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- Saint Longinus at the Cross – A Veteran's Story
- System Configuration for an Extreme-Range Normobaric Hypoxia Generator
- Dengue Epidemics During the Second World War in Queensland

The Journal of the Australasian Military Medicine Association

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Journal of Military and Veterans' Health

Australasian Military Medicine Association

STATEMENT OF OBJECTIVES

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
- Disseminating knowledge of military medicine
- 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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Editorial

Infectious Diseases in Military Medicine

In spending a little less time on COVID-19, I have been reflecting on the role of infectious diseases in military operations, as diseases like tuberculosis, Japanese encephalitis and even syphilis make a resurgence in Australia and overseas. Biselli et al. provide an excellent historical review of the role of military health personnel in researching, diagnosing and managing operationally critical infectious diseases, from Emil von Behring's work on diphtheria and tetanus therapies, to Major Walter Reed's work on Yellow Fever, and the early adoption of vaccinations and other therapies by various militaries with significant consequent benefits to their overall health and operational fitness.[1] Professor Shanks has added to this medical historical literature in this issue with his review of dengue epidemics in Queensland during the Second World War.

The Australian Defence Force (ADF) has recently created and appointed three reserve personnel, one from each service, to Principal Consultant roles for Trauma Specialists, Force Health Protection and in Nursing, Mental or Allied Health. These roles will report to the Surgeon General ADF (SGADF) and will be the first point of contact for the SGADF in obtaining academic, clinical, and technical advice through the network of specialist practitioners both within the ADF and into the civilian sector. They will also lead the establishment of the broader Faculty of Defence Health to include Senior Consultants and Consultants. They will have a key role from 2024 onwards in ensuring that the SGADF and Joint Health Command are receiving the appropriate operational, policy and clinical advice, including in the infectious disease space, through these networks.

Our first issue of 2024 contains a range of articles on diverse topics spanning infectious diseases, mental health, health monitoring, military operational training, and military health history. We continue to attract a good range of articles, including from overseas. Other military and veterans' health articles, however, are always very welcome, and we would encourage all our readers to consider writing on their areas of military or veterans' health interest. We would particularly welcome papers based on presentations from our 2023 conference in Perth, but welcome any articles across the broader spectrum of military health.

Dr Andy Robertson, CSC, PSM
Commodore, RAN
Editor-in-Chief

References:

1. Biselli R, Nisini R, Lista F, et al. A historical review of military medical strategies for fighting infectious diseases: From battlefields to global health. Biomedicines 2022;10(8):2050.

Use of a Health Monitoring System During a US Military Exercise During the COVID-19 Pandemic (April 2021): Participant Characteristics, Demographics and Differences in Participation

T Dignam, K Vandebelt

Abstract

Background: Because of the close working environment, military personnel are exposed to respiratory disease, often greater than the civilian sector. During the COVID-19 pandemic (April 2021), an Oracle short message service (SMS)–based, mobile phone, daily COVID-19 health monitoring system was employed to monitor and protect the health of military members participating in a large-scale, 17-day exercise in the south-eastern United States.

Methods: Military member demographic and self-reported mobile phone health monitoring system data were aggregated and analysed descriptively. Bivariable and logistic regression methods were employed to assess health monitoring system participation differences.

Results: A total of 419/529 (79%) military members joined and used the system. Military members reported 4666 daily health status updates. Compared with enlisted members, officers were less likely to participate in health monitoring (odds ratio [OR] 3.5, 95% confidence interval [CI] 1.9, 6.3, $P<0.0001$). Compared with logistics & maintenance, all other career fields were less likely to participate in the health monitoring system program (OR 2.8, 95% CI 1.6, 4.8, $P=0.0002$). Compared with Wing A, all other Wings and support staff personnel were less likely to participate (OR 43.3, 95% CI 5.9, 318.4, $P=0.002$). The drop-out proportion was 0.2%.

Conclusions: We found significantly higher COVID-19 health monitoring system participation among enlisted personnel, members from Wing A, and Logistics and Maintenance personnel. Participation in the health monitoring system enabled medical staff to recognise symptoms associated with respiratory illness early during a large-scale military exercise.

Introduction

From April 8–24, 2021, approximately 1300 US Air Force and Air National Guard (ANG) military members from 12 wings and support staff participated in a joint US Military air exercise in the southeast US. The coronavirus 2019 (COVID-19) Delta variant was being reported in the United States during this time.[1] Because of crowding and close working environments, military personnel are subject to respiratory disease exposure, often greater than in the civilian sector.[2] To mitigate potential COVID-19 infections, primarily due to anticipated large gatherings and crowded indoor work settings, leadership requested the development of a COVID-19 health monitoring surveillance system prior to the exercise. Because Oracle America Inc. (Austin, Texas) previously developed a vaccine safety monitoring system with the Centers for Disease Control and Prevention (CDC),[3,4] the ANG requested technical collaboration with Oracle. To conduct symptom surveillance among a healthy population, a custom mobile phone-based,

daily health survey, based on requirements from the ANG, was developed by Oracle prior to the exercise and deployed in the Oracle COVID-19 patient monitoring system (PMS) environment using Short Message Service (SMS) reminders. SMS reminders have been effectively used to increase compliance with vaccination schedules,[5] health promotion[6] and improved attendance rates at outpatient clinics and health promotion centres.[7,8] The system we employed relied on symptom monitoring. This contrasts with previous studies monitoring military populations, which relied on testing for SARS-CoV-2, the virus that causes COVID-19, for surveillance activities.[9,10] The goals of this project were to: 1) provide monitoring and clinical support to military members participating in the mass gathering event who had a known COVID-19 exposure or developed COVID-19 symptoms before, during or after the exercise; 2) quickly provide data required to conduct contact tracing for close contacts of military members who have tested positive for COVID-19; 3) support a safe working environment for military members; and 4) keep leadership updated of COVID-19 occurrence via a dashboard. This report describes the health monitoring system, COVID-19 outcomes, differences in system participation and implications for future military exercises.

Methods

Units accomplished COVID-19 illness pre-screening, including symptom monitoring and testing of military members before departure to the exercise at the discretion of the home wing. Military members testing negative for SARS-CoV-2 before departure were allowed to join the exercise. More than 500 military members comprising four wings and support staff worked, lodged and dined at the primary exercise base, which included air and ground training facilities. The remaining approximately 800 military members and other wings participated in the exercise at other sites across the southeast US. The exercise director assembled a five-member COVID-19 public health/medical team consisting of a medic, public health technician, public health officer, nurse and physician to provide guidance regarding infection prevention, testing, quarantine, isolation, return to work, contact tracing and surveillance.

Health monitoring

All military member exercise participants were presumed to have mobile phones because 97% of Americans are estimated to own a cell phone.[11] The web-based, user-friendly, smartphone SMS health monitoring system was used daily from April 12 to 21 (or 10 days when all military members arrived at the exercise) and allowed the public health/medical team and leaders (i.e., command staff and First Sergeants) from each wing to communicate and track military members who were reporting sick or exposed to COVID-19 positive people. The system included a dashboard for leadership to view real-time aggregate metrics. Leadership was not able to view individual-level health data. The team focused on symptom monitoring of military members from wings and support staff participating at the primary exercise location. All military members who participated in the exercise were eligible for inclusion in data analyses. Military members had their name, birthdate, mobile phone number and ZIP code collected pre-exercise by First Sergeants. Upon exercise arrival, most military members received a welcome brief about COVID-19 risks and prevention and an overview of the health monitoring system. They were sent a text message from Oracle COVID-19 PMS system to validate their information and participate in the system (Figure 1). A small number of military members missed the welcome brief because of travel delays. Participation in health monitoring was strongly encouraged but not mandatory. Military members received a message requesting their participation when they joined the symptom monitoring and to enter their daily health information: 'The U.S. Department of Health and Human Services and this exercise thank you for your participation in entering information for the purpose of understanding, responding to and potentially developing new treatments to address the COVID-19 emergency' (Figure 1). After participants voluntarily opted into the system and validated their information, the medic and public health technician added participants to the system one by one or in bulk. After participants were entered, they received a text message. After receiving the message, participants could start participating immediately in the daily health update survey. Military members were defined as participating in the health monitoring system if they validated their identifying information during the exercise. Validation required the member to consent to participate and correctly enter their last name, date of birth and ZIP code via their mobile phone. Entries were validated against the information provided by First Sergeants pre-exercise. Military members were locked out after three failed validation attempts. Following validation, the military member was prompted to answer seven questions (Figure 2).

A daily individualised text message web link was sent to each participant on subsequent days, displaying six questions about general wellness, symptoms, behaviours and potential COVID-19 exposures (Figure 3). If the military member reported feeling ill, they were prompted to notate their symptoms using a checkbox. Symptoms included the following: fever

Figure 1

Figure 2

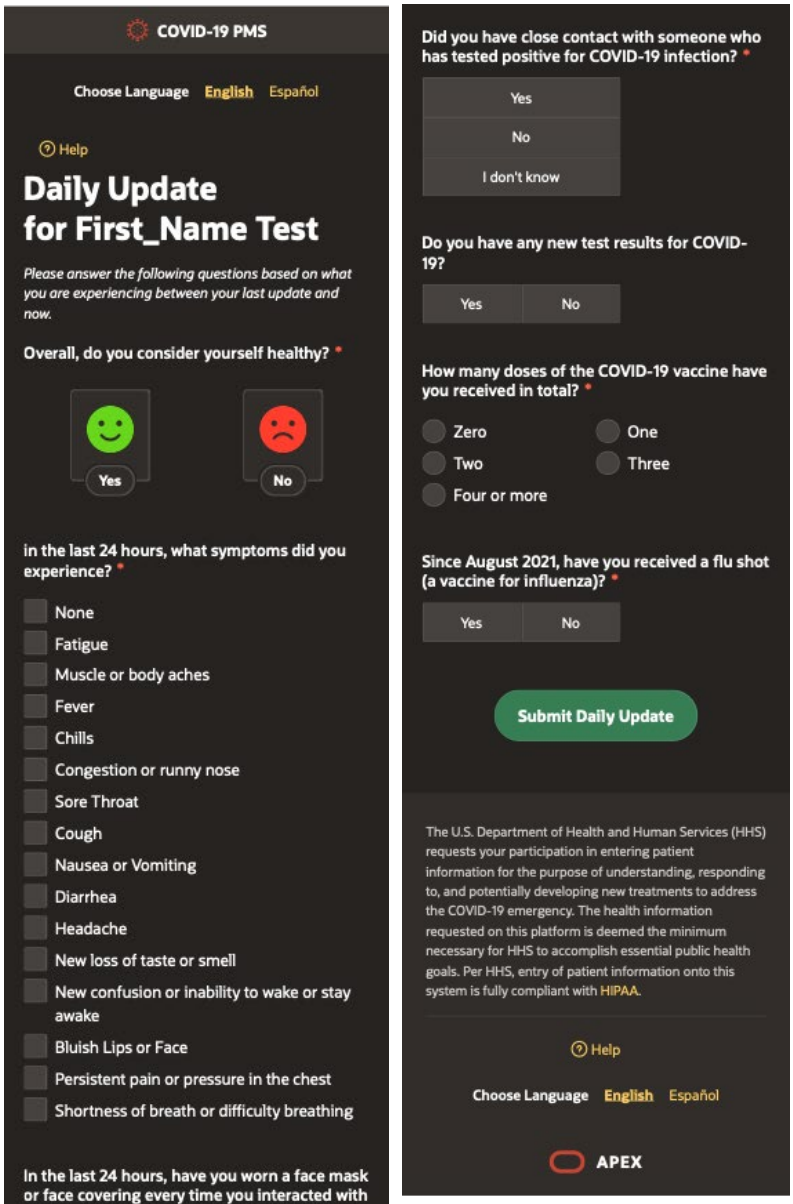
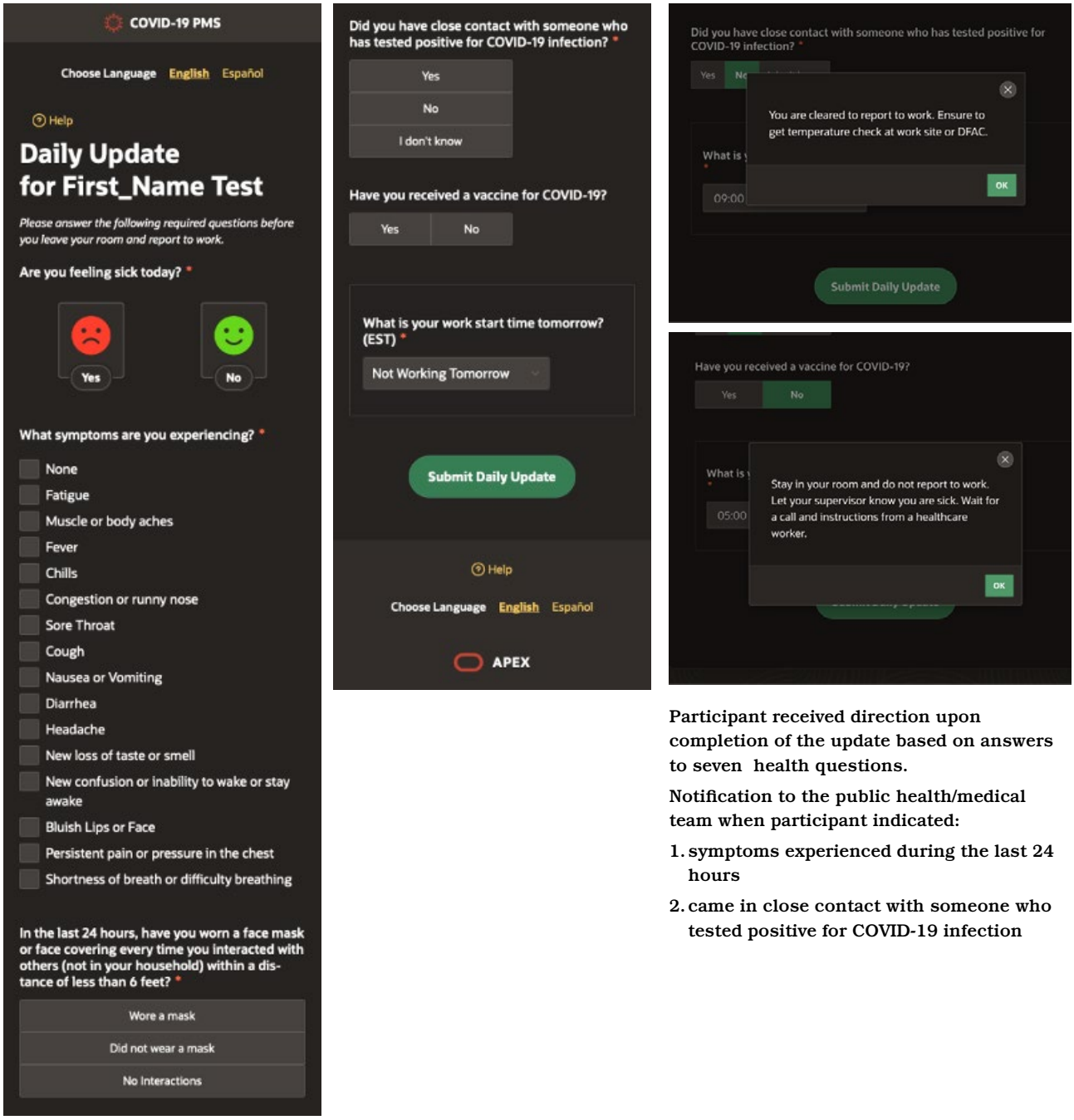


Figure 3



Participant received direction upon completion of the update based on answers to seven health questions.

Notification to the public health/medical team when participant indicated:

1. **symptoms experienced during the last 24 hours**
2. **came in close contact with someone who tested positive for COVID-19 infection**

or chills, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting and diarrhoea.[12] Military members who reported symptoms daily were aggregated and discussed among the COVID-19 public health/medical team and wing First Sergeants to determine if testing or other actions were required. Because work shifts varied, military members were requested to state their starting time for the next day via the system. The system used the start time information to send a text message 2 hours prior to the work shift or at 0800 if the participants stated they had the day off. Monitoring continued 3 days post-exercise to ensure military members' health was monitored upon arrival home. When participants self-reported being ill via the health monitoring system, the public health/medical team received a text message and/or an email notification about the member. Military members were informed by the system to inform their supervisor and to stay in their room until further notice. This allowed the team to act swiftly and initiate the appropriate protocol. Military members who did not report their daily status were sent system reminder(s) by the tool to complete the self-assessment.

