAK BODIES AND ADVISORY GROUPS
CLINICAL TREATMENT GUIDELINES

## How do I ask DVA to fund an emerging treatment for one of my veteran patients?

If a health provider believes their patient would benefit from an emerging treatment that is not listed under the MBS, the provider is asked to obtain prior approval for funding of the service. Forms can be found at www.dva.gov.au/about-us/dva-forms/treatment-prior-financial-approval-request . The approval is for an individual, not for the treatment in general. The treating clinician will need to outline:

- the clinical need;
- that established therapies have failed or reasons why they are unsuitable;
- an outline of the treatment plan; and
- itemised costing.

Certain treatments may need additional information to be supplied. For very new treatments, provision of supporting published evidence is appreciated. There is no guarantee that DVA will fund treatment, but it will be considered as outlined here.

New treatments and technologies are constantly emerging. As use of these treatments increases, more evidence becomes available. DVA follows a careful pathway to assess each treatment and balance the risks and benefits to seek the best outcome for veterans.

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