

EDITORIAL

Open Access

Pushing the frontiers of military medical excellence: updates, progress and future needs



Jun Jie Seah¹ and De-Yun Wang^{1,2*} 

Abstract

Since its establishment in 2014, *Military Medical Research* has come a long way in becoming a premier journal for scientific articles from various different specialties, with a special emphasis on topics with military relevance. The field of military medicine may be obscure, and may not be readily encountered by the typical clinician on a day-to-day basis. This journal aims not only to pursue excellence in military research, but also keep current with the latest advancements on general medical topics from each and every specialty. This editorial serves to recap and synthesize the existing progress, updates and future needs of military medical excellence, discussing foremostly the unique traits of literature published in this journal, and subsequently presenting the discourse regarding wartime and peacetime medicine, the role of the military in a public health emergency, as well as wound healing and organ regeneration. Special attention have been devoted to military topics to shed light on the effects of Chemical, Biological, Radiological and Explosive (CBRE) warfare, environmental medicine and military psychiatry, topics which rarely have a chance to be discussed elsewhere. The interconnectedness between military combat and soldier physical and mental well-being is intricate, and has been distorted by pandemics such as coronavirus disease 2019 (COVID-19). This journal has come a long way since its first article was published, steadily contributing to the existing knowledge pool on general medical topics with a military slant. Only with continuous research and sharing, can we build upon the work of the scientific community, with hopes for the betterment of patient care.

Keywords: *Military Medical Research*, Military medicine, Clinical medicine, General medicine, Basic science, Coronavirus disease 2019 (COVID-19), Post-traumatic stress disorder (PTSD)

Introduction

Ever since its inception in 2014 when its inaugural manuscript was published, *Military Medical Research* has continued to publish a plethora of scientific articles contributing to the knowledge base of the scientific community, ranging from case reports to full-fledged practice-changing clinical practice guidelines (CPGs). As a peer-reviewed open access journal, *Military Medical Research* boasts a wide range of research articles, comprising basic science, clinical medicine, and military

medicine. Indeed, what sets this journal apart from other general medical journals is its military slant. Compared to other specialties, military medicine can come across as obscure or esoteric to many, and may be unfamiliar to many scientists or clinicians, given that such a subject matter is not encountered on a day-to-day basis. Nonetheless, while this journal maintains its focus on military medicine, *Military Medical Research* also keeps up-to-date with the current medical frontier, accepting original high-quality clinical research articles from various specialties, basic science research and even CPGs. Just recently, Zeng et al. [1] published a CPG for transurethral plasmakinetic resection of prostate for benign prostatic hyperplasia, building upon its previous 2018 version with newer direct evidence, making evidence-based

*Correspondence: entwdy@nus.edu.sg

¹ Department of Otolaryngology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore
Full list of author information is available at the end of the article



© The Author(s) 2022. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

recommendations for perioperative and postoperative management. Another CPG also newly published summarised evidence-based recommendations for granulomatous lobular mastitis (GLM), which is helpful for a rare disease that previously had no unified guidelines. Recent literature suggested a possible role of *Corynebacterium* infection in the disease process of GLM [2], providing interesting insights into ever emerging topics.

At the time of writing, *Military Medical Research* has amassed a total of 355 articles (excluding corrections or errata), comprising 116 military-related articles, and 239 non-military articles. Non-military topics still form the majority of articles in *Military Medical Research*, giving it a strong footing in keeping current with medical knowledge.

Upon further scrutiny, many various specialties have been included for publication over the past few years, comprising various general and sub-specialised medical and surgical specialties, as well as special topics like coronavirus disease 2019 (COVID-19, Fig. 1). A diverse mix of articles not only keeps readers engaged, but also encourages authors to explore widely.