Table 1: Member characteristics (N=529)

Member characteristic	Number (%)	Member participation in system (%)	Non-participation odds ratio (95% confidence interval)
Health monitoring system participation			
Participated	419 (79.2)	NA	NA
Never participated	110 (20.8)		
Air Guard Wing/grouping			
Wing A	138 (26.1)	137 (99.3)	Ref
Wing B	177 (33.5)	137 (77.4)	40.0 (5.4, 295.0)
Wing C	128 (24.2)	90 (70.3)	57.8 (7.8, 428.8)
Wing D	55 (10.3)	36 (65.4)	72.3 (9.4, 558.3)
Exercise support staff	31 (5.9)	19 (61.3)	86.5 (10.6, 703.4)
All Wings/support staff versus Wing A	391 (73.9)	282 (72.1)	53.0 (7.3, 383.2)
COVID-19 Vaccination status			
Full	274 (51.9)	206 (75.2)	8.9 (2.1, 37.5)
Partial	56 (10.6)	54 (96.4)	Ref
Not started	134 (25.3)	102 (76.1)	8.5 (2.0, 36.7)
Medical decline	65 (12.2)	57 (87.7)	3.8 (0.8, 18.6)
Individual medical readiness			
Current/due	444 (83.9)	352 (79.3)	Ref
Overdue	85 (16.1)	67 (78.8)	1.0 (0.6 1.8)
Personnel classification			
Enlisted	437 (82.6)	375 (85.8)	Ref
Officer	92 (17.4)	44 (47.8)	6.6 (4.0, 10.8)
Enlisted and officer career category			
Commander/director	4 (0.8)	1 (25.0)	26.8 (2.7, 265.0)
Logistics & maintenance	338 (63.8)	304 (89.9)	Ref
Medical	14 (2.6)	14 (100.0)	Undefined*
Operations	100 (18.9)	55 (55.0)	7.3 (4.3, 12.4)
Pilot/flyer/flying instructor	27 (5.1)	14 (51.9)	8.3 (3.6, 19.1)
Special duty	8 (1.6)	8 (100.0)	Undefined
Support	36 (6.8)	21 (58.3)	6.4 (3.0, 13.5)
Weather/meteorological	2 (0.4)	2 (100.0)	Undefined
All career categories versus logistics & maintenance	191 (36.1)	115 (60.2)	5.9 (3.7, 9.3)
Healthcare personnel			
Yes	22 (4.2)	22 (100.0)	Ref
No	507 (95.8)	397 (78.3)	Undefined
Gender			
Male	441 (83.4)	344 (78.0)	1.6 (0.9, 3.1)
Female	88 (16.6)	75 (85.2)	Ref
Age (years)			
19–24	81 (15.3)	74 (91.4)	Ref
25–29	104 (19.6)	82 (78.9)	2.8 (1.1 7.0)
30–34	101 (19.0)	81 (80.2)	2.6 (1.04, 6.5)
35–39	103 (19.5)	80 (77.7)	3.0 (1.2, 7.5)
40–44	72 (13.6)	48 (66.7)	5.3 (2.1, 13.2)
45–49	33 (6.2)	23 (69.7)	4.6 (1.6, 13.4)
50+	35 (6.6)	31 (88.6)	1.4 (0.4, 5.0)
All age groups versus 19–24 years	448 (84.7)	345 (77.0)	3.2 (1.4, 7.1)
Previous COVID-19 diagnosis			
Yes	52 (9.8)	52 (100.0)	NA
No	368 (69.6)	367 (99.7)	
Missing	109 (20.6)	0 (0.0)	
Previous COVID-19 hospitalisation			
Yes	6 (1.2)	6 (100.0)	NA
No	414 (78.2)	413 (99.8)	
Missing	109 (20.6)	0 (0.0)	

***Undefined: Small cell sizes (<5) do not allow the normal approximation odds ratio to be calculated.**

Oracle America Inc. provided technical support during the exercise. Oracle America Inc. and the host ANG wing signed a memorandum of agreement to formalise this government–private sector partnership.

SARS-CoV-2 testing

On site, COVID-19 polymerase chain reaction (PCR) testing test kits were available from the public health/medical team and offered to all military members. Testing supplies consisted of Remel Microtest M4RT, no beads (Thermo Fisher) and sterile flock nasal swabs (Puritan Medical Products). Tests were transported and analysed at a nearby US Air Force base laboratory using GeneXpert for nucleic acid testing (Cepheid, Sunnyvale, CA, USA). COVID-19 results were available within 24 hours via the Armed Forces Health Longitudinal Technology Application (AHLTA). Healthcare workers wore personal protective equipment (i.e., gloves, face shields, masks, and gowns) to test military members for possible COVID-19 infection.

Mask wearing

Per US Department of Defense (DOD) guidance at the time of the exercise, mask wearing was mandatory during participation in the exercise (unless it interfered with the mission).[13]

Temperature self-check stations

At five locations throughout the flight line were self-check, forehead thermometers (BERRCOM® non-contact digital infrared thermometer), hand sanitiser and daily sign-in sheets. The sign-in sheets allowed people to note their temperature and validate that they had no COVID-19 signs or symptoms as defined by CDC in April 2021[12] before reporting to work site.

Return to work

Military members who answered during their daily update: 1) to feeling ill; 2) recording one or more symptoms; or 3) reporting close contact with someone who tested positive for COVID-19, received a notification not to report to work, to let their supervisor know they were sick or exposed and that a public health/medical team member would be calling them. The system sent a text and or an email notification to the medical/public health team of the military members who reported sick. The team followed up with all military members and initiated the appropriate testing, contact tracing, isolation and quarantine protocols. Military members who did not report their daily status were sent system reminders by the tool to respond to the daily symptom monitoring.

Data

We examined three sources of data: 1) Air Force medical records; 2) Oracle COVID-19 health monitoring database; and 3) a participant return to work and contact tracing tracking database. We extracted military member demographic, Air Force career field, unit, rank, COVID-19 immunisation status, medical readiness and home unit data from ANG medical records. Data regarding previous COVID-19 illness and hospitalisation, and healthcare worker status were collected from participants in the health monitoring system. The tracking database was managed by the public health/medical team. It included all documentation of participants reporting symptoms and close contacts of confirmed COVID-19 cases, presumptive cases and/or cases that have sought testing in the absence of symptoms. Wing names were removed and assigned letters A, B, C and D during data analyses. The de-identified, limited analytic data are available from the corresponding author upon reasonable request.

Vaccination status

Military members were vaccinated against COVID-19 disease per DOD guidance as of April 2021.[14] Military member exercise participant vaccination status was calculated based on their pre-exercise status.

Statistical analysis

Military member personal information was removed, and a de-identified analytic database was created. Descriptive data analyses of sample distributions and characteristics of those invited to participate in health monitoring were accomplished. Military member demographic characteristics and personnel information were analysed to predict participation in the system. The number of military members who started and ended participation before the exercise ended ('drop out proportion') was also calculated. Bivariable and logistic regression analyses were conducted to assess military member characteristics associated with participation in the health monitoring system. Characteristics significantly associated ($P < 0.05$) with system participation were evaluated in multivariable analyses. Multivariable analyses assessed each characteristic one at a time. Statistically significant characteristics ($P < 0.10$) identified in the first multivariable analysis were included in a second multivariable analysis. During the second multivariable analysis, we used a forward-selection strategy to add one characteristic at a time

to the most predictive model until all characteristics in the model were statistically significant (P <.05). Interactions between characteristics and the confounding variable were assessed. Variance inflation factors were used to assess collinearity between variables in predictive models. Data analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, North Carolina).

Security

Oracle Inc. developed personal security measures in partnership with DOD and provided the secure, protected platform used during the exercise. Oracle America Inc. and the host Air National Guard wing signed a memorandum of agreement to use the COVID-19 health monitoring system. Oracle America Inc. implemented and maintained appropriate technical and organisational security measures for processing personal information to prevent accidental or unlawful destruction, loss, alteration or unauthorised disclosure of personal information. These security measures govern all security areas applicable to the health monitoring platform, including physical access, system access, data access, transmission and encryption, input, data backup, data segregation and security oversight, enforcement and other security controls and measures.

Human subjects protection

The Department of the Air Force, Component Office of Human Research Protections reviewed the study protocol. The activity was determined not to be human subject research and was exempt from the human subject internal review board.

Results

Military member characteristics

Five hundred and twenty-nine military members were invited to participate in COVID-19 health monitoring, and 419 (79%) participated. The average military member age among invited participants was 34.2 years (min./max.: 19–64 years). One hundred and four invited military members (20%) were 25–29 years of age; 441 (83%) were male; 437 (83%) were enlisted; 330 (62%) were fully or partially vaccinated; 444 (84%) were medically ready to deploy; and most military members (96%) were not health care workers (Table 1). Ninety-two (92) participants were officers, and 71 (77%) were classified as either pilots/flyers/flyer instructors or operations.

Military member participation characteristics

Among the 419 military members who validated their personal information, they did so, on average, within one day (min./max.: < 1–5 days, std. dev.: 1.3 days), and 398 (95%) did so within 3 days. System participants were more likely to be enlisted (n=375, 89%) from Airlift Wing A (n=137, 32%) and Airlift Wing B (n=137, 32%), male (n=344, 82%), ages 19–39 years (n=317, 76%), fully vaccinated against COVID-19 (n=206, 49%), medically ready to deploy (n=352, 84%), and in the logistics and maintenance career field (n=304, 73%) (Table 1). The most common subgroups who validated and participated in health monitoring were those who were medical personnel (100%), from Wing A (99%), partially vaccinated (96%), ages 19–24 years (91%), in the logistics and maintenance career field (90%), enlisted (86%) and female (85%). The dropout rate using the system was two military members (0.2%).

Table 2: Multi-variable logistic regression estimates of the association between symptom monitoring participation and other member characteristics, (N=529)

Member characteristic	Beta	Non-participation odds ratio (95% confidence interval)	Standard error	Wald chi-square	P-value
Air Guard Wing					
Wing A		Ref			
All other wings and support staff	3.77	43.3 (5.9, 318.4)	1.018	13.71	0.0002
Personnel classification					
Enlisted		Ref			
Officer	1.25	3.5 (1.9, 6.3)	0.3042	16.84	<0.0001
Enlisted and Officer career category					
Logistics & maintenance		Ref			
All other career fields	1.03	2.8 (1.6, 4.8)	0.277	13.89	0.0002

Predictive factors

In bivariable analyses, non-participation in the system was independently significantly associated with being a member of any wing or support staff other than Wing A (OR 53.0, 95% CI 7.3, 383.2), being fully vaccinated for COVID-19 (OR 8.9, 95% CI 2.1, 37.5) or not started the COVID-19 vaccination process (OR 8.5, 95% CI 2.0, 36.7), being an officer (OR 6.6, 95% CI 4.0, 10.8), being in a career field other than logistics and maintenance (OR 5.9, 95% CI 3.7, 9.3), being in any age group except 19–24 years (OR 3.2, 95% CI 1.4, 7.1) (Table 1). Based on multivariable analyses, non-participation in the system was significantly associated with being a member of any wing or support staff other than Wing A (OR 43.3, 95% CI 5.9, 318.4), being an officer (OR 3.5, 95% CI 1.9, 6.3), and being in a career field other than logistics and maintenance (OR 2.8, 95% CI 1.6, 4.8) (Table 2). Age (considered both as continuous and as age groups) was not significant in the multivariable model and did not strengthen the final model (i.e., lower the Akaike information criterion). Officers who were invited to participate in the military exercise were, on average, older (avg 39 years) compared with invited enlisted members (avg 33 years) ($P < 0.0001$). Collinearity assessment did not identify significant correlations between variables in the models.

Cases, contact tracing and vaccination

The public health/medical team tracked 4666 daily status updates. Which, among 419 participants, yields 11.1 status updates/participant (or, on average 1.1 daily status updates for each participant during the 10-day monitoring period). Twenty-seven military members (6%) reported various symptoms during the exercise. The most frequently reported symptoms were sore throat (n=8), headache (n=7), muscle or body aches (n=6), congestion or runny nose (n=6), and fatigue (n=6). All military members who reported symptoms had follow-up provided by First Sergeants, flight doctors and/or the public health/medical team. Many symptoms were determined to be from allergies and post-COVID-19 vaccine administration side effects.

The COVID-19 public health/medical team administered 14 initial and return-to-work COVID-19 tests to seven military members and tracked 11 with known COVID-19 close contact exposure (i.e., within 6 feet, for at least 15 minutes, over a 24-hour period).[15] Three exposed were asymptomatic, fully vaccinated and returned to work. Six military members were quarantined, tested negative, were asymptomatic and returned to work on post-exposure day 8. The remaining military member tested positive, was isolated in an assigned room, instructed to end participation in the exercise, and was sent home via personal vehicle to further isolate for 14 days. Fifty-five military members received a first or second dose of Moderna COVID-19 vaccinations during the exercise (administered by the local ANG medical group).[16]

Discussion

Several COVID-19 health and symptom monitoring systems have been used during the COVID-19 pandemic,[17-20] but predictors of participation using such systems have been minimally explored. We did not find prior studies about COVID-19 health or symptom monitoring among military populations. Previous civilian reports show participation or intention to participate percentages lower than we observed during our military exercise. Meyer and colleagues reported daily COVID-19 symptom monitoring using a mobile phone app questionnaire among male German professional football players and game officials.[17] They found that 64% of the players and 47% of the officials participated in the system over a 9-week period (May–July 2020). However, reasons for differences in participation were not explored. Dutch researchers examined predictors of intention to use a COVID-19 mobile phone symptom monitoring app among 238 adults.[21] They found that 45% of respondents were willing to use a mobile application for COVID-19 symptom recognition and monitoring and that younger age, attitude towards technology and fear of COVID-19 were predictors of intention to use. Another study examined attitudes towards using a mobile phone app or a website to track their COVID-19 symptoms and receive recommendations.[22] The study conducted April–June 2020 among 10 760 US adults with chronic health conditions reported that 22% of respondents were extremely/very likely to use a mobile phone app or a website to track their COVID-19 symptoms.

Most military members (79%) invited to participate in our health monitoring system registered and reported daily health status updates. We identified three factors that predicted participation in health monitoring: being enlisted, being a member of Wing A and being in the logistics and maintenance career field. A potential reason for lower participation among officers was that 26/27 (96%) of the pilots/flyers were officers. In bivariable analysis, pilots/flyers were 8.3 times less likely (95% CI 3.6, 19.1) to participate in the system compared with logistics and maintenance career fields. Perhaps the attitude of aircrew towards medical monitoring (i.e., increased risk of non-flying status) created the participation

difference that was observed between officers and enlisted members. Similarly, operations officers were 7.3 times more likely (95% CI 4.3, 12.4) to not participate in the health monitoring system. In a 2019 study, Britt and colleagues examined barriers and facilitators of treatment-seeking for mental and physical health problems among a US Military population.[23] They found that more officers preferred managing mental and physical health problems independently compared to enlisted personnel. This 'do it yourself' attitude provides a potential reason for lower participation among officers in the present study. A final potential reason for lower officer participation was decreased officer attendance at pre-exercise briefings. Several pre-exercise briefings were conducted, which provided an opportunity to review the usage of the COVID-19 health monitoring system and the enrolment process. Missing attendance at these briefings may have decreased awareness about symptom monitoring and lack of participation. However, we did not collect attendance information at pre-exercise briefings; this is an observational finding.

Members from Wing A demonstrated significantly higher participation in health monitoring compared to other wings and support staff. A potential reason for high compliance was Wing A had a very proactive First Sergeant who ensured full attendance at the Wing A pre-exercise briefing, strongly encouraged participation in the system and was available for technical assistance. For example, the First Sergeant from Wing A corrected errors with member phone numbers and quickly reported technical issues for resolution by the public health/medical team.

Members in the logistics and maintenance career field were significantly more likely to participate in health monitoring during the exercise. The reasons for this finding are unclear. A possible reason is that 40% of members in the logistics and maintenance career field were younger (i.e., ≤ 29 years) and most (98%) were enlisted, a predictor of participation.

Military member attendance at pre-exercise briefings appears to be important to health monitoring participation. Military members were educated about receiving a text message (i.e., not spam), instructions to enrol, where to report if ill, and received guidance to stay safe during the exercise. Personnel briefed at the in-processing briefings were notified that the COVID-19 public health/medical team would be on call 24/7 for questions regarding guidance with symptoms or potential exposure to COVID-19. If injuries or illnesses were life-threatening, members were instructed to report to a local hospital for care. During pre-exercise briefings, members were informed of the importance of self-assessment and reporting daily health status to have a successful exercise.

During the exercise, only one military member was confirmed positive via PCR testing for COVID-19 illness. The public health/medical team played an essential role in overseeing the health of the military members participating in Air Force and ANG military exercises. Communication, preparation, protocols, health monitoring and vaccination were the team's keys to successful health management. Protocols from the CDC and Georgia State Health Department were reviewed by the public health/medical team with visiting Wing physicians and the Georgia State Air Surgeon. Agreement was reached on return-to-work guidance, masking guidance and close contacts exposure guidelines for quarantine to ensure that the public health/medical team provided current information to inform pre-exercise briefings, COVID-19 health monitoring system requirements, leadership and public health on-site operations.

Access to military member health records and daily health status provided the COVID-19 public health/medical team adequate information to meet real-world responsibilities: 1) monitoring and clinical support to military members; 2) quickly providing data required to conduct contact tracing for close contacts of military members who have tested positive for COVID-19; 3) support a safe working environment for military members; and 4) update leadership about suspected/confirmed COVID-19 occurrence via a dashboard.

Being fully vaccinated had a positive impact on operational success. Per exercise protocol, vaccinated, asymptomatic military members with known exposure from a COVID-19-positive case reported back to work. Military members who had COVID-19 illness within the previous 3 months, recovered and remained without COVID-19 symptoms were to return to work, per protocol. Upon arrival, 61% of participants were fully or partially vaccinated. The COVID-19 health monitoring system supported a safe work environment, enhanced by the temperature check stations and mask-wearing guidelines.

This is the first study we are aware of that reports on using mobile technology for self-reported symptom health monitoring/reporting among a military population. The findings have broader implications for future military exercises, military readiness and digital health environments. Exercise training time is valuable and can be expensive. We provided an easily available and rapidly deployable mobile technology,

allowing leadership to focus on executing the exercise mission rather than the potential disruption due to widespread respiratory disease exposure. Regular information sharing with leadership, using a small health team to address potential health issues, user-friendly technology, pre-planning and agreement on return-to-work health protocols may be helpful in future military events. Our symptom monitoring system is potentially useful for identifying disease trends and possible cases during future military exercises. Symptom monitoring information could be combined with self-reported vital signs data, geographic information, and 'telehealth' to address emerging health issues rapidly in the military setting. Soldier acceptance and provision of actionable information to leadership are important factors to ensure success for future military exercises.

This study is subject to limitations. We did not survey non-participants about why they did not participate in the health monitoring system (e.g., concern regarding cost of receiving text or data security). Identifying barriers to participation is an area of future research. Repeated PCR testing represents the current 'gold standard' for assessing COVID-19 diagnosis. Symptom reporting is a weaker indicator of the presence of COVID-19 disease, especially among younger populations.[24] However, our experience was that among our younger population (average age 34 years), symptom monitoring with daily temperature checks and education about prevention proved proactive in preventing COVID-19. Although not designed into the health monitoring system, a potentially helpful system capability is to broadcast health messages during the event. Examples of such messages include building closures, COVID-19 prevention measures and health-related updates from leadership.

Conclusion

Today, mobile phones and apps are ubiquitous. During a public health emergency, the use of a web-based, smartphone health monitoring system was an opportunity to collect real-time health monitoring data and provide a strategy to facilitate and establish procedures for a safe return to normal operations. Most exercise members self-assessed and reported daily health status updates via the health monitoring system. We found significantly higher COVID-19 health monitoring system participation among the enlisted, members from Wing A, and logistics and maintenance personnel. In the future, military leaders may consider mandatory attendance in-processing briefings or use technology to video link military members. Special attention should also be given to certain Air Force career fields. Future studies could be conducted to determine barriers to officer participation in health monitoring system usage. Health monitoring allowed exercise leadership to focus on mission command and control. Health monitoring allowed for early recognition of symptoms associated with respiratory illness, where an outbreak would have disrupted an important military exercise.

Declarations

Disclaimer: The opinions and assertions contained herein are the private views of the authors and are not to be construed as the official policy or position of the US Government, the Department of Defense, the Department of the Air Force, the Air National Guard or the Oracle Corporation.

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The Department of the Air Force (DAF) Component Office of Human Research Protections (COHRP) Exempt Determination Official (EDO) determined this activity is not human subjects research.

Institutional clearance: 165th Airlift Wing Public Affairs and the Georgia State Air Surgeon reviewed and approved the manuscript.

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Social Isolation of War Veterans with Post-Traumatic Stress Disorder Based on Emotional Inhibition: The Mediating Role of Rejection Sensitivity

S Eyni, S Elham Musavi

Abstract

War veterans experience significant social isolation due to problems in their cognitive-emotional process. Therefore, the present study aimed to determine the mediating role of sensitivity to rejection in the relationship between emotional inhibition and social isolation in veterans with post-traumatic stress disorder (PTSD). In this descriptive and correlational research, 300

veterans with PTSD, admitted and treated at Isar Psychiatric Hospital in Ardabil, Iran, in 2022, were selected as a targeted sample and investigated throughout the process. The study made use of Russell's Social Isolation Scale (1996), Kellner's Emotional Inhibition Questionnaire (1986), and Berenson et al.'s (2009) Rejection Sensitivity Questionnaire for data collection. They were then analysed utilising Structural Equation Modeling (SEM) using SPSS and Lisrel 8.8 software. The results confirmed the causal relationship between emotional suppression, rejection sensitivity, and social isolation in veterans with PTSD based on various fit indices. Inhibition of emotion and sensitivity to rejection directly affected the social isolation of veterans with PTSD. Moreover, emotional inhibition through sensitivity to rejection indirectly affected the social isolation of veterans with PTSD ($P<0.05$). Therefore, emotional inhibition and sensitivity to rejection play a vital role in the social isolation of PTSD patients. In addition, targeting these two components through psychological treatments can effectively reduce the social isolation of veterans with PTSD.

Keywords: veteran, social isolation, emotional inhibition, rejection sensitivity, post-traumatic stress disorder.

Introduction

As an unpleasant and stressful phenomenon, war can cause psychiatric disorders.[1] Post-traumatic stress disorder (PTSD), a pervasive, long-term, and debilitating disorder among veterans, is considered a significant challenge in public health.[2] PTSD is associated with significant social exclusion.[3] Veterans of war also experience significant loneliness and social isolation. Social isolation is an objective experience that examines a person's adaptation to the social environment based on the frequency of social interactions and integration of the person in social networks.[4] In the mental health field, social isolation should always be considered among veterans.[5] Due to increased depression, suicidal thoughts or attempts, and re-hospitalisation in psychiatric hospitals, veterans with limited social and economic capital are exposed to social isolation in late adulthood.[6]

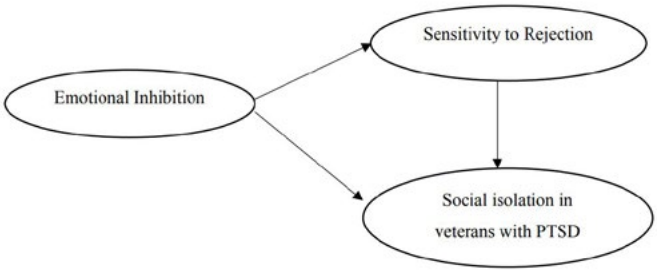
Studies have shown that emotional inhibition is one of the factors affecting personal efficiency, and people whose emotional expression style is emotional control and inhibition feel lonely and are afraid in social relationships and interactions. Due to low self-efficacy caused by this feeling, they experience social isolation and fear of social evaluation.[7] Therefore, the psychological variable that can be considered concerning social isolation in veterans with PTSD is emotional inhibition. Regarding the information processing approach viewpoint, emotional inhibition is one of the main components of emotional processing that affects a person's

psychological processes. Emotional inhibition is the tendency to consciously inhibit emotional expression during emotional arousal.[8] In general, emotional inhibition has consequences, including complaints, considering insignificant details of events that usually do not cause excitement, the tendency to impulsive behaviour, discomfort, avoidance of social relationships, weakness in self-care and low self-efficacy.[9] The expression and persistence of vivid, uncontrollable and distressing intrusive memories are one of the main features of PTSD.[10] Research reveals that trauma survivors who experience psychological distress, mostly avoid the behavioural expression of their emotions.[11] Also, after a traumatic event, attempts to suppress or avoid traumatic memories sometimes paradoxically increase the expression of intrusive memories.[12] The results of research studies confirm that healthy people can actively suppress their emotional memories through the lateral prefrontal cortex. In contrast, individuals with PTSD frequently experience unwanted memories of previous traumatic experiences, even when they try to avoid them.[13] Research results indicate that many veterans experience discomfort in communicating with others. [14] In addition, those symptoms of emotional numbness are independently associated with more emotional distress and less social contact.

Moreover, research studies confirm that maladaptive behavioural reactions, especially social withdrawal (or isolating oneself from others), are influenced by perceptions and emotions related to rejection sensitivity.[15] Sensitivity to rejection is a personality trait characterised by excessive sensitivity to social rejection. People with high sensitivity to rejection perceive social interactions as threatening, which leads to decreased satisfaction and support for social networks.[16] Sensitivity to rejection has a positive and substantial relationship with social avoidance and psychological distress and a negative and substantial relationship with self-esteem and social self-efficacy.[17] Sensitivity to rejection can lead to psychological issues through problems in emotion regulation,[18] negative emotionality,[19] extreme aggressive behaviours[20] and high reactivity to social experiences.[21] Research indicates that the position of avoidance is high in people who are sensitive to rejection.[22] Exposure to trauma can increase aggressive individuals with high sensitivity to rejection, which may hinder the ability to seek social support.[23] Sensitivity to rejection and low social support significantly predict PTSD symptoms in trauma survivors.[24] Wang et al. investigated and confirmed the mediating role of sensitivity to rejection in the relationship between interpersonal-social stressors and depressive symptoms in the military community.[25]

A review of the related literature shows that the social isolation of veterans can increase the incidence of depression, suicidal thoughts or attempts, and readmission to psychiatric hospitals.[5] Research also confirms that social isolation is associated with the severity of PTSD symptoms in war veterans through the catalyst of the war stress response.[26] Since inhibition and social isolation is the main component of PTSD, assessing social isolation based on the personality traits of emotional inhibition and sensitivity to rejection can play a significant role in assessing the vulnerability of war veterans. Failure to examine the direct and indirect effects of emotional inhibition and rejection sensitivity on social isolation in veterans with PTSD in previous studies is a gap that is filled by this study. The result of such a study serves as a preliminary basis for further studies as well as the design of appropriate interventions to reduce social isolation in veterans with PTSD. Therefore, the originality of this research topic adds to the importance and necessity of this research. Therefore, in the following conceptual model, the present study was conducted to determine the mediating role of sensitivity to rejection in the relationship between emotional inhibition and social isolation in veterans with PTSD (Figure 1).

Figure 1. The conceptual model of the research



Methods

Study design and sample

In terms of purpose, this study is applied, and in terms of the data collection method (research design), it is considered descriptive-correlation research. The statistical population consisted of all veterans with PTSD hospitalised in Isar Ardabil Psychiatric Hospital in 2022. Since, according to many researchers, the minimum sample size required in the structural equation model is 200, the research sample size was considered 350, considering the possibility of dropping out of the subjects and increasing the

external validity. After removing the outlier data, 300 questionnaires were entered into the statistical analysis; therefore, the research sample included 300 veterans with PTSD who were selected as a purposive sampling, considering the acceptance of the veterans to participate in the research in the first place and having the entry and exit criteria from the statistical population. The entry criteria are: 1) minimum education of diploma; 2) age range from 40 to 70; 3) obtaining a score above the cut-off point in the PTSD checklist (PCL-M); 4) absence of psychotic symptoms, including hallucinations and delusions; 5) absence of other diagnoses with post-traumatic stress disorder; and 6) not suffering from substance abuse related disorders. The exclusion criteria are: 1) incompleteness of the questionnaires and 2) unwillingness to cooperate with the researcher.

Data collection tools

Posttraumatic Stress Disorder Checklist-Military Version (PCL-M). This instrument is a 17-item, 5-choice one developed as a diagnostic aid by Weathers et al. for the US National Center for Posttraumatic Stress Disorder.[27] Five items are related to re-experiencing traumatic symptoms, seven are related to symptoms of emotional numbness and avoidance, and the other five items are related to intense arousal symptoms. The cut-off point for PTSD is considered to be 50. This scale was standardised in Iran by Goodarzi.[28] In a study by Goodarzi, the internal consistency of the questionnaire was 0.93;[28] in research by Weathers et al.,[27] the consistency coefficient was 0.97 for Vietnam War veterans.

Social Isolation Scale. Russell created this scale to assess the objective feeling of social isolation, which contains 20 questions.[29] It is scored on a 4-point Likert scale (never = 1, rarely = 2, sometimes = 3, always = 4). Questions 1, 5, 6, 9, 10, 15, 16, 19 and 20 are scored reversely. Research reported the retest reliability of the scale as 0.89.[29] In Iran, the scale's reliability has been obtained using Cronbach's alpha method of 0.93. Moreover, the correlation coefficient between the questions with a total score of 0.3 was reported as significant, indicating the scale's construct validity.[30] The present study estimated the scale's reliability at 0.88 using Cronbach's alpha method.

Kellner Emotional Inhibition Questionnaire. This questionnaire includes 16 items that evaluate 4 subscales of verbal inhibition, shyness, hiding emotions and self-control based on a 5-point Likert scale (from no = 0 to always = 4).[31] In this questionnaire, the items' scores are added together to evaluate the emotional inhibition level, and then the total score is obtained, which is considered from zero to 64. In the study of Grandi et al., Cronbach's alpha coefficient of the whole scale was 0.79, which designates the acceptable internal consistency of the emotional inhibition scale.[32] The results also pointed out a distinction between clinical and non-clinical populations. Asadollahi et al. obtained Cronbach's alpha coefficient of 0.79 for the total scale score in the Iranian population, and the four factors of the questionnaire were also confirmed using confirmatory factor analysis.[33] Moreover, the correlation between Kellner's Emotional Inhibition Questionnaire and the Executive Dysfunction Questionnaire indicated the concurrent validity of the questionnaire above. In the present study, the scale's reliability was obtained using Cronbach's alpha method for a total score of 0.69.

Rejection sensitivity questionnaire - adult version. The rejection sensitivity questionnaire of Berenson et al. is adapted from the Dooney and Feldman rejection sensitivity questionnaire.[34]

It is formed based on the history of socio-cognitive learning, measuring the process of cognitive, emotional processing related to stressful and rejection situations. It is active in situations where rejection or acceptance is possible. This scale consists of nine two-part questions (A-B) and is based on a 6-point Likert scale (Part A ranges from 1 = I am not worried at all to 6 = I am very worried, and Part B ranges from 1 = Very unlikely to 6 = Very likely). By subtracting the score of expectation of acceptance in each situation (Part B) from the number 7, the score of expectation of rejection is calculated. Then, in each situation, the rejection expectation score is multiplied by the anxiety degree, and the average score for nine situations is calculated and considered as the person's sensitivity to rejection. The internal consistency of this scale is reported as 0.89, and its retest reliability is 0.91 using Cronbach's alpha method. The scale's reliability was obtained using Cronbach's alpha method of 0.83 in the present study.

In order to conduct the research, after coordination with the Vice-Chancellor of Education and Research of Ardabil University of Medical Sciences, the necessary coordination was made with the directorate of Isar Psychiatric Hospital. Considering their willingness to participate and using the purposive sampling method, 350 veterans with PTSD were selected based on the psychiatrist's diagnosis and based on the *DSM-5* diagnostic criteria and confirmation of this diagnosis through the Post-Traumatic Stress Disorder Checklist – Military version by the examiner. After obtaining the consent of the research

samples and before presenting the questionnaires and collecting information, the target samples were individually informed about the objectives and quality of the research, and the necessary communication was established with them. After obtaining written consent from the veterans to participate in the research, the scales of social isolation, emotional suppression, and sensitivity to rejection were presented to them.

This work was done individually, and in case of any ambiguity during the completion process, the necessary guidance was provided to the subject in the framework of how to implement the relevant questionnaires. Simultaneously, assuring the confidentiality of the information and preparing the research sample mentally and psychologically to participate in the research were other ethical points of this research. Also, the standard codes of ethics in medical research include 13, 14, 2 (benefits from findings for the advancement of human knowledge), code 20 (coordination of research with religious and cultural standards) and codes 1, 3, 24 (consent of subjects and their legal representative), which were observed in this study.

Analysis

Finally, after collecting the questionnaire and removing the outliers, the raw data from 300 questionnaires were analysed using descriptive statistical tools such as mean, standard deviation, variance and Pearson correlation test using SPSS version 25 software and structural equation modelling using Lisrel software version 8.8.

Results

The statistical sample studied included 300 veterans with PTSD with a mean (standard deviation) age of 57.26 (7.12) years, who were 50 to 72 years old. Fifty-four (18%) of these veterans were single, and 246 (82%) were married. One hundred sixty-two people (54%) had a diploma, and 138 people (46%) had a higher education than a diploma. Furthermore, 74 veterans were below 25%, 86 were 25–50%, 94 were between 50–70%, and 46 were above 70%. Table 1 shows the research variables' mean, standard deviation, variance and Kolmogorov-Smirnov test results.

Table 1 shows that the Kolmogorov-Smirnov statistic of the research variables is insignificant. Therefore, the distribution of social isolation variables, emotional inhibition and sensitivity to rejection is normal (P<0.05).

According to the results of the correlation matrix (Table 2), there is a positive and significant relationship between the social isolation of PTSD veterans with emotional inhibition and sensitivity to rejection at a significant level of 99%. In addition, there is a positive and significant relationship between emotional inhibition and sensitivity to rejection sensitivity (P<0.01).

Table 1. Description of research variables

Variable	Mean	SD	Variance	Kolmogorov-Smirnov	Significance Level
Social isolation	51.30	11.97	143.49	0.92	0.186
Emotional inhibition	36.00	12.76	162.97	0.88	0.057
Sensitivity to rejection	13.13	4.43	19.68	0.88	0.123

Table 2. Correlation matrix of research variables

Variable	1	2	3
Emotional inhibition	1		
Rejection sensitivity	0.672**	1	
Social isolation	0.787**	0.665**	1

P<0.01 p*<0.05**

In the following, the direct and indirect effects of emotional inhibition on the social isolation of veterans with PTSD will be investigated through the mediation of rejection sensitivity. Figure 2 shows the final model between the research variables in T-value mode.

According to the fit indices of the research model, the comparative fit index (CFI) is equal to 0.92, the normalised fit index (NFI) is equal to 0.91, and the fit index' goodness (GFI) is equal to 0.83, the chi-square ratio on the degree of freedom ($\frac{\chi^2}{d_f}$) is equal to 39 2.0. The Root Mean Square Error (RMSEA) index is 0.068, which, according to the obtained results, can be said that the research model is approved in terms of significance and fit indicators.

Table 3 shows that the direct effect of emotional inhibition variables and sensitivity to rejection on social isolation is significant. Additionally, the direct effect of the emotional inhibition variable on sensitivity to rejection is positive and significant.

Figure 2. Research model test (T-Value mode)

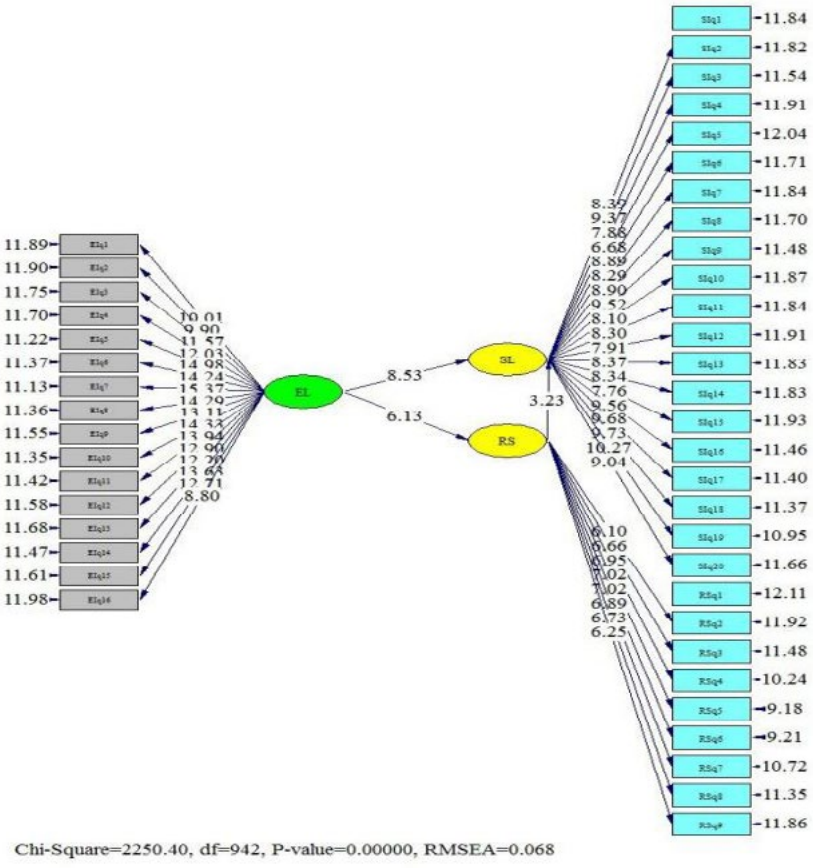


Table 3. The results of the direct effects of the research conceptual model

variables			Path coefficients	T-value	SEM	Significance
Emotional inhibition	→	Social isolation	0.71	8.53	0.046	Significant
Emotional inhibition	→	Sensitivity to rejection	0.64	6.13	0.053	Significant
Sensitivity to rejection	→	Social isolation	0.19	3.23	0.101	Significant

Table 4. Analysis of the indirect effects of the research conceptual model

Research hypothesis					T-Sobel	Standard path coefficient	VAF statistics	Test result
Emotional inhibition	→	Rejection sensitivity	→	Social isolation	3.091	0.122	0.146	**Proved**

In order to investigate the indirect effect of the emotional inhibition variable on social isolation with the mediation of sensitivity to rejection, the Sobel test was used. Additionally, to determine the intensity of the indirect effect through mediation, the researchers used a statistic called VAF, the results of which are presented in Table 4.