The different types of articles contribute to the improvement and optimisation of patient care in their own unique way. Indeed, while different article design types hold different levels in the hierarchy of evidence, no single article design type takes precedence over another. Every article design focuses on a particular area of knowledge that is necessary for further studies to build upon, and contributes to the existing

abundance of clinical knowledge. Eventually, the aim is for betterment of patient care and outcomes (Fig. 2).

Military Medical Research encompasses all different design types in both military and non-military related articles (Fig. 3). Majority of articles published consisted of review articles, followed by cross-sectional, and cohort studies. Non-military articles generally outnumbered military articles across the various article design types.

Thematic focus is also a feature of *Military Medical Research*. Call for articles attempt to encourage authors to contribute papers pertaining to existing hot topics where medical knowledge is constantly evolving [3] (Table 1). Themes are widely diversified, and comprise medical research from different ends of both military and non-military spectrums. Topics such as altitude medicine, war-related injuries and post-traumatic stress disorder (PTSD) alluding to military psychiatry cannot be ignored in the field of military medicine. On the other hand, topics discussing tissue engineering, microbiome, and COVID-19 are geared towards peacetime medical operations. Themes can span both categories such as the spectrum of sepsis to septic shock, where several high quality articles with a respectable number of citations have been published, including a basic science article by Xu et al. [4] discussing the role of the IL-33-ST2 axis in sepsis, as well as a meta-analysis that synthesized the existing literature comparing norepinephrine with vasopressin in patients with septic shock [5]. Overall, the varied nature of this journal not only keeps it as an interesting read, it