According to the value of indirect t-statistics (T-Sobel) between the above variables, which is outside the range (-1.96–1.96), the hypothesis of the indirect effect of emotional inhibition on social isolation is accepted. Therefore, in addition to the direct effect, the emotional inhibition variable indirectly affects social isolation through sensitivity to rejection.

According to the value obtained for the VAF statistic, it can be seen that 14.6% of the effect of emotional inhibition on social isolation can be explained through sensitivity to rejection.

Discussion

The present study aimed to investigate the mediating role of rejection sensitivity in the relationship between emotional inhibition and social isolation of PTSD veterans. The research findings depicted that emotional inhibition and rejection sensitivity significantly affected the social isolation of veterans with PTSD. Also, emotional inhibition through sensitivity to rejection indirectly affected the social isolation of veterans with PTSD.

The findings indicate that emotional inhibition positively and significantly affects social isolation among PTSD veterans. This finding aligns with the results of studies.[11,13,14] The research results indicate that many veterans experience discomfort in communicating with others; moreover, the symptoms of emotional numbness are independently associated with more emotional distress and less social contact.[14] Trauma survivors who experience psychological distress mostly avoid the behavioural expression of their emotions.[11] In explaining this finding, the theories of PTSD imply that the experiential avoidance of traumatic memories through the suppression of thoughts as a significant and traumatic factor causes the maintenance of disturbing symptoms.[35] Imposed war veterans who experience emotion regulation problems (such as emotional disinhibition) learn to use inflexible pessimistic cognitions. They also use pessimistic-based behaviours as a maladaptive social and emotional management strategy.[36] These pessimistic cognitions and behaviours can provide them with social isolation. Also, based on Gross's theory, inhibition is an emotion regulation strategy that refers to reducing, restraining, or abandoning emotionally expressive behaviour when a person is in an emotional state. As a response-based emotion regulation strategy, it occurs late when emotion is still present and does not contribute to reducing emotional experience. Emotions will remain unresolved, so there is a greater cognitive need to suppress emotions, which can negatively affect physical and psychological health. Expressive inhibition distorts the experience of emotions, leading to reduced control over emotions and reduced capacity for their effective regulation.[36] Due to the ineffective regulation of emotions, inhibition is associated with experiencing more negative and less positive emotions, avoiding close relationships, indicating more depressive symptoms, and lowering general wellbeing. In veterans with PTSD hospitalised in psychiatric hospitals due to being socially inhibited, inhibition during social interactions will lead to increased adverse emotional reactions and, thus, withdrawal from social situations.

The results revealed that rejection sensitivity has a positive and direct effect on the social isolation of PTSD veterans, which aligns with the research results.[16,17,21] Sensitivity to rejection and low social support significantly predict PTSD symptoms in trauma survivors.[24] People with high sensitivity to rejection perceive social interactions as threatening, leading to decreased satisfaction and support of social networks.[16] Research results indicated that sensitivity to rejection has a positive and significant relationship with social avoidance and psychological distress and a negative and significant relationship with self-esteem and social self-efficacy.[17] Research indicates that the position of avoidance is high in people who are sensitive to rejection.[21] Elaborating more on the gained results and based on the loneliness theory of Cacioppo and Hawkely, people

at a high level of loneliness become cognitively more alert to social threats and predict social interactions more negatively, leading to more socially avoidant behaviours.[37] Also, based on the PTSD cognitive model of Ehlers and Clark, sensitivity to rejection as a strategy to control PTSD symptoms can affect the social interactions of veterans with PTSD as a prior experience or belief and cause them to withdraw from social relationships. In fact, the theoretical framework of the mixed interpersonal circular model specifies interpersonal relationships along two orthogonal dimensions (dominance and gentleness) that represent the interpersonal perceptions and overt behaviours of people with high rejection sensitivity (hostile dominance, over-dominance). In other words, sensitivity to rejection is a cognitive-emotional tendency to expect anxiety, easy perception and a solid reaction to rejection.[16] People with high sensitivity to rejection always anticipate rejection from others, showing maladaptive responses to rejection (such as excessive efforts to please others, social withdrawal or hostile behaviours). These behaviours, in turn, provoke excessive rejection from others. Therefore, it weakens interpersonal relationships, provides the basis for social isolation and reinforces a self-perpetuating cycle of negative relationship outcomes.

The results also revealed that sensitivity to rejection could mediate the relationship between emotional inhibition and social isolation of PTSD veterans. As far as the researchers' knowledge is concerned, no study could be found to be directly aligned with these results; however, there are studies from which such results can be deduced.[18,25] Research investigated and confirmed the mediating role of sensitivity to rejection in the relationship between interpersonal-social stressors and depressive symptoms in the military community.[25] Delving into the issue in order to explain these findings, it can be declared that sensitivity to rejection can lead to psychological problems by creating issues in emotion regulation.[18] Exposure to trauma can increase aggressive individuals with high sensitivity to rejection, which may hinder the ability to seek social support.[23] Research studies also indicate that the induction of experiential rejection leads to several negative consequences that can reflect dysfunctional responses in veterans with PTSD. These responses include a decreased ability to control impulses and self-regulation strategies, rumination, increased anger and perception of hostility, a sense of being worthless and decreased self-awareness.[11] The veterans of the imposed war suffering from PTSD and hospitalised in mental hospitals use maladaptive emotion regulation strategies based on reducing negative emotions (emotional inhibition) in the emotion regulation processes. They fear losing control when expressing their emotions and facing rejection or abandonment. In other words, emotion regulation problems increase physiological and cognitive arousal and distress in responding to stressful factors (excessive rejection by others). This same arousal will cause maladaptive coping behaviours such as avoidance and social isolation, which paradoxically increases PTSD symptoms.

Emotional inhibition and sensitivity to rejection play an indispensable role in the level of social isolation of veterans with PTSD, and targeting these two components through psychological treatments can be effective in reducing the social isolation of veterans with PTSD.

Strengths and limitations

This research is limited to veterans with PTSD of the psychiatric hospital of Ardabil city, so we should be cautious in generalising the results. This research was carried out by correlational method, making it impossible to explain the cause-and-effect relationship based on it; therefore, the results should be interpreted cautiously. In addition, this research was only done quantitatively. If qualitative methods such as in-depth and semi-structured interviews were used, more complete results would be obtained. Therefore, it is suggested that this research be done on other regions of the country with more samples. Moreover, according to the research findings, it is suggested that the results of this research be used in psychiatric hospitals to reduce the social isolation of veterans with PTSD. It is also suggested that courses be implemented as educational workshops in psychiatric hospitals in order to reduce emotional inhibition and sensitivity to rejection.

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Saint Longinus at the Cross – A Veteran's Story

M J Davies

Abstract

Although other historical and Biblical figures prior to St Longinus have demonstrated many aspects of a Spiritual Wound and Injury (SW&I), Saint Longinus is worthy of specific consideration on several levels. To start with, with his seven simple words, 'Truly this was the Son of God,' he is the first person to publicly declare the divinity of Christ after his Crucifixion. The tumultuous, joyous and deeply conflicting events of the Crucifixion led to a SW&I that plunged Longinus into a period of nightly terror where he described the lions of doubt, shame and guilt mauled him every night. This is an experience that many modern veterans suffering from a SW&I would understand. To understand the importance of this event as a case study of SW&I, this article begins by developing a background profile of Longinus and then places him in the centre of events of the day of the Crucifixion. Using these and subsequent events in his life, the specific nature of Longinus' SW&I will be described and potential implications for the modern sufferers of the condition analysed.

Note: For this work, God is defined as 'a spirit or being believed to control some part of the universe or life and often worshipped for doing so, or something that represents this spirit or being'.[1] It may be pluralised, for example, Gods. This paper accepts the existence of God but is open faith and makes no imputation regarding the nature or supremacy of any religion or faith or claims regarding sex, gender, identity or multiplicity of God.

Key Words: veteran, mental health, spiritual health, spiritual wounds and injuries, SW&I, moral injury

Introduction

> *Jesus, when he had cried again with a loud voice, yielded up the ghost. And, behold, the veil of the temple was rent in twain from top to bottom; and the earth did quake, and the rocks rent, And the graves were opened, and many bodies of the saints which slept arose, And came out of the graves after his Resurrection, and went into the holy city, and appeared unto many. Now when the centurion, and they that were with him, watching Jesus, saw the earthquake and those things that were done, they feared greatly, saying, 'Truly this was the Son of God'.* Matthew 27:54.[2]

In one simple, short and prophetic sentence, 'Truly this was the Son of God', an obscure Roman centurion utters the first acknowledgement of the divinity of Christ after his Crucifixion. What lifted this centurion further from obscurity was that he was one of the first recorded cases of a Spiritual Wound and Injury (SW&I).

A SW&I occurs when a traumatic event or series of events creates a break or change in an individual's relationship with God or a divine presence. This relationship may be direct or facilitated through a Religious/Spiritual Care Practitioner (RSCP) such as a priest, rabbi or minister. It may be caused by an act of commission or omission by the individual with negative consequences or a perceived failure to act according to their needs or wants on God's behalf.[3-5] A SW&I can significantly impact the mental health and overall wellbeing of individuals who pass through traumatic events or circumstances. It can be particularly prevalent in veterans of the military or armed forces.

While the Crucifixion and subsequent events have resounded across time and space, they had specific implications for one soldier. Longinus was a Roman centurion in the Judea garrison who purportedly pierced Jesus' side with a spear while on the Cross. A centurion was an important rank in the Roman military organisation. Tactical and practical, these men were usually senior soldiers with many years of hard-won experience and commanded the basic fighting unit of the Roman Army, a century (80–100 Legionaries). As such, it seems unlikely that he would have casually proclaimed the divinity of a non-Roman god. He was also thought to be blind or visually impaired in some way. However, in one of the many miracles that day, he was reputedly cured when the blood and water that poured from

the wound in Christ's side splashed into his eyes.[6-8] Longinus may have interacted with Christ and his disciples on three occasions before, during and after the Crucifixion. This is important as it may point to a journey or growth in his faith and beliefs, eventually leading to sainthood.

To understand the importance of this event as a case study of SW&I, this article begins by developing a background profile of Longinus and then places him in the centre of events on the day of the Crucifixion. Using these and subsequent events in his life, the article will describe the specific nature of Longinus' SW&I and analyse potential implications for modern sufferers of the condition.

Who was Longinus?

The precise historical detail of 1st century Christian figures can be challenging to establish. Often, this is due to issues of basic historiography at the time and subsequent hagiographical redactions, revisions and, in many cases, fabrications. As such, there are inevitable gaps and contradictions. In the case of Longinus, his history prior to the Crucifixion has yet to be discovered and there are contradictory accounts of his life afterwards. At the same time, these accounts may not necessarily be contradictory but rather sequential.

The principal source regarding events of the Crucifixion are the four canonical Gospels of Matthew, Mark, Luke and John, although none mention the name Longinus. Of the four Gospels, Luke (23:47), Mark (15:39) Matthew (27:54) mention an unnamed 'centurion'. John (19:34) refers to a 'soldier' and 'soldiers'. Attribution of the name Longinus to the centurion at the Crucifixion does not appear until the 4th century in the apocryphal *Acts of Pilate* in the *Gospel of Nicodemus*.[9] Pilate (Roman Governor), writing to Herod (Jewish client king), describes how his wife Percola had 'heard that Jesus was risen, and had been seen in Galilee, she took with her Longinus the centurion and the 12 soldiers who watched the tomb and went forth, as it were to a great sight, to welcome the person of the Messiah'.[10]

Two locations are thought to be possibilities for the birthplace of Longinus. Gregory of Nyassa (335–305) claimed in his *Letters* that it was Sandralis (or Adrales) near Tyana in modern Turkey.[11] The second location is the ancient Roman city of Anaxum. The Monks of St. Basil founded a monastery there in the 8th century and named it after Longinus. The city was renamed Lanciano (now in the Chieti province in central Italy), the Italian word for lance.[12,13] Lance imagery is an essential part of the overall Longinus tale as his name may have been based on a Latinised Greek word for lance, (λόγχη).[14] This also fits with the overall idea of Longinus as a centurion. The principal centurion of a Roman Cohort (6 centuries) was known as the First Spear (*Primus Pilus*).[15]

Of course, John's Gospel does not say centurion but mentions soldier and soldiers. One commentator, Rose Peebles (1911), takes this to indicate that two distinct characters may have been involved in the fateful thrust of the spear. The first was a common soldier, 'merely a wicked participator in the Crucifixion', and the other was 'a convert to belief in Jesus, who at once became a prominent supporter of his faith'.[16] The difference between John's Gospel and the remainder of the canonical Gospels is worth noting. However, the weight of commentary from the Gospels, canonical and apocryphal, tends to favour the presence of a centurion. What is important about Peebles' assessment is the idea that the centurion Longinus became a 'convert to belief in Jesus'. It is possible that the centurion whose servant was cured by Jesus in Matthew 8 was not Cornelius as sometimes thought, but Longinus. In addition, a centurion was a senior-ranking soldier within the Roman Army. As such, unlike the common soldiery, a centurion had authority, responsibility, and some (albeit minor) flexibility in the conduct of events.

In contrast, the soldiers at the Crucifixion were thought to have been from Cohors I Sebastenorum, a non-Roman auxiliary unit of Samaritans from Northern Israel/Turkey. Although very much moulded on the model of a Roman legion, their training and equipment were of a lower standard. Despite or because of this, it would not have been unusual for a Roman centurion such as Longinus to be placed in a command position within an auxiliary force, possibly as a retirement position following service in the legions. Given the long-standing issues between the Jews and Samaritans, Cohors I Sebastenorum may have been deliberately placed in this role far from home in an environment where they were less likely to side with the occupied population.[17] Some evidence of that can be seen in the epithet given to the Sebasteni cavalry regiment, 'the hammer of the Jews'.[18]

Longinus at the Cross

The overall Crucifixion is covered in melancholy detail in the Gospels of Matthew, Mark, Luke and John. Longinus' role on the day and during the subsequent Resurrection can be pieced together using the canonical and the apocryphal Gospels.

Scourging

John 19:1-3 says that once Christ had been sentenced to Crucifixion, 'Pilate took Jesus and had him flogged'.[2] Such flogging or scourging was not uncommon before execution as it served two important purposes for the Romans. The first was to break the individual's will so they were physically weakened and unable to escape. The second was to make a very public point to any witnesses of the power of Rome and the penalty for disobedience. What was uncommon was the mocking and humiliation Christ endured. The Crown of Thorns and a purple robe were signs mocking his kingship, and the verbal and physical abuse were particularly cruel actions. Perhaps, this is what Peebles meant when she described 'wicked participator(s) in the Crucifixion'.[16]

Part of the viciousness and severity of Christ's scourging described in John 19:1, Mark 15:15, and Matthew 27:2 may have been based on the hatred the Samaritan soldiers had for the Jewish people. Even so, Longinus would have been in command of these events. While he may not have participated or even openly condoned the actions, he could have stopped them with a word. Of course, it can be easily argued that as a trained soldier, he was merely following the orders of his superior.

Path to the Cross

The badly injured and weakened Christ was then led to execution carrying his Cross. Again, this pitiful procession was part of the demonstration of cruelty and power the Roman authorities were trying to project. Longinus would have been in command of this party and may have issued the order to make Simon the Cyrene take up Christ's Cross when he fell (Matthew 27:32).[2] What is not clear is whether this was done as an act of expediency to keep the column moving or an act of kindness.

Crucifixion

Longinus was in command at the Crucifixion. This would have been mostly procedural, and the soldiers would have followed a well-practised routine. Jesus was stripped of his clothing, fixed to the Cross and then hung to die. According to John (19:34-37), a soldier was:

> 'sent to break the legs of the condemned men and thus hasten their death. They did not break his legs when they came to Jesus and found that he was already dead. Instead, one of the soldiers pierced Jesus' side with a spear, bringing a sudden flow of blood and water. The man who saw it has given testimony, which is true. He knows that he tells the truth and testifies so that you also may believe'.[2]

Breaking the legs of a person undergoing Crucifixion was a common act to hasten death as it would collapse the victim's lungs. As previously mentioned, none of the Canonical Gospels mentions Longinus doing this, and it seems unlikely that a centurion would have undertaken such a menial task. Christ's legs were not broken; a spear was thrust into his side under the fifth rib—a deliberate and precise action to deliver a fatal wound. As Christ had only hung on the Cross for a relatively short time, he may not have been dead before the spear thrust. A well-trained centurion would be aware of the effect that such a wound would have had. It would also be most likely caused by a hepatic laceration, which almost certainly would have produced a rapid demise in a scourged, debilitated, dehydrated man.[19] The centurion *Acts of Pilate* in the *Gospel of Nicodemus* attributes this final act to Longinus

The interesting question is, why did Longinus choose this course of action? Longinus actions of that day were deliberate and followed well-established practices, and he delivered the orders from his superiors. Nevertheless, he had deviated from these orders initially by forcing Simon the Cyrene to help Christ carry his Cross and then piercing him with a spear rather than breaking his legs. Generally, Roman soldiers followed orders to the letter, so this may question whose order she was following. One argument from John 19:31 was that his deviations were merely administrative, as the Crucifixion occurred just before the Sabbath and the bodies had to be taken down. If so, getting the column to the point of execution and breaking the criminal's legs would have sped up the process, although not as conclusively and quick as a fatal spear wound. That was only used for Christ. Was this a *coup de grace* or a last act of mercy for a dying man?[19] If so, why just Christ and not the criminals?