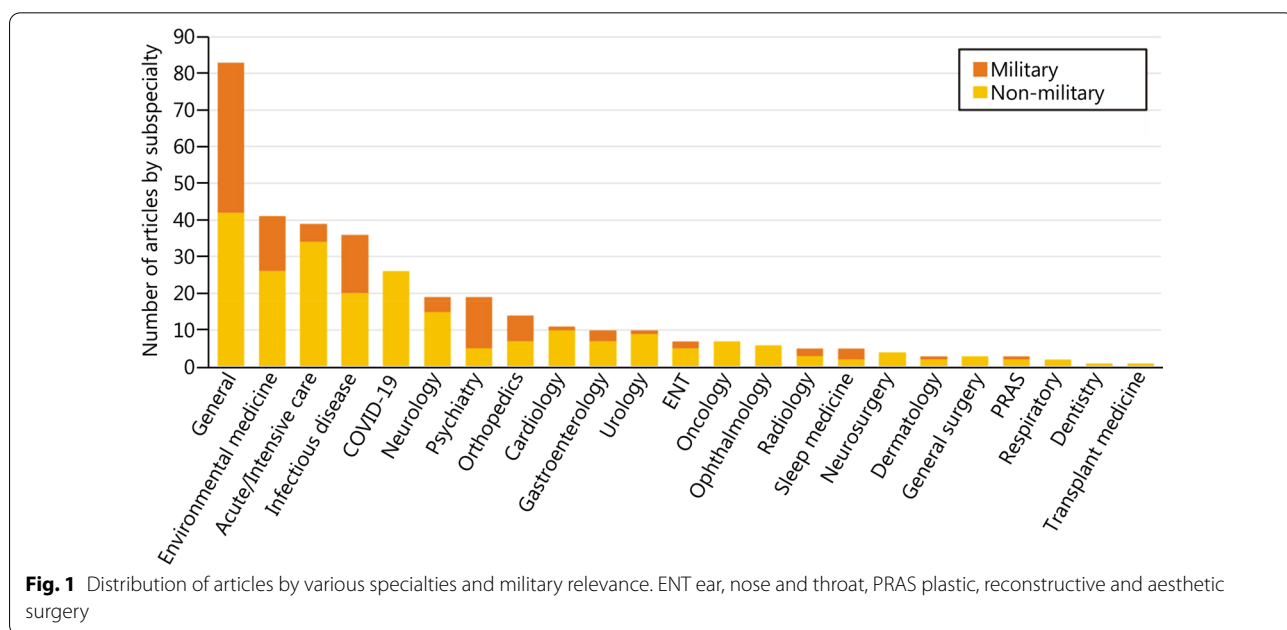
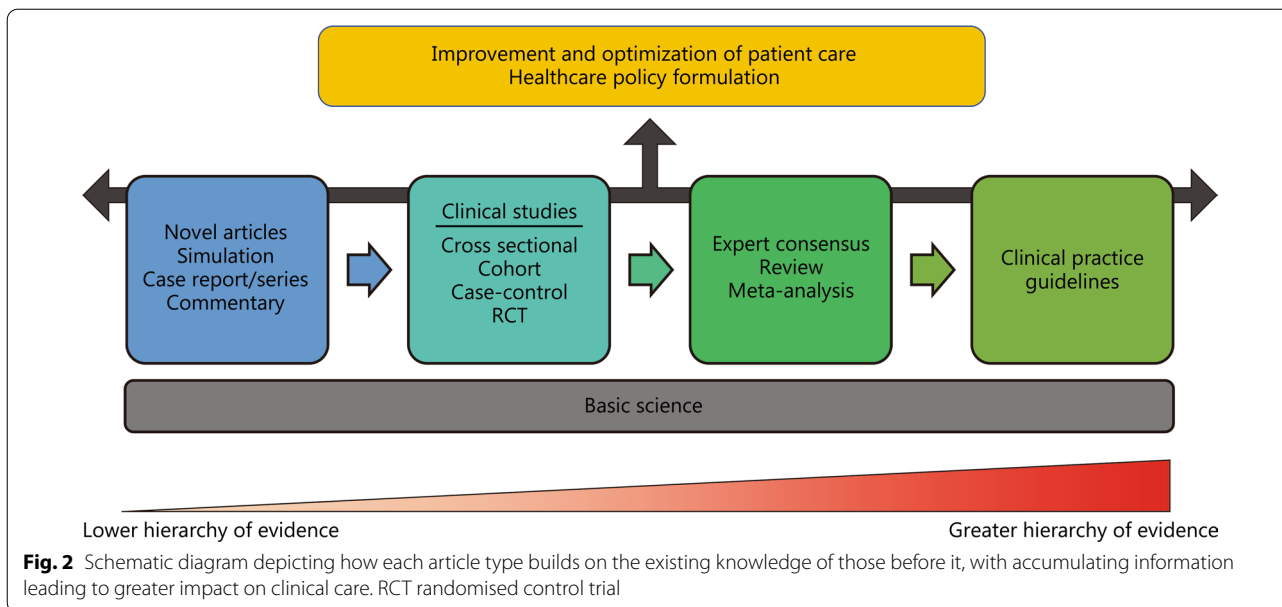


Fig. 1 Distribution of articles by various specialties and military relevance. ENT ear, nose and throat, PRAS plastic, reconstructive and aesthetic surgery



is pitched to both the generalist and specialist for a one-stop journal for up-to-date knowledge.

Military focus

Principles of military medicine

Alongside the evolution of modern warfare, healthcare in the military setting has also seen numerous advancements that deserve attention. Resources that have been dedicated to such topics are paramount for us to attain deeper insights into military medicine. This editorial hence presents a timely opportunity to revisit the

tenets of military medicine, and understand its importance despite being a relatively esoteric subspecialty.

One way to understand the scope of military medicine would be to consider the dichotomy of peacetime and wartime settings. In the former, a good understanding of civil emergency management is necessary. The principles of mitigation, preparedness, response, and recovery, are tenets that stood the test of time, and can guide healthcare professionals amidst the chaos of a mass casualty scenario. Zhang [6] comprehensively described the organization and implementation of mass medical rescue after two earthquakes in Wenchuan of Sichuan Province

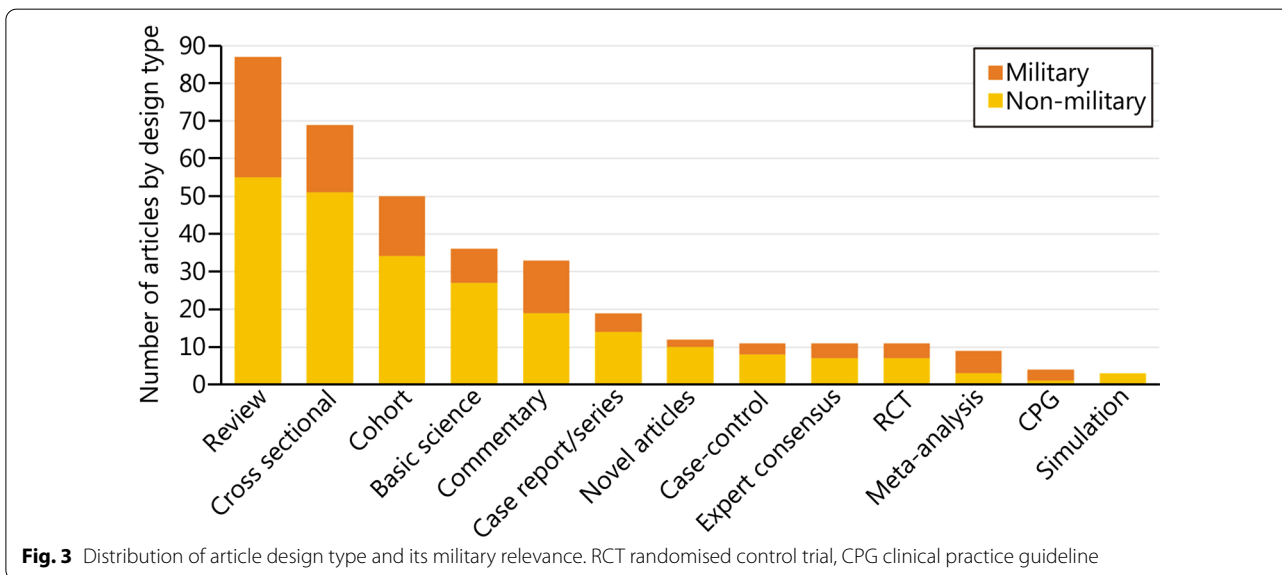


Table 1 Thematic call for articles over the years in *Military Medical Research*

Year	Theme
2014	Current clinical research progress on high altitude medicine
2016	Sepsis
2017	Health concerns of war-related ankle and foot injuries Post-traumatic stress disorder (PTSD): biopsychosocial translational research and everyday practice
2018	Sepsis and septic shock
2020	Diagnosis and treatment of heat stroke Tissue engineering and regenerative medicine Severe torso trauma: epidemiology, diagnosis, rescue and management
2021	Microbiome Coronavirus disease 2019 (COVID-19)

and Yushu of Qinghai Province. The principles of organizing, coordinating and participating in an efficient and evidence-based medical rescue effort were recounted, resulting in formidable casualty outcomes despite the large-scale devastating nature of the natural disasters. Indeed, sharing of experiences amongst the scientific community results in a win–win situation where learning can take place without repeatedly suffering the wreckage of the catastrophe itself.

In the setting of wartime medicine, a good grasp of the principles of mass casualty triage, disaster management, and damage control resuscitation (DCR) are integral to minimize battle-related morbidity and mortality. The latter has been discussed extensively by Mutafchyski et al. [7], detailing not only the pathophysiology governing the need for DCR, but also affords statistical data in the context of blast injuries, and incorporating management recommendations in both military and non-military settings. Resource allocation becomes an important doctrine, given that casualties may overwhelm the treatment capacity of the supporting medical force, necessitating accurate and reliable triage to maximize survivors. Xie et al. [8] proposed and successfully tested out a novel triage and medical evacuation system for naval warfare, helping to combat the limitations of existing triage systems and improve on triage efficiency. In the pre-hospital setting, techniques of Tactical Combat Casualty Care are also heavily emphasized and taught to medics entering the combat arena. The three phases of care under fire, tactical field care, and combat casualty evacuation care are protocolized in detail by Butler Jr et al. [9]. There is an emphasis on Advanced Trauma Life Support, to cater to the overwhelming number of traumatic injuries expected in war. Injuries such as gunshot wounds, penetrating thoracoabdominal trauma and burns take centre stage in the range of injuries faced by military medical personnel.