Perhaps Longinus was caught between his orders and his faith. If, as suggested, he was already on a path to belief, it might be argued that Longinus may have known by divine direction that, in some way, his military orders were compatible with a bigger mission. This argument starts with a possible previous relationship with Christ that led him to seek healing for his servant, which may have been the start of an ascent on his Spiritual Arc (see Figure 1).[5] It is also possible that he had been made aware of key prophecies in Psalm 22 and Isaiah 53 (see Thin Place

Events (TPE) X in Figure 1). Also of note is Zechariah 12:10, 'I will pour out on the house of David and the inhabitants of Jerusalem a spirit of grace and supplication. They will look on me, the one they have pierced'.[2] Obliquely, as Christ was the Lamb of God, the commandments in Exodus 12:46, Numbers 9:12 and Psalm 34:20 regarding not breaking the bones of the Passover Lamb may also be relevant.

Guarding the Body

According to Pilate, Longinus and the same 12 soldiers were tasked with guarding Christ's tomb. Matthew 28:1-6 goes on to report:

> 'After the Sabbath, Mary Magdalene and the other Mary went to look at the tomb at dawn on the first day of the week. There was a violent earthquake, for an angel of the Lord came down from heaven and, going to the tomb, rolled back the stone and sat on it. His appearance was like lightning, and his clothes were white as snow. The guards [presumably including Longinus as the Guard Commander] were so afraid of him that they shook and became like dead men'.[2]

The *Acts of Pilate* in the *Gospel of Nicodemus* also indicate that Longinus, the soldiers, and Pilate's wife returned to 'welcome the person of the Messiah'.[10] Matthew 28:12 says:

> 'some guards went into the city and reported to the chief priests everything that had happened. When the chief priests had met with the elders and devised a plan, they gave the soldiers a large sum of money, telling them, "You are to say, 'His disciples came during the night and stole him away while we were asleep.' If this report gets to the governor, we will satisfy him and keep you out of trouble." So the soldiers took the money and did as they were instructed. And this story has been widely circulated among the Jews to this very day.'[2]

This statement implies that Longinus took a bribe to deny the Resurrection. If so, this stands at odds with the previous discussion that he was at least merciful to Christ if he was not an active participant in his journey acting under divine inspiration orders.

After the Crucifixion

Ramsey Michaels noted in 1967 that a 'wealth of medieval legend celebrates the acts and the martyrdom of this hybrid figure Longinus'.[20] Accordingly, several contradictory and overlapping stories of what happened to Longinus after the Crucifixion exist. One version has it that Longinus was condemned to be torn apart by a lion every night, only to have his body restored during the day in preparation for another night's agony.[10] At some point, Longinus was thought to have been converted to Christianity and became an active preacher of the word. As a result, he was persecuted by the Romans and fled from Palestine. In one version of his post-Crucifixion life, he arrived Mantua in 36 CE and was taken care of there at the local hospice until he was martyred on 2 December CE 37.[12] A different story has him fleeing from Jerusalem to reside in Caesarea in Cappadocia, where he was appointed bishop and then martyred.[21]

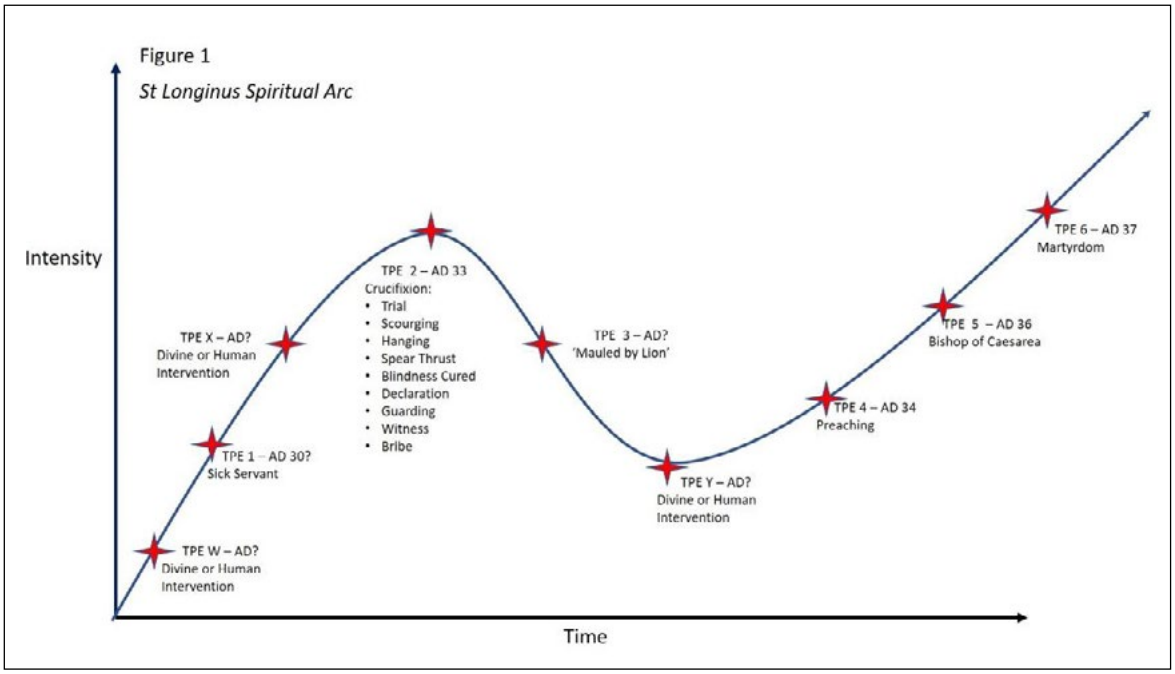
Rather than being a series of contradictions, these events can be reassembled sequentially to demonstrate Longinus' Spiritual Arc (see Figure 1). Despite the vagaries of basic historiography and hagiography in this period, Longinus' spiritual rise, fall, growth and degradation can be mapped against a series of TPE to create a Spiritual Arc.[5] These TPEs are the spiritual equivalent of Moral Injury's (MI) Potential Morally Injurious Events (PMIE).[22] The TPE concept is drawn from Celtic mythology/theology and describes 'thin places' in the universe or physical places where the visible and the invisible world come into their closest proximity.[23] Such spots were considered the border between the spiritual and temporal realms. It is not an unreasonable extension to the concept that significant and horrific events occurring in a particular location and time may also be considered Thin Places. If so, the Crucifixion has to be the best example of this. A PMIE and a TPE may occur at the same time and place. However, each may be interpreted differently by the individual involved.[3-5] A potential sequence for Longinus' Spiritual Arc is described in Figure 1. In the example, there are a number of TPE. TPE W, X, Y and Z represent unknown but possible events. TPE 1–6 represent events described in a number of sources although the dates are approximate.

- **TPE W.** If Longinus was the centurion who sought Christ's help for his sick servant (Matthew 8),[2] what motivated him to do so? It hardly seems a likely action for a centurion to seek help from a member of a conquered population who was considered a potentially seditious character. It is possible that TPE W

was an example of unspecified divine or human intervention or management to guide him in this direction.

- **TPE 1.** Longinus approaches Christ and asks him to heal his sick servant who 'lies at home paralysed, suffering terribly' (Matthew 8:5).[2] He does this with an unusual degree of humility and submission, telling Christ that he does not deserve him to come under his roof and that he believes that if Christ says so, the servant will be cured (Matthew 8:10).[2] In return, Christ says, 'Truly I tell you, I have not found anyone in Israel with such great faith'.[2] Again, there is a sense of a missing background encounter there.
- **TPE X.** It is plausible that after such a momentous encounter, Longinus would be grateful and possibly changed and may have sought out further unspecified divine or human intervention or management to guide him. This may have started a conversion process guided by one of Christ's followers.
- **TPE 2.** Longinus led the conduct of the execution from scourging to burial. The critical question that this prompts is: whose orders was he following? Ostensibly, the orders were Pilate's and Longinus carried these out faithfully and fully. He was led by divine guidance to assist in completing a prophesied and necessary journey. Possibly, this may have been evidenced by the acts of kindness in getting another man to carry Christ's Cross, and a mercy killing that he initiated that was out of the scope of earthly orders.
- **TPE 3.** There is an argument that Longinus suffered from some form of visual impairment before the Crucifixion. It cannot have been too severe, as it did not prevent him from serving in the military. In any case, when the blood and water spilled from Christ's side, they ran down the shaft of the spear and spilled into his eyes, curing them of the ailment.[16] This may represent a miracle in recognising his difficult duties and his treatment of Jesus that day.
- **TPE Y.** In the next period of Longinus' life, he is condemned to be torn apart by a lion every night, only to have his body restored during the day in preparation for another night's agony.[10] This sounds metaphorically familiar to many veterans suffering from mental illnesses like PTSD.
- **TPE Z.** At some point, there must have been another unspecified divine or human intervention or management that delivered him from this torment.
- **TPE 4.** Longinus is described as spending the following years of his life preaching.
- **TPE 5.** Longinus becomes the Bishop of Caesarea.
- **TPE 6.** Longinus is martyred.

Figure 1



The Spiritual Wounds and Injuries of St Longinus

As a *veteranus* (veteran), the circumstances of Longinus point to his experiences as a relevant case study of the causes and presentation of a SW&I.[24]

Following Longinus' Spiritual Arc, there appear to be several possible SW&I:

- **Change of Faith?** Nothing is known about Longinus' religious beliefs or faith. In general, the Romans worshipped a pantheon of Gods adapted from Greek culture, other cultures they had conquered and or emperors deified after their death. Many Roman soldiers of this period worshipped the God Mithras.[25] Something or someone must have motivated Longinus to reach out to Christ for help with his servant. The servant was subsequently cured, and it stands to reason that TPE W represents an unknown moment of change in Longinus' life. This may have been his conversion or at least the first significant step. This postulation highlights that SW&I following a TPE can also be positive events that strengthen and cause the Spiritual Arc to ascend further.
- **Crucifixion.** Given what might have been a new or growing faith for Longinus, the Crucifixion would have been tumultuous, on some levels joyous but also profoundly conflicting. Tumultuous as the saviour he was now following was being led to his death under his command. For a person new to the faith, being called by God to undertake the actions of that day would have almost been incomprehensible. Even if he was just a witness, being in such a situation may have caused him to question the omnibenevolence of God, leading him to ask, 'Why God, did you do this to me?' It would also have been a joyous occasion as he was healed of his vision issues and witnessed the risen Lord. It conflicted on every level because the joy of healing set against the day's awful events. With the day's horror, there may have been the knowledge that he was playing an important part in some part of a bigger mission. At the same time, he may have been experiencing great shame in knowing he took a bribe to deny that Christ had risen. The incredible mixture of this tumult, joy and conflict may have created a significant SW&I that affected his mental health and overall general wellbeing.
- **Mauling.** It is little wonder then that in the next period of Longinus' life, he is condemned to be torn apart by a lion every night.[10] These lions, doubt, shame, and guilt are the same that afflict veterans whose experiences with trauma have caused a break or change in their relationship with God. Doubt about whether he made the right decision to follow Christ, then act as he did and what, if any, was God's plan in this engineered horror. Shame in acting a way they feel may have angered or dishonoured him in God's eyes, such as taking a bribe to deny what happened. Also, guilt at following orders and divine direction led to the death of Christ. This may have manifested as anger, depression, anxiety or other typical mental health conditions.
- **Healing.** TPE Y represents another unknown moment of change in Longinus' life. Someone or something pulls Longinus out of a degrading Spiritual Arc. It sets him on a path of preaching, culminating in his appointment as Bishop of Caesarea. There is no indication of who or what this may have been. Some apocryphal sources indicate he was in contact with the broader Christian community and perhaps even the disciples. Perhaps they facilitated and supported his healing. It could have also been a comrade. Acts 10:1 says that 'there was a certain man in Caesarea called Cornelius, a centurion of the band called the Italian band'.[2] This was likely Cohors II Italica Civium Romanorum, part of the Roman Garrison (Stagnaro, 2017). Healing of a SW&I will involve a range of different practitioners, both spiritual and temporal. Still, the importance of 'mates' cannot be underestimated. Since Cornelius and Longinus were senior centurions, they may have moved in the same military environment, knowing and supporting each other in their parallel faith journeys.

Implications for contemporary veterans

Despite the almost 2000 years that have passed since Longinus' fateful act, the circumstances of this 1st century Roman centurion still have significant relevance as a case study for contemporary veterans suffering from SW&I:

- **Professional soldier.** Longinus was a professional soldier. As a centurion, he had over 20 years of service across several campaigns. He would have been experienced, well-trained and professional. Although such preconditioning undoubtedly would have helped, it would not have made him invulnerable to being spiritually wounded and injured. Many individuals have or will become veterans following the long-running coalition wars in Iraq and Afghanistan, and

Australian experiences in Bougainville, East Timor and other locations. Despite the length of their service, they are likely to have a significant burden of damage, some spiritual, that will need to be addressed for many years to come. Like Longinus, their SW&I may be immediate, while others may only occur once triggered by a TPE many years later.

- **Complex operations in enemy territory.** The Roman Army in Judea was an occupying force. In many ways, the force was a coalition of elements from across the Empire comprising Roman Legions and Samaritan troops, such as Cohors I Sebastenorum. This would have been 'yet another deployment' for the Roman legionaries. In contrast, the Samaritan troops that Longinus commanded had a particular enmity towards the Jews. Australian soldiers faced similar complexities in Afghanistan when working alongside coalition and Afghan National Army soldiers against local and international Al-Qaeda fighters.
- **Difficult decisions.** There appears to be some evidence that Longinus had encountered Jesus or perhaps his followers and supporters before the Crucifixion. He may have also received some instruction regarding this new and emerging faith. Nevertheless, he had been given a task by his superiors to complete. In the Roman Army, orders were very much orders, and there was no leeway for disobedience, regardless of personal beliefs and feelings. Contemporary veterans may have also been in similar circumstances where their orders were following the Laws of Armed Conflict and specific Rules of Engagement but still *felt* wrong. Regardless, they had to be carried out, and this may have left a lasting burden on the soldiers that would be carried well into their veteran years.
- **Compromises.** While Longinus could have hardly released Christ, he chose some actions that were skimming the edge of disobedience to help him. In particular, getting another man to carry Christ's Cross and a possible mercy killing was out of the scope of earthly orders. On the other hand, Longinus took a bribe to deny the Resurrection. While bribery in the ancient world was common, taking a bribe from the Jewish temple elders would have been against Roman law and a denial or diminishment of his possible emerging faith. Such compromises, even ones with honourable intentions, create conflict. Some veterans live with the implications of such compromises for many years. Examples may include events where an appropriate order and militarily necessary strike against a legitimate target create unintended 'collateral damage' to innocent parties. In a personal faith sense, compromising orders, even for what may be a good reason, is still breaking orders. Many veterans may suffer lasting mental health and wellbeing issues unless some form of forgiveness for their choices can be found.
- **Mauling.** The mauling of Longinus is a good metaphor to describe how some veterans will suffer. Each night, he would be mauled by lions and, in the morning, would have recovered sufficiently to be mauled again that night. This reflects a cycle of suffering and treatment that may seem endless for contemporary veterans. In a medical or psychological sense, this may mean waves of depression or anxiety coloured by substance abuse and anger that are reduced and possibly eventually cured through pharmacological and counselling interventions. A similar paradigm applies to those suffering from SW&I, albeit this will involve spiritual counselling and support led by principally religious and spiritual care practitioners with support from others.

Conclusion

There were many wounds suffered on the day of the Crucifixion. One of the mob that came to arrest Christ lost an ear to Peter's sword. Mary lost a much-loved son, and the disciples lost a teacher, a father and a friend. Christ suffered terrible wounds to his flesh—not least of these being the fatal thrust from Longinus' spear. The centurion who commanded the Crucifixion also suffered a series of SW&I, which would follow him in one way or another for the rest of his life.

Although other historical and Biblical figures before Longinus demonstrated some aspects of SW&I, Saint Longinus is worthy of specific consideration on many levels. To start with, with seven simple words, 'Truly this was the Son of God' he was the first person to publicly declare the divinity of Christ after his Crucifixion. In many respects, it is a sensational and almost outrageous statement from a man who was very much part of the occupying Roman military establishment. It is a statement that may have been drawn from a growing faith that may have been n and shaped before that day. While the interventions at TPEs W, X and Y are postulations, logically, there must have been some act or words that changed the behaviour of this highly experienced soldier. It is important to remember that SW&I can also represent a positive change in an individual's relationship with God.

At the same time, the events on the day of the Crucifixion would have tested anyone's faith. The momentous moments after Christ's death have to be set against his sheer joy of restoring his eyesight.[6-8] Yet, despite this, Longinus took a bribe to deny the event (Matthew 28:12).[2] These tumultuous, joyous and deeply conflicting events led to a SW&I that plunged Longinus into nightly terrors where the lions of doubt, shame and guilt mauled him every night. This is an experience that many modern veterans suffering from a SW&I would understand.

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System Configuration for an Extreme-Range Normobaric Hypoxia Generator

P Weinrauch

Abstract

This manuscript describes the development of an extreme-range normobaric hypoxic environment (FO_2 6.5%; PO_2 31.4 kPa; simulated altitude 9300 m) utilising readily available commercial equipment and a low-cost portable hypoxia generator. The experimental configurations described validate the working hypothesis that reducing atmospheric oxygen partial pressure of air intake into a portable normobaric hypoxia generator will result in further oxygen depletion of Normobaric hypoxia (NH) air produced by the device. Within appropriately controlled conditions, creating extreme-range normobaric hypoxic environments may interest selected military personnel and high-altitude mountaineers for conducting training and research activities involving simulated rapid ascent exposures to extreme altitude.