These aforementioned topics have been heavily discussed in *Military Medical Research*.

Special fields of military medicine

Chemical, biological, radiological and explosive (CBRE) warfare

CBRE warfare is rarely encountered during peacetime, as it is difficult to realistically simulate for training purposes. Li et al. [10] explored the challenges with emergency medical preparedness and response in CBRE attacks, and proposed appropriate countermeasures based on prior real-life experiences. An interesting strategy utilises a professional multidisciplinary consulting team comprising physicians, nuclear physics and chemical experts to efficiently tackle such unique threats. Rump et al. [11] also discussed CBRE warfare with a special focus on radiological dispersal devices (also known as “dirty bomb”). The danger of a dirty bomb detonation is attributed not only to its explosive effect causing blast injury, but also to its area denial effect, where the radioactive contamination mandates quarantine and intensive large-scale clean-up, resulting in marked economic as well as short and long term health effects.

Environmental medicine

The effects of the environment on the health of soldiers most definitely cannot be ignored. Especially in tropical climates, high temperatures can impact the physical and mental well-being of soldiers, regardless of peacetime or wartime activities. Heat-related illnesses, such as mild heat illness, heat injury, or heat stroke, refer to the spectrum of physiological disturbances that occur when the body is exposed to high environmental temperatures, with consequent deleterious sequelae on the cardiovascular, gastrointestinal, hepatobiliary, musculoskeletal, and central nervous systems [12]. Under thermal stimulation, pathological decompensation of bodily systems can occur, consequently leading to systemic inflammation and multi-organ failure [13]. Heat acclimatisation may hence attenuate these effects by initiating physiological and behavioural adaptations to protect thermal homeostasis, improve performance and reduce heat illness risk [14]. Yang et al. [15] developed a 47-point scoring system to assess the severity of exertional heat stroke (EHS), with variables comprising clinical parameters, laboratory tests, and acute gastrointestinal injury classification. Their score can predict mortality from EHS, performing better than the Acute Physiology and Chronic Health Evaluation (APACHE) II and Sequential Organ Failure Assessment (SOFA) scores in this aspect. On the other end of the spectrum, cold injury is not as frequently encountered and researched upon, and manifests mainly

in temperate climates. Jin et al. [16] discussed at length in an expert consensus statement regarding the epidemiology, prevention, diagnosis and treatment of cold injuries, and borrowed many experiences from military cold injuries, which have a much higher incidence than the civilian setting. Many lessons can be learnt from the experiences of environmental injury, and it is important to remain cognizant of its effects in the military and civilian setting.

Military psychiatry

Military psychiatry is also an emerging field in the wartime setting. With reference to Fig. 1, psychiatry is one of the few specialties where military articles outnumbered non-military ones in *Military Medical Research*, depicting the increasing emphasis and importance of military psychiatry that has become an invaluable and intangible effect of war [17]. The phenomenon of combat stress reaction (CSR) refers to labile polymorphic manifestations affecting cognition, affect, and behaviour during battle [18]. Risk factors for the development of CSR non-exhaustively include older soldiers, lack of physical fitness, lower educational level, married individuals, lower rank and experience, and those with a recent birth or death in the family [19]. In contrast, PTSD is characterized by a constellation of re-experience and avoidance symptoms after exposure to a traumatic event, and can potentially be chronically debilitating [20]. A study on 1730 war veterans from Pennsylvania found that significant predictors of PTSD included female sex, high combat exposure, history of concussion, high stressful events within the past year, high lifetime trauma exposure, low social support, and low social capital. Interestingly, serving on multiple tours was a protective factor for PTSD [21]. It is important to distinguish between CSR and PTSD, as the latter can be easily undetected and lead to long-lasting psychological sequelae. Raza et al. [22] reviewed the effects of military experiences on dementia risk, and found that military deployment, traumatic brain injury (TBI), PTSD, and poor sleep all contribute to dementia development, with the strongest link arising from TBI. The effect of the military on the mental health of soldiers is not a temporary one, but can have long-term deleterious effects even long after they have left the military, impacting on quality of life. To tackle the negative effects of sleep deprivation or poor sleep quality on the mental health well-being of soldiers, Harrison et al. [23] studied the chronotype profile of U.S. sailors, and suggested aligning military schedules with endogenous circadian rhythms to optimise performance. On the other hand, Baig et al. [24] found that quetiapine monotherapy can increase engagement in trauma-focused psychotherapy, given that fluoxetine, the alternative pharmacologic

treatment for PTSD, has an extended onset of action and can exacerbate post-concussion syndrome in mild TBI. Despite military psychiatry being an established field, there leaves much more knowledge to be discovered in this ever-evolving specialty, which is only made possible with continued research.

Medical support in a public health emergency: a word on COVID-19

The response to infectious disease crisis represents one of the major tasks of the military during peacetime medical operations. The COVID-19 pandemic has, without a doubt, revolutionized the focus of the scientific community since end-2019. Over the past two years, COVID-19 has not only been the talk of the town, but many scientific articles, be it basic scientific papers, clinical studies or trials, or even case reports of unique phenomena, have sprung up and populated the pages of many medical journals. The dynamic nature of articles published about COVID-19 since the start of the pandemic reflects how our understanding of the disease evolves as we learn more about it.

Basic science and advancements

Basic science articles form the foundation and basis for other clinical studies to build upon, and are integral in the comprehensive understanding of the pathobiology of disease, especially in the context of COVID-19 virology. Yang et al. [25] delved right into the essence of basic science in a laboratory study on human lung epithelial cell lines, explaining how retinoic acid-inducible gene I binds the 3' untranslated region of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA genome via its helicase domains, preventing viral RNA replication independently of interferons, and can also restrain full-length angiotensin-converting enzyme 2 (ACE2) expression and consequently cellular entry by SARS-CoV-2. Neighbouring cell-cell fusion which produces multinucleated syncytia is implicated in the pathogenesis of COVID-19, and that such syncytia were readily detected in the post-mortem lung tissues of patients with COVID-19 alongside extensive damage in tissue structures [26]. These syncytia also facilitated virus spread via the cell-to-cell route, shielded from the extracellular antibodies that hinder cell-free transmission.

Another review by Pang et al. [27] on the topic of neutralising antibodies in COVID-19 infection, discusses not only the pathomechanism of how neutralising antibodies interfere with the virulence of the SARS-CoV-2 virus, but also explores the differential antibody response in mild and severe COVID-19 infection, expounding on how the rapidity of neutralising antibody production

has implications on mortality. Indeed, a rooted understanding of virology serves as the foundation for further research on COVID-19, including vaccine development and pharmacological treatment.

An interesting review providing a timely update on the COVID-19 status by Guo et al. [28] was published in March 2020, just shortly after the World Health Organisation declared COVID-19 a pandemic. This heavily-cited article shared comprehensive insights on various aspects of the disease, ranging from basic virology and mechanism of infection, to practical tips on clinical diagnostic and management recommendations. Even with such a recent disease that broke out not long ago, the variety in research articles published in *Military Medical Research* is limitless, exemplifying its role as a general medical journal hub for knowledge exchange.

Effect on organ systems

It is not unexpected that COVID-19, being a new disease, has many unknown sequelae on various different organ systems apart from its primary pathology of causing