Introduction

Normobaric hypoxia (NH) generators are typically used by endurance athletes as a method of obtaining adaptive training responses for marginal performance gains by exposure to oxygen-depleted environmental conditions. NH represents a low-cost and relatively convenient method of hypoxic stimulus training compared to natural environmental altitude exposure or the use of a hypobaric chamber. Athletic hypoxic adaptation can be conducted by either intermittent hypoxic training or chronic passive hypoxic exposure. Intermittent hypoxic training involves simultaneously subjecting the athlete to NH conditions while performing exercise. Chronic passive exposure is where the athlete is exposed to NH for extended durations throughout the day while at rest, typically by sleeping in a semi-closed altitude tent enclosure or purpose-designed chamber to simulate a 'train low, sleep high' conditioning cycle.

Portability, convenience and affordability have resulted in small-sized NH generators gaining popularity as a surrogate method of altitude acclimatisation for mountaineers and for conducting research on respiratory function at altitude. Commercially available portable NH generators are typically limited to generating hypoxic air with oxygen fraction (FO_2) approximating 9%–9.5% with an estimated partial pressure of oxygen (PO_2) of 44 kPa, simulating an altitude of 6700 m. While this exposure range is sufficient for the adaptation requirements of endurance athletes, obtaining more extreme simulated exposures may be of interest to selected military personnel and high-altitude mountaineers for conducting training and research activities involving higher altitudes.

This manuscript describes the development of an extreme-range normobaric hypoxia environment (FO_2 6.5%; PO_2 31.4 kPa; simulated altitude 9300 m) using readily available commercial equipment and a standard portable NH generator.

Materials and methods

Characteristics of JAY-10H hypoxic generator during normal operational use

JAY-10H (Longfian Scitech; Hebei, China) is a portable NH generator with characteristics typical for a personal use hypoxic training device (Figure 1). Technical parameters of the JAY-10H generator are listed in Table 1. The JAY-10H has two output gas outlets. The high-concentration oxygen gas outlet (FO_2 93%) represents the waste by-product of NH gas production. A flow metre on the right of the front console can adjust the high-concentration oxygen flow rate. NH output volume is dependent on the NH gas concentration selected. NH output volumes up to 100 litres per minute are only obtained when less hypoxic air is being generated. When the most oxygen-depleted NH air output (FO_2 9%) is generated, the production volume rate is substantially reduced.

Figure 1: JAY-10H 100-litre hypoxic generator (Longfian Scitech Co. Ltd; Hebei, China).

Table 1: Technical parameters of the JAY-10H 100-litre hypoxic generator (Longfian Scitech Co. Ltd; Hebei, China).

Model	JAY-10H
Weight	26.7 kg
Dimensions (cm)	58 (height), 37 (width), 36 (depth)
Maximum output flow	100 Litres per minute (when FO2 20.9%)
Minimum FO2	9%
Minimum PO2	44 kPa
Maximum simulated altitude	6800 m

The JAY-10H NH generator creates hypoxic air in a pulsatile waveform at a rate of 9 cycles per minute. The waveform is characterised by a short phase of high-flow rate NH air production followed by a longer duration phase of low flow rate NH air production. During the high-flow rate phase of the cycle, the NH air produced is of lower FO_2 compared to the low flow rate phase. Due to the pulsatile NH output of the generator, a reservoir bag is commonly used to blend the oxygen-depleted gas to achieve greater consistency of user-inspired FO_2.

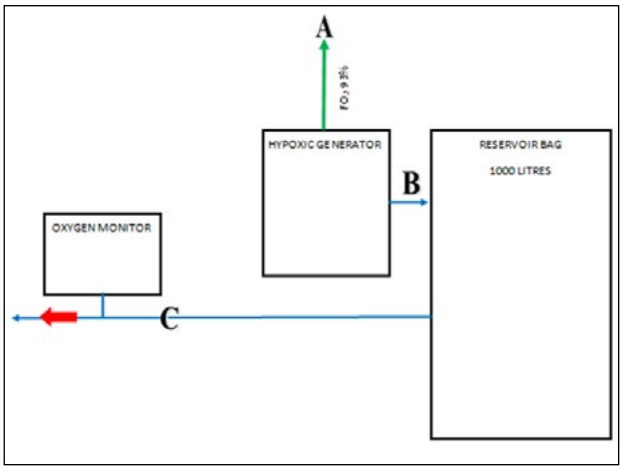
Validation testing of JAY-10H hypoxic generator during normal operational use

Initial validation testing was conducted to confirm the working characteristics of the JAY-10H hypoxic generator in normal operational use. Validation testing and all subsequent experimentation were conducted in temperature-controlled normobaric normoxic conditions at sea level (25°C; 1012 kPa; FO_2 20.9%; altitude <50 m). Environmental conditions were monitored using a Kestrel 4250 Racing Weather Tracker (Nielsen-Kellerman; Pennsylvania, USA). Ambient oxygen levels and NH oxygen concentration were monitored using a SmartSensor AR8100 Oxygen Meter (Smartsensor; Donguan, China).

For validation testing, NH air output was directly connected to a 1000-litre capacity reservoir bag (Qingdao Hinor Medical Industry Co. Ltd.; Shandong, China) to obtain a stable average output oxygen concentration with respect to the cyclic generator output (Figure 2; Figure 3). A 1000 litre reservoir bag was selected as prior pilot testing demonstrated a smaller volume 100 litre reservoir bag was insufficient for this purpose. Outflow from the reservoir bag was connected to tubing with a one-way valve at the end to prevent retrograde airflow into the system. Oxygen concentration within the output tubing was monitored by an oxygen meter (SmartSensor AR8100; Donguan, China) connected by a low-volume T piece. Using this method, a stable and reproducible average oxygen concentration from the generator could be determined under various conditions once the reservoir bag was completely inflated. Validation testing was conducted three times for each of three separate settings of the hypoxic flow regulator using unrestricted (high rate) waste oxygen flow or restricted waste oxygen flow (2 litres per minute). Complete deflation of the reservoir bag was conducted before each test. Altitude equivalency was calculated to the nearest 100m using the Baillie Lab Altitude Air Pressure Calculator (Roslin Institute; University of Edinburgh).[1]

Figure 2 – JAY-10H validation testing configuration with inflated 1000-litre reservoir bag. Schematic configuration is demonstrated in Figure 3.

Figure 3: Schematic of JAY-10H hypoxic generator validation study. Green arrow (A): High oxygen concentration waste output. Blue: Normobaric hypoxic air output. Red arrow: One-way valve with directionality marked. B: Cyclic concentration hypoxic air output directly from the generator. C: Mixed hypoxic air from reservoir bag without cyclic variability of oxygen concentration.

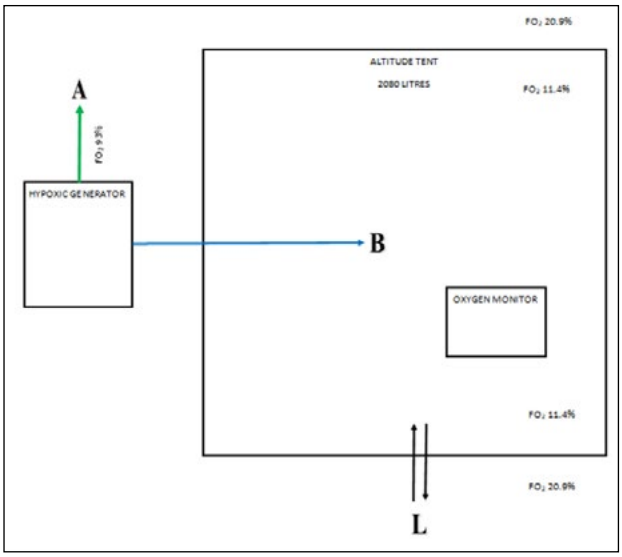


Lowest (most oxygen depleted) FO_2 readings were obtained using a combination of Position 1 of the hypoxic flow regulator together with unrestricted (high rate) oxygen regulator flow. This configuration obtained an average FO_2 of 9.2% (standard deviation 0.3%), simulating an approximate hypobaric altitude of 6800 m (PO_2 44.5 kPa).

The results of these validation tests demonstrated the JAY-10H hypoxic generator to be a consistently reliable device for creating depleted oxygen air, with the lowest and highest average recorded FO_2 readings closely approximating those published by the manufacturer.[2]

After initial validation testing, the JAH-10H was connected to a standard 2080-litre altitude tent to assess the degree of oxygen depletion achieved during standard operational techniques for passive NH exposure conditioning (Figure 4). FO_2 obtained within the altitude tent using this configuration was 11.4% (PO_2 55.1 kPa; simulated altitude 5100 m). The difference between FO_2 readings obtained from within the altitude tent (11.4%) compared to initial validation testing using the 1000-litre reservoir bag (9.2%) represents the effect of two-way air leakage from the altitude tent enclosure.

Figure 4: Schematic of system testing for standard operational use of the JAY-10H generator with a 2080-litre altitude tent used for resting subject hypoxic conditioning. A (green arrow): Highly oxygenated (FO_2 93%) waste output from a hypoxic generator. B: Depleted oxygen generator output. L: Two-way leak rate between altitude tent and surrounding atmosphere.



System configurations for extreme-range normobaric hypoxic air generation

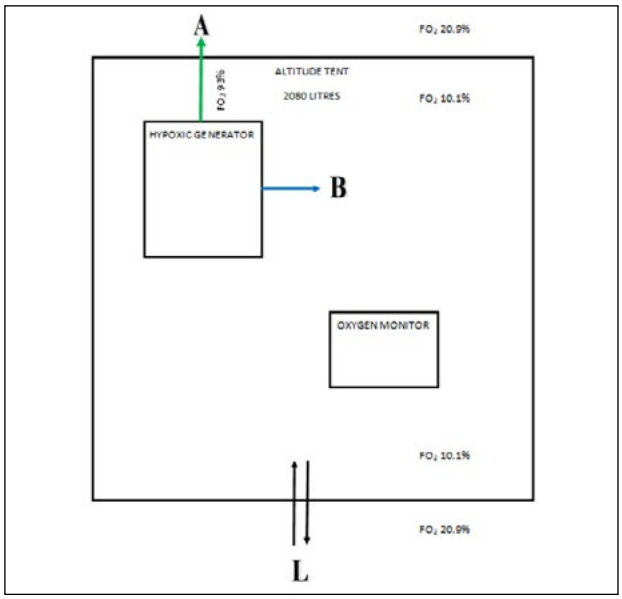
Performance and technical specifications of output from a portable NH generator assume employment of the device within normobaric normoxic conditions (101 kPa, FO_2 20.9%). Manipulation of these baseline operating conditions will likely impact device performance and, therefore, NH output. The working hypothesis of the following experiments was that reducing ambient oxygen partial pressure of air intake into the JAY-10H generator would result in further depletion of NH air produced by the device.

Due to the incremental nature of how the test systems were developed, each configuration will be presented sequentially, including results and discussion relevant to each configuration.

Extreme-range NH test configuration 1

The first extreme-range NH experimental configuration involved placing the JAY-10H generator inside the 2080-litre altitude tent enclosure. Oxygen-rich generator waste gas was extracted from the system by routing the generator output tubing outside the tent enclosure. NH gas output was thus recirculated within the semi-closed system for subsequent reuptake by the generator (Figure 5). Altitude tents are not completely closed system as a degree of two-way gas leakage is expected, thus impacting the level of oxygen depletion obtained within the enclosure.

Figure 5: Extreme-range NH test configuration 1 schematic. A (green arrow): Highly oxygenated (FO2 93%) waste output from hypoxic generator removed from the system into atmosphere. B: Depleted oxygen output into altitude tent enclosure. L: Two-way leak rate between altitude tent and surrounding atmosphere.



Using this method, the JAY-10H generator created a steady-state FO_2 of 10.1% within the tent enclosure (PO_2 48.8 kPa; simulated altitude 6200 m). As the altitude tent was effectively acting as large-size reservoir bag, cyclic fluctuation of FO_2 was not observed. Therefore, a test subject placed inside the altitude tent with the generator in this configuration would be exposed to a simulated altitude of 6200 m.

The environment created using this configuration was less oxygen depleted than obtained from a closed system 1000-litre reservoir bag with generator input of 20.9% oxygen during initial validation testing (FO_2 9.2%). While test configuration 1 failed to achieve further oxygen depletion of NH output when compared to the more standard configuration (FO_2 10.1% v 9.2%), the oxygen saturation obtained was, however, lower than compared to when the generator was connected to the altitude tent but located outside the enclosure (FO_2 11.4%, Figure 4). These observations illustrate the impact of leakage into a semi-closed system on the levels of ambient oxygen saturation obtained within a tent enclosure. However, the results also demonstrate that reducing generator intake oxygen partial pressure does result in a further reduction in NH output, thus validating the initial hypothesis.

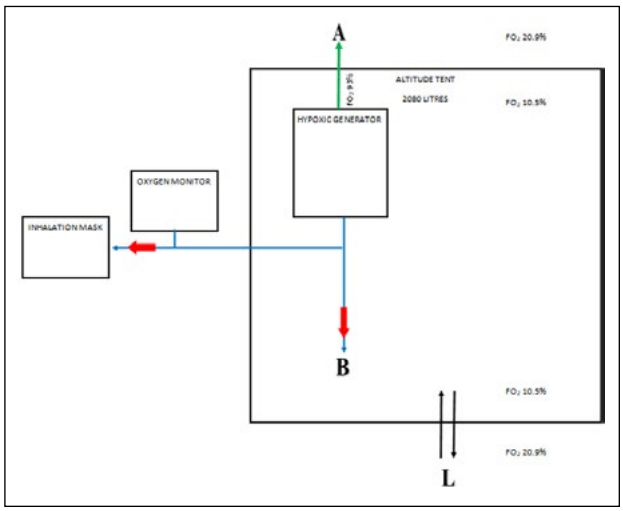
However, several practical limitations exist in using this configuration for conditioning and research. First, the oxygen depletion obtained is no more effective than what can be obtained using standard generator configurations. Furthermore, conditions for test subjects placed inside an altitude tent with a NH generator in operation would limit tolerance of this method due to excessive heat, noise and carbon dioxide accumulation.

Test configuration 1 did not provide a practical or effective method for generating extreme-range NH conditions. However, it did provide proof of concept for further development of extreme-range NH generation by subjecting the device to oxygen-depleted normobaric air intake.

Extreme-range NH test configuration 2

The second extreme-range NH configuration evaluated was an extension of the previous method where the JAY-10H generator was placed inside the 2080-litre altitude tent from which oxygen-rich waste gas was extracted. However, NH gas output was now connected to a split tubing system, each fitted with one-way valves (Figure 6). Using this configuration, human test subjects could be situated outside the altitude tent and breathe depleted NH air using a mask, thereby eliminating problems associated with heat, noise and carbon dioxide accumulation observed when subjects are situated inside the altitude tent. NH output from the generator was either directed to the subject for on-demand ventilation or diverted back into the altitude tent for recirculation and further oxygen depletion. Output FO_2 was measured off the test subject gas line using a T piece.

Figure 6: Extreme-range NH configuration 2 schematic. A (green arrow): Highly oxygenated (FO2 93%) waste output from hypoxic generator removed from the system into atmosphere. Blue arrows: Movement of depleted oxygen generator output. B: Recirculated NH output. L: Two-way leak rate between altitude tent and surrounding atmosphere. Green arrow: High-concentration waste oxygen output. Red arrows: One-way valves with directionality marked.

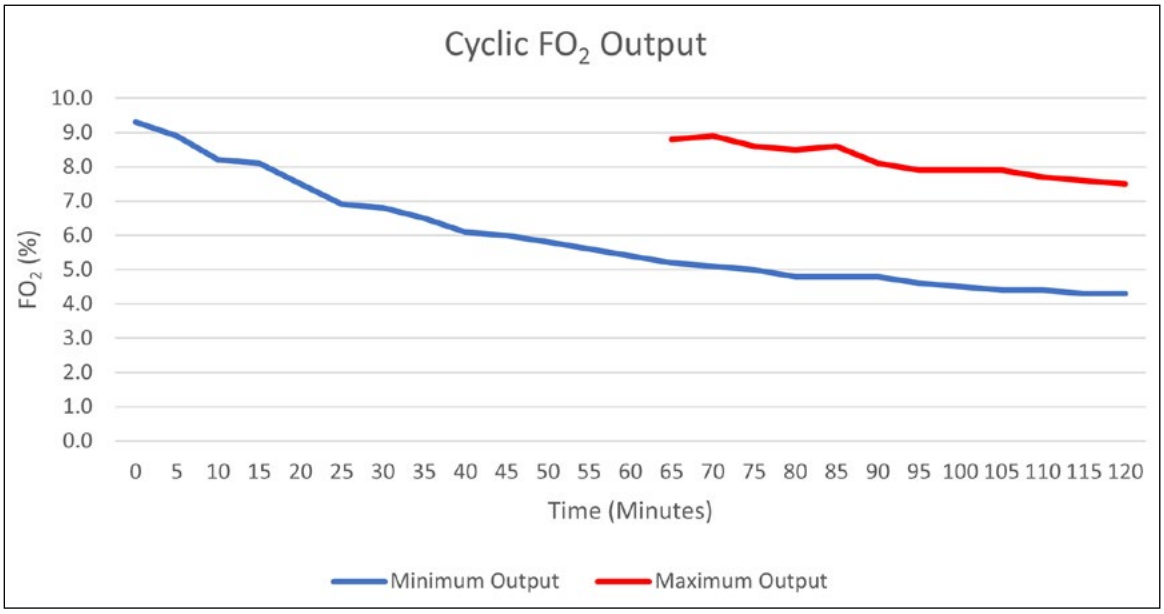


Due to the removal of the intervening reservoir between the JAY-10H generator and the subject gas line, this test configuration resulted in a cyclic NH gas output. Maximum and minimum oxygen percentages of the cyclic NH output are demonstrated in Table 2 and Figure 7. FO_2 NH output decreased steadily over 2 hours from initiation of the experiment, after which a steady state of output was maintained with a cyclic minimum FO_2 4.3% and a cyclic maximum FO_2 7.5%.

Table 2: Generator cyclic FO2 output ranges in relation to time while operating in normobaric extreme hypoxia test configuration 2.

TIME (Min)	MIN OUTPUT FO_2 (%)	MAX OUTPUT FO_2 (%)
0	9.3	
5	8.9	
10	8.2	
15	8.1	
20	7.5	
25	6.9	
30	6.8	
35	6.5	
40	6.1	
45	6.0	
50	5.8	
55	5.6	
60	5.4	
65	5.2	8.8
70	5.1	8.9
75	5.0	8.6
80	4.8	8.5
85	4.8	8.6
90	4.8	8.1
95	4.6	7.9
100	4.5	7.9
105	4.4	7.9
110	4.4	7.7
115	4.3	7.6
120	4.3	7.5

Figure 7: Generator cyclic FO2 output ranges over time while in normobaric extreme hypoxia test configuration 2.

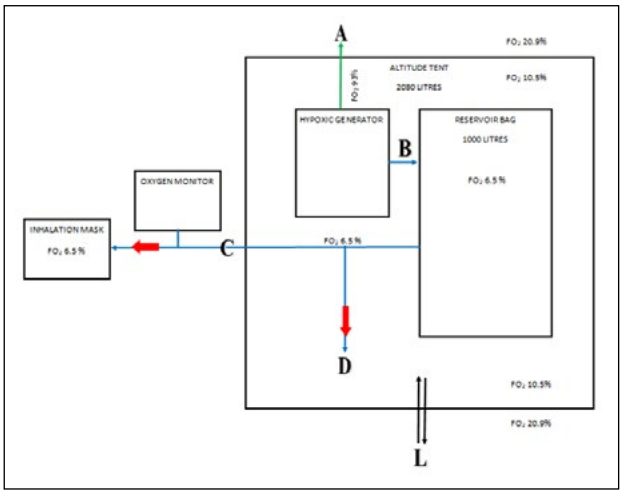


The results of test configuration 2 confirmed with direct evaluation of generator output that operating the JAY-10H within an oxygen-reduced environment results in significant further oxygen depletion, which could be obtained when operating the generator within normobaric normoxic conditions.

Extreme-range NH test configuration 3

The third extreme-range NH experiment represented an extension of experimental configuration 2 but incorporated a 1000-litre reservoir bag attached directly to the generator and placed within the 2080-litre altitude tent enclosure (Figure 8). The reservoir bag outlet was connected to a split tubing system, each fitted with one-way valves. NH output from the reservoir bag was either directed to the subject for on-demand breathing or diverted back into the altitude tent for recirculation and further oxygen depletion. Output FO_2 was measured off the test subject line using a low-volume T piece.

Figure 8: Extreme-range NH test configuration 3. Steady-state conditions for extreme-range normobaric hypoxic chamber in final working configuration. Red arrows: One-way valves with directionality marked. Blue arrows: Movement of depleted oxygen hypoxic air. A (green arrow): Oxygenated waste output from hypoxic generator (FO_2 93%) removed from the system into atmosphere. B: Extreme-range normobaric hypoxic air direct from generator with cyclic variation in concentration (FO_2 4.3% - 7.5%). C: On-demand reservoir bag output (consistent FO_2 6.5%). D: Reservoir diversion recirculating unused hypoxic air into altitude tent for subsequent reuptake by hypoxic generator. L: Two-way leak rate between altitude tent and surrounding atmosphere.



In addition to the advantages of having test subjects outside the altitude tent, attaching a 1000-litre reservoir bag in this configuration creates inspired FO_2 consistency by blending the gas output. A further advantage of having a reservoir bag in this configuration relates to the practical aspects of managing the substantially elevated minute ventilation volume anticipated in subjects when exposed to such extremes of hypoxia, which may exceed generator capacity when operating under these conditions.

A consistent NH output FO_2 of 6.5% was obtained (PO_2 31.4 kPa; simulated altitude 9300 m) using this test configuration 3.

Discussion

These evaluations demonstrate that a commercially available portable NH generator may be employed in alternate configurations to create extreme-range normobaric hypoxic conditions. The application of these techniques may be of potential interest as a surrogate alternative to hypobaric hypoxic testing in the conduct of extreme high-altitude research or for use in training activities where the neurocognitive effects of effect of rapid altitude exposures with minimal preconditioning acclimatisation are being simulated.

These experimental configurations validate the working hypothesis that reducing ambient oxygen partial pressure of air intake into a portable hypoxia generator will result in further depletion of NH air produced by the device. The practical value of configurations developed in these experiments is that they may be easily reproduced using inexpensive equipment readily available on the commercial market.

Further modifications of the configurations described will likely result in further oxygen depletion of the NH output obtained. For example, enclosing the NH generator within a definitively closed loop system and eliminating the leak rate associated with using a standard altitude tent would likely result in further oxygen depletion. Similarly, more powerful higher-flow hypoxic generator systems may be used to offset the impact of leak rate associated with altitude tent enclosures. Such configurations may be of interest to aircrew wanting to achieve simulated altitudes above 9300 m; however, hypobaric hypoxic testing may be a more appropriate and higher fidelity method for such applications.

Conclusion

This manuscript describes the development of an extreme-range normobaric hypoxic environment (FO_2 6.5%; PO_2 31.4 kPa; simulated altitude 9300 m) using readily available commercial equipment and a standard portable NH generator. The experimental configurations described validate the working hypothesis that reducing atmospheric oxygen partial pressure of air intake into a portable normobaric hypoxia generator will result in further depletion of NH air produced by the device. Within appropriately controlled conditions, obtaining extreme-range normobaric hypoxic environments may be of interest to high-altitude mountaineers and to conduct research activities involving extreme simulated altitudes.

Warning disclosure

Exposure to extreme-range hypoxia using the methods described in this manuscript may result in severe permanent hypoxic brain injury or death. These techniques are recommended for use by trained health professionals and researchers within highly controlled and supervised environments. Under no circumstances is the use of NH for athletic conditioning outside of the indications and methods described by the relevant product manufacturer recommended. The author takes no responsibility for injury sustained by applying any of the techniques described in this manuscript.

Disclaimer

The views expressed in this manuscript are those of the author and do not reflect official Australian Defence Force policy or endorsement.

Conflict of interest statement

The author(s) declare no conflicting interests in relation to this manuscript.

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Dengue Epidemics During the Second World War in Queensland

G D Shanks, J Aaskov

Abstract:

Although dengue became endemic in northern Australia in the 19th century, the enormous movement of people and material during World War II resulted in localised dengue epidemics in Queensland. Factors promoting the epidemics included mixing diverse civilian and military populations, including evacuees from tropical areas, and little focus on preventive measures until outbreaks occurred. Epidemics consisting of a few thousand recognised dengue cases were seen in both Townsville and Brisbane. Brisbane hospital records showed 116 cases in 1942 and 87 cases in 1943. US units experienced attack rates of 80% over a few months. All dengue outbreaks in Australia since 1980 have been due to the introduction of the virus by viraemic travellers. The threat of re-introduction will continue.

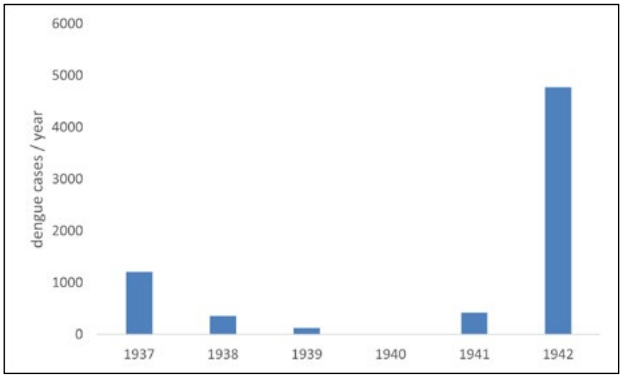
Dengue rate in US soldiers in Northern Territory and Queensland 1942

Approximately 80% of all US personnel in this area were attacked within a period of about 3 months.[1]

Dengue is an arboviral infection spread by Aedes mosquitoes, which can spread rapidly through unprotected military units. The Southwest Pacific Theatre of World War II was marked by dengue epidemics in deployed forces, which had operational consequences, primarily due to the large number of casualties and the frequent occurrence of post-viral fatigue syndromes. Many Australian and US soldiers were infected with dengue in Australia during the military build up to the various offensives in Papua New Guinea and the Solomon Islands.[1,2] Although dengue exists in Australia today, it is largely the consequence of focal spread from individual travellers to Australia from tropical locations.[3] Large dengue epidemics in modern Australia would likely depend on extraordinary collections of mixed military and civilian populations under field conditions, which likely explained the wartime dengue epidemics in Queensland.

Dengue was endemic in northern Australia from the late 19th century, with large outbreaks occurring in 1897 and 1905.[4,5] It was the view of Queensland Health authorities that dengue was endemic in the Northern Territory and only reached Queensland through travellers[2,6] Dengue was included with malaria as a vector-borne disease whose control in Queensland largely depended on excluding cases by quarantine procedures.[7] During the massive movement of both military and civilian populations during the general mobilisation to face the expected Japanese offensive, this epidemiologically questionable approach was never going to be effective. Beginning in early 1942, large numbers of Australian and US military personnel arrived in Queensland, and civilians were evacuated from islands in the Torres Strait. Dengue epidemics began in the Northern Territory around Darwin and were soon reflected in disease in Townsville from 1941 and Brisbane from 1942.[2,7] The Townsville epidemic was thought to have occurred from spread via Cloncurry, Longreach and Charters Towers.[2] This may have reflected a major transport route from the Northern Territory to Queensland (see Figure 1 showing several thousand dengue cases in Townsville in 1942, where peak incidence was estimated at 25/1000 men/week).[2] Figures for Brisbane are less reliable because dengue was not a reportable disease until January 1943. Brisbane hospitals recorded 116 inpatients in 1942 and 87 in 1943.[8] Outpatient cases were under-reported with some medical practitioners claiming they did not have time to report cases and that as few as 20% of cases were being recorded. However, 599 cases, with numbers peaking in March 1943, were noted in various Brisbane newspapers.[9]

Figure 1: Dengue cases reported to the public health authorities in Townsville, Queensland 1937–42.[8]



Dengue's military significance during World War II became all too apparent when > 8000 cases occurred in the Australian Imperial Forces (7th and 9th Divisions) during operations in New Guinea in 1943.[7] Dengue's effect was particularly noted during the Morobe, Lae, Finschhafen, Markham and Ramu Valley campaigns. The lack of specific symptomatology or a diagnostic test meant that most of these cases were 'pyrexia of unknown origin' determined as an epidemic. The first isolates of dengue virus, which would enable the development of diagnostic tests and research to develop a dengue vaccine, were made by Susumu Hotta in Japan in 1943.[10] Later, and independently, LTCOL Albert Sabin of the US Army isolated dengue viruses from troops in New Guinea, including Australians.[11] The most important differential diagnosis was partially suppressed malaria, which was extremely common in the same soldiers in New Guinea who were often on less than perfect atabrine (mepacrine) chemoprophylaxis. Although no cases of dengue haemorrhagic fever were described, the cost to military operations was in large numbers of front-line soldiers who were physically unable to fight often for a few weeks due to dengue fever and its aftermath, characterised by post-viral fatigue.[12,13]

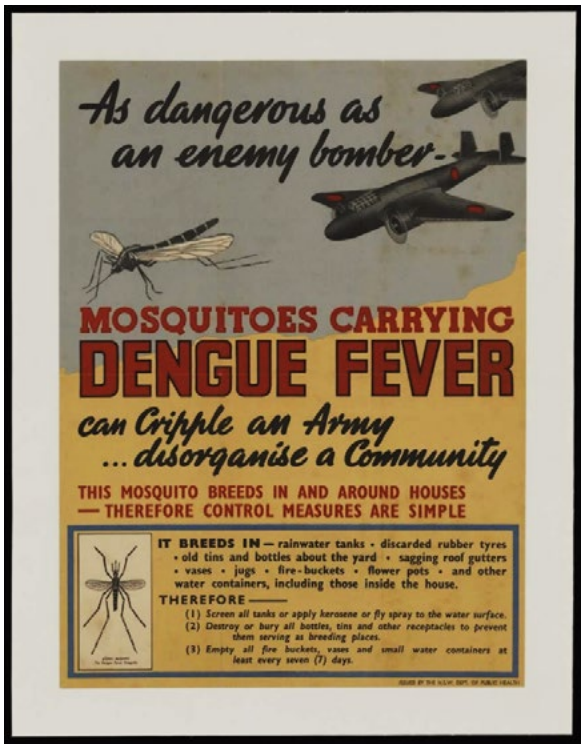
US Army forces also were severely affected by dengue. In March and April 1942, an extensive dengue outbreak occurred in two US Army infantry divisions (32nd and 41st), concentrating in Queensland and the Northern Territory before moving to Papua New Guinea. In 3 months, > 80% were estimated to have become ill with dengue. Further dengue epidemics were reported in early 1943 in Rockhampton (463 cases) and Brisbane.[1] Preventive medicine teams in Rockhampton sprayed waste oil on standing water to prevent breeding of the *Aedes aegypti* vector; however, mosquitoes were still breeding in 80% of 6000 houses surveyed (see Figure 2). Dengue continued to be a major military medical problem in the Southwest Pacific Theatre, with > 24 000 dengue cases reported by the US Army in New Guinea during 1944.[1] Whether the infection originated from the earlier Australian epidemics or was indigenous to New Guinea was an academic question of little practical importance.

Figure 2: US Army photo of preventive medicine soldiers spraying kerosene on water to kill mosquitoes near Rockhampton 1942. Copyright now in the public domain.[1]

Dengue was considered an important threat to the health of civilian populations in Queensland and, by extension, to the vital logistical efforts to support soldiers fighting in New Guinea. In 1942, a review article (without any direct casualty figures because these were restricted during wartime) was published in the *Medical Journal of Australia* to inform medical officers and physicians throughout Australia because dengue had spread to northern New South Wales.[14] Convincing civilian populations that mosquitoes *were as dangerous as an enemy bomber* and that one's familiar rainwater storage tanks were an important source of mosquito breeding was unlikely to be successful, but attempts were made to educate the civilian population as shown in Figure 3.

The root cause of dengue epidemics in Queensland during World War II was the massive mixing of human populations during war mobilisation in an area where the principal vector, *Aedes aegypti,* was abundant and had first been shown to be a vector of dengue virus. Given the historical circumstances, it is hard to see how it could have been otherwise. The mosquitoes were well entrenched in the environment, and most control measures were unlikely to have impacted much, especially after epidemics had already begun. Although dengue vaccines have

Figure 3: Poster proclaiming the danger (as an enemy bomber) of dengue infection to the Australian war effort during World War II. NSW Department of Health.



been progressing towards registration for 70 years, a vaccine of use to the military may soon be on the horizon.[15] It is unclear what level of protection a vaccine will provide in personnel operating in an unimmunised civilian population. In thinking about future regional military contingencies, it is worth remembering that more dengue cases than malaria occurred in the ADF while deployed to East Timor.[16] Dengue remains a threat to Australian and Allied troops garrisoned in northern Australia or deployed in most tropical regions of the world. Military personnel must understand that repellents and insecticide-impregnated uniforms provide some personal protection against dengue, and broader public health measures are required for formations.

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Immediate Action Drills for the Deployed Operating Theatre Department

A Mahoney, K W Bender

Abstract

Deployed surgical teams work together to perform time-critical damage control resuscitation. However, the team often includes members who have never worked together or in the field. A successful team can rapidly acquire knowledge of their clinical environment and each other. In this paper, we explain how Immediate Action Drills (IADs) for the operating theatre department (OTD) can be used to orient individual clinicians to the field and how collective training in these drills can maximise the safety and efficiency of the surgical team.

Introduction

Damage control resuscitation and initial wound surgery are vital capabilities of deployed health facilities that emerge from the time-critical integration of multiple clinical teams, from reception in the emergency department to post-operative critical care. In the contemporary Australian Defence Force (ADF), these clinical teams comprise both full-time and part-time clinicians who are often drawn from several different units and may or may not have previous experience working together or in the field.

Capability can be defined 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'.[1] From this, to achieve the capability of damage control resuscitation, deployed health facilities must be able to draw upon a pool of clinicians who have achieved individual operational clinical readiness.[2] These individuals must then be oriented to the deployed environment and rapidly acquire the ability to synchronise their clinical behaviours within a team likely to contain several unfamiliar faces. Further, the team must have robust processes to induct new members during sustained operations. In many ways, this makes a clinical department such as a deployed operating theatre very different from other high-performing military teams, which draw upon individuals who have completed standardised initial and advanced training and are likely to have substantial experience working together prior to deployment.

We have previously proposed a framework for facilitating individual operational clinical readiness, recognising that reliance upon unstructured civilian clinical experience cannot guarantee competent and confident proceduralists to perform battlefield surgery and resuscitation.[2,3] In this paper, we outline our approach to promoting collective clinical readiness at the level of field hospital departments, supported by a *Field Orientation Manual* (Figure 1). Our proposal is consistent with the Australian Army's training doctrine, which emphasises that commanders must place constant emphasis on tailored training of individuals and teams to generate optimal collective effectiveness.

Goals

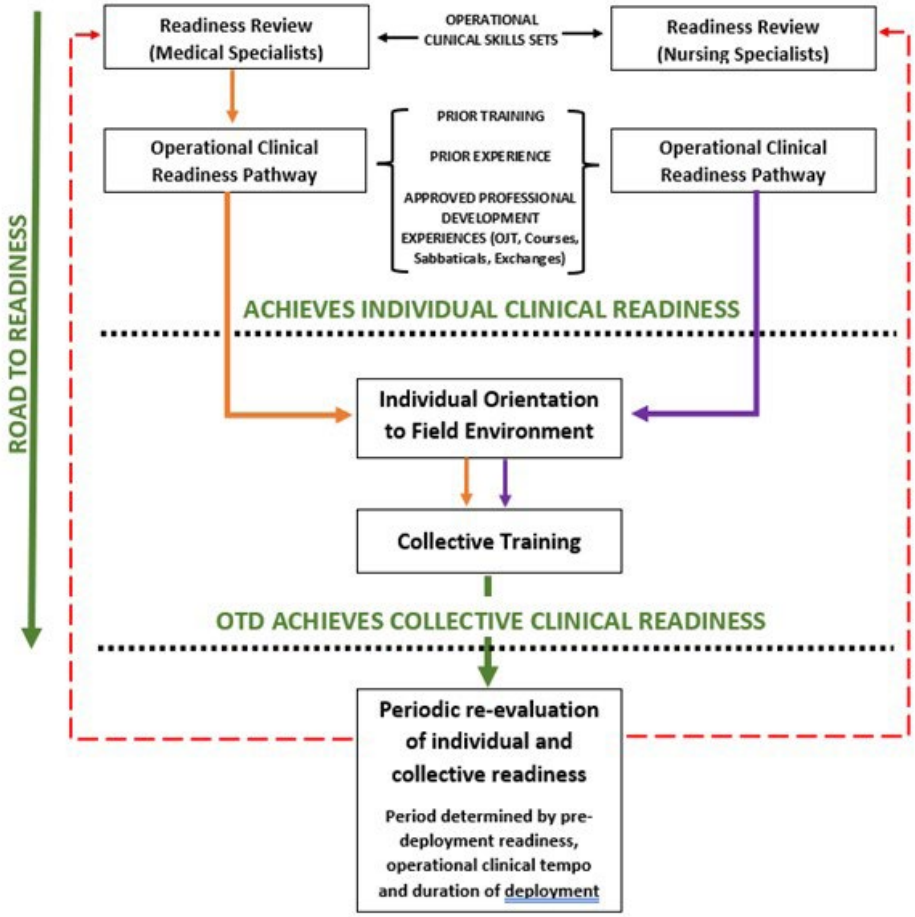
Our goals in establishing a field orientation process were to:

1. Ensure all clinicians can operate safely in the field environment.
2. Ensure that team members know their roles and the location of key equipment and consumables in time-critical clinical scenarios.
3. Allow for timely identification of deficiencies and equipment errors before declaring full operational capability (FOC) of a newly deployed operating theatre department (OTD).
4. Provide a framework for the preservation of corporate knowledge or 'lessons learned' that does not rely upon continuity of staffing.

Approach

Compared with other military training, exercises involving the deployed health facility have traditionally incorporated individual, small team and whole-of-hospital simulation. However, attending multiple major exercises, we noted that the content

Figure 1: Pathways to individual and collective clinical readiness



of small team or departmental drills is often left to the discretion of the department OIC or the individual specialists within the OTD. These individuals may or may not have previous experience with deployed health care and may not be aware of the range of 'high acuity low occurrence' (HALO) events that benefit from rehearsal prior to declaring FOC.

We noted that training serials based on HALO events often resulted in individual team members identifying gaps in their knowledge of OTD processes, as well as allowing for rectification issues such as non-functioning equipment or misplaced consumables. The most prominent example of this was training to manage malignant hyperthermia (MH).[5] An MH response is characterised by well-defined individual roles and responsibilities, supported by task cards and team checklists. We see this type of team training as advantageous because it can be 'walked through' by a team with no previous knowledge of each other or the physical care environment, and in doing so, it allows them to acquire knowledge of both.

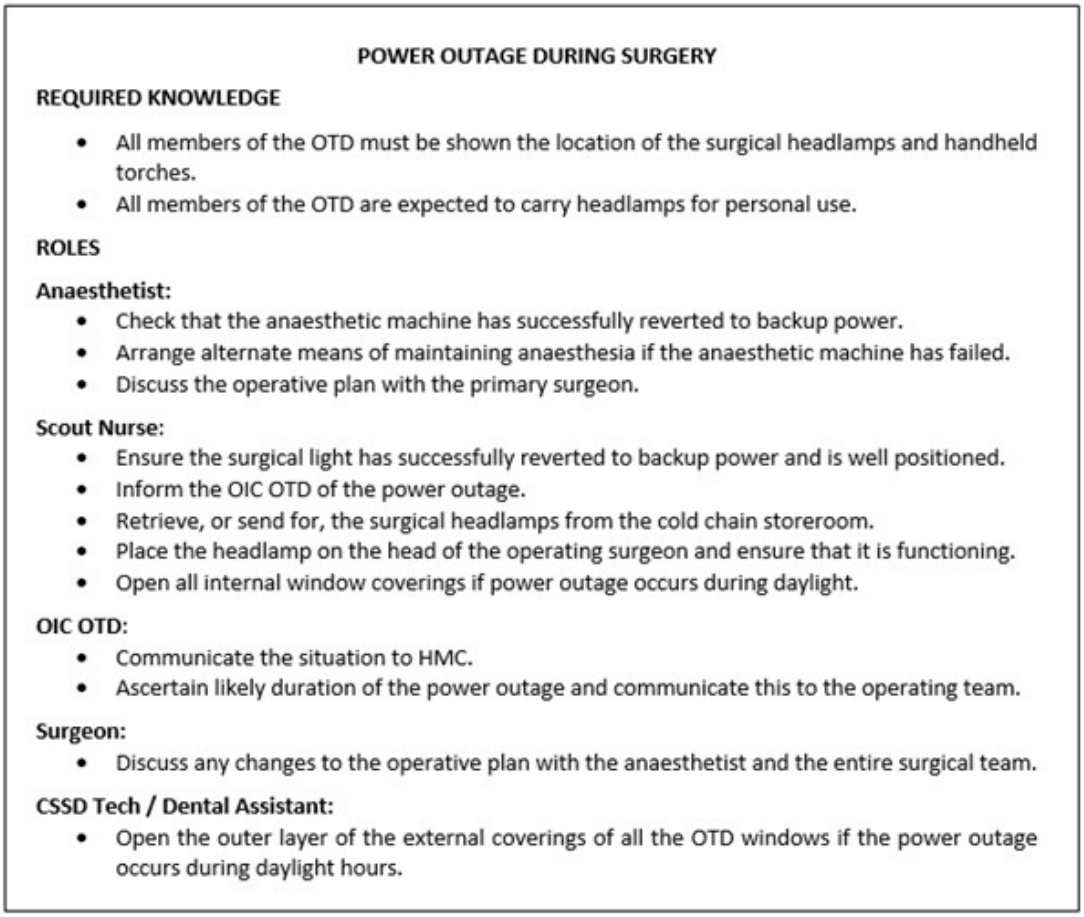
Drawing from these lessons, we identified several other clinical scenarios that demand an immediate, coordinated response by the OTD team. These comprise surgical, anaesthetic and logistic crises that feature predefined roles for each team member, which sometimes deviate from their responsibilities during routine operations. These were:

- fire in OTD
- power outage during surgery
- death in the OTD
- rapid theatre turnover
- major trauma
- red blanket (bypass of the resuscitation bay)
- anaphylaxis
- malignant hyperthermia.

Solution

We determined that the best way to ensure a consistent, timely response to each of these clinical scenarios was to develop a series of Immediate Action Drills (IADs) for the OTD. Drills are characterised by a predetermined sequence of actions performed in response to a clearly defined trigger; within the scope

Figure 2: Summary card – power outage during surgery



POWER OUTAGE DURING SURGERY

REQUIRED KNOWLEDGE

- All members of the OTD must be shown the location of the surgical headlamps and handheld torches.
- All members of the OTD are expected to carry headlamps for personal use.

ROLES

Anaesthetist:

- Check that the anaesthetic machine has successfully reverted to backup power.
- Arrange alternate means of maintaining anaesthesia if the anaesthetic machine has failed.
- Discuss the operative plan with the primary surgeon.

Scout Nurse:

- Ensure the surgical light has successfully reverted to backup power and is well positioned.
- Inform the OIC OTD of the power outage.
- Retrieve, or send for, the surgical headlamps from the cold chain storeroom.
- Place the headlamp on the head of the operating surgeon and ensure that it is functioning.
- Open all internal window coverings if power outage occurs during daylight.

OIC OTD:

- Communicate the situation to HMC.
- Ascertain likely duration of the power outage and communicate this to the operating team.

Surgeon:

- Discuss any changes to the operative plan with the anaesthetist and the entire surgical team.

CSSD Tech / Dental Assistant:

- Open the outer layer of the external coverings of all the OTD windows if the power outage occurs during daylight hours.

of the drill, no further instructions are required from the team leader. Drills are consolidated through overlearning and spaced repetition to enhance performance and long-term knowledge retention.[4]

Importantly, drills may constitute a complete initial response to a clinical crisis, as is the case for MH or power outage drill (Figure 2), or they may bring the team to a state of collective readiness in preparation for further tasking, as is the case for the major trauma drill. Drills are widely used for this purpose in other military contexts. At the individual level, all are familiar with weapons IAs. Likewise, small teams apply the basic drill, counter ambush drill and chemical, biological, radiological and nuclear defence drills, among many others.

Team training based on drills offers several advantages over ad hoc clinical scenarios or revision of standard operating procedures (SOPs). First, it allows a new team to swiftly acquire a common language and understand which team member should be expected to undertake each task in time-critical situations. Second, drills provide a ready-made framework for initial training each time the theatre team is constituted, allowing department leadership to focus on devising more complex follow-on training or whole-of-hospital simulation. Third, drills facilitate cognitive offloading of the team leader in a crisis because a single command brings the department to a state of action without the need for detailed instructions. Fourth, drills facilitate tracking of individuals' orientation to the field. Fifth, drills enable the team to recognise latent factors such as dysfunctional facility layout and equipment deficiencies before receiving the first casualty, consistent with the evidence for in situ hybrid simulation in commissioning new civilian hospitals.[6] Finally, drills build team cohesion and facilitate quality assurance through benchmarking of protocol adherence and time to completion.

To facilitate the use of the IADs we developed a *Field Orientation Manual for the OIC OTD*. This title was chosen to highlight that it should be utilised once a team arrives *on location* in the field environment and not just as a repository of corporate knowledge but as a tool to orient the team to each other and the environment itself.

The manual contains explanatory material enabling an OIC to implement drill-based team training

without prior knowledge of their team or the drills themselves. The OIC can also draw upon a Quick Reference Guide (QRG) that explains key logistic features of the hospital that are needed to execute the various IADs. The QRG outlines the hospital's pathology and imaging capabilities; composition of standard sets of sutures, anaesthetic drugs and instrument 'grab bags'; the documentation requirements of the field hospital OTD; and the role of the OTD personnel in the most notable of whole-hospital responses, the mass casualty drill. We believe this 'walk-through' guide would enable an entirely new theatre team to achieve collective readiness, consistent work practices and a safe work environment.

Where deemed useful, we have supported each drill with 'role cards' (Figure 3) that outline each role along with other visual aids that can be used for quick reference to check particular equipment, such as the 'Suture starter set' (Figure 4) or the 'Emergency anaesthetic drug set (Figure 5).

Figure 3: Role card – major trauma drill

Figure 4: Suture starter set

SUTURE STARTER SET
2 x 3-0 PDS
2 x 2-0 Vicryl
2 x Double-armed 3-0 or 4-0 Prolene
2 x 4-0 Nylon (cutting needle)

Figure 5 – Emergency anaesthetic drug set

EMERGENCY ANAESTHETIC DRUG SET	
Ketamine	200mg in 20mL normal saline
Midazolam	5mg
Fentanyl	500microg
Rocuronium	100mg
Metaraminol	10mg in 20mL normal saline
Cephazolin	2000mg in 10mL water

Finally, the overall document also included a compliance tracker, allowing the OIC to mark off each team member as they are oriented to specific equipment and drills of the OTD.

Discussion

In other contexts, it has been said that 'a good plan, violently executed now, is better than a perfect plan next week' (Patton). We believe that maxim applies equally to the initial management of high acuity scenarios in the OTD. In the past, we have observed a tendency to 'reinvent the wheel' each time an OTD is constituted for deployment or exercise, with each surgeon, anaesthetist or nurse adding or subtracting from the load list and putting their own 'spin' on collective practices. While there is much in trauma surgery and resuscitation that cannot be templated, that does not relieve those of us who are professional military trauma specialists from standardising all that we can. A standard tray of instruments and sutures, or routine anaesthetic induction drugs, that can be opened immediately by a scrub nurse or anaesthetic assistant when the major trauma drill is activated is superior to a bespoke list of consumables that can only be readied when the surgeon or anaesthetist returns from the resuscitation bay.

The efficacy of the *Field Orientation Manual* and its IADs has not been formally evaluated. However, each of the IADs has been piloted at a major exercise, and we have received positive responses from both part- and full-time clinicians of all specialties. We noted IADs enabled team members to 'work at the top of their scope'; for example, a medic anaesthetic assistant could confidently draw up induction and resuscitation drugs and prime a rapid infuser based on their role outline for major trauma, rather than waiting for a plan from the anaesthetist.

Beyond learning individual responsibilities within a team response, we observed that execution of the IADs orients the team to their physical environment and each other. The fire in the OTD and power outage drills help OTD staff understand the electrical supply

to theatre, the location of firefighting equipment and the facility's layout. The death in the OTD drill introduces the team to broader administrative issues such as casualty tracking and mortuary management in the deployed environment, while demonstrating that time to complete this process affects theatre readiness to receive further casualties. The major trauma and red blanket drills familiarise the team with the surgical equipment, and the anaphylaxis and MH drills are valuable to orient the team to the anaesthetic equipment. Our approach does not obviate the need for more detailed SOPs. These provide an enabling framework for the IADs, as well as guidance on the management of less time-critical situations. Nonetheless, clinical IADs provide a framework for the team to know each other and their environment, enabling recognition of individual and collective capability gaps. We believe a team where all individuals have completed IAD-based orientation training will have a greater capacity to respond to more complex training and care provision demands.

We believe that the utility of clinical IADs should be further evaluated, both within the OTD and other hospital departments. All clinical areas have scenarios that require immediate response with minimal need for variation between instances: for example, resuscitative thoracotomy in the emergency department or unintended extubation in the intensive care unit. This draft proposal has already been replicated in draft form in the OTD of other services. It has been noted as a positive activity in external review processes, such as The Royal Australasian College of Surgeons Trauma Verification.

Conclusion

The OTD *Field Orientation Manual* is a compendium of IADs targeting a suite of time-critical events in the field hospital operating theatre, supported by decision aids, task cards and visual prompts. The manual can potentially assist team leaders in orienting a new team to the deployed clinical environment and each other. It may help provide continuity of corporate knowledge that otherwise might be lost through the rotation of experienced members, allowing past lessons to be preserved rather than learned repeatedly. It may also give confidence to hospital commanders, who will know that an OTD that has completed individual and collective rehearsal of the IADs is at full operating capability. Our model is consistent with Army's broader training philosophy, and we advocate further evaluation of clinical IADs in all deployed hospital departments.

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JMVH Article: '*John Keith Henderson: First Australian to Provide Dental Treatment to Troops on Active Service*'

N Westphalen

Dear Sir/Madam,

The July 2022 JMVH article regarding John Keith Henderson, the first Australian to provide dental treatment to personnel on active service, is important because it expands on an otherwise rarely-examined component of Australia's military medical history. While commending the author's work to that end, the article requires further elaboration regarding the medical detachment that supported the Australian Military and Naval Expeditionary Force (ANMEF) at the beginning of World War I.[1]

The author's statement (as is the reference upon which it is based) that 'the medical detachment of the ANMEF comprised four medical officers, one Warrant Officer and 35 other ranks' is factually incorrect. These figures only include the Army medical component aboard the troopship *Berrima*, not ANMEF as a whole.[2] The author's statement that ANMEF had no nursing staff is likewise only true in that none came from Army.

In fact, besides the Army component (and again, contrary to the original reference used by the author), the 600-man RAN contingent aboard *Berrima* had its own medical officer (Surgeon Jack Skeet RAN), while Surgeon Jack Willis RANR was appointed to the store ship *Aorangi*, and Surgeon Frederick Kenny RANR to the submarine depot ship *Upolu*.[3,4,5] In addition, the medical staff aboard the ANMEF hospital ship *Grantala* comprised six surgeons, seven nurses (the first women to serve at sea with the RAN), 26 men for dispensary, radiology, pathology and orderly roles and nine non-medical sailors for disciplinary, clerical, signalling, carpentry and boat-handling duties.[6,7] *Grantala*'s medical team was led by Acting Fleet Surgeon William Nichols Horsfall RAN, who had served with the British Royal Navy as (probably) its first Australian-born medical officer (from Fitzroy Victoria) from 1904 to 1913.[8,9,10,11]

***Grantala*'s professional medical, nursing and chaplaincy staff, August 1914.[12] The nurses all came from Sydney's Royal Prince Alfred Hospital; who, with the surgeons, were employed as 'special service' civilians rather than uniformed officers, which led to disciplinary problems with the orderlies. Horsfall is in the centre of the front row.**

***Grantala*'s medical orderlies and supporting non-medical sailors, August 1914.[13] The orderlies came from Sydney's Royal Prince Alfred Hospital or the civilian NSW St John Ambulance Brigade, the latter including several tram drivers. Horsfall is in the centre of the second row.**

These ships were escorted from the Louisiade Archipelago to Rabaul by the battlecruiser *Australia* (I), the light cruisers *Sydney* (I) and *Encounter* (I), the destroyers *Yarra* (I) and *Warrego* (I) and the submarines *AE1* and *AE2*, which therefore were also part of ANMEF.[14,15,16] The first three of these ships likewise had their own RAN medical staff.

John Henderson's role fully deserves the recognition sought by the author, especially if he provided his services for the RAN as well as the Army ANMEF component four years before the first RAN dental officer (Surgeon Dentist Milton Spencer Atwill) was appointed in April 1918.[17] To that end, I trust this letter provides better context to his story.

Yours sincerely

Dr Neil Westphalen

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Notes

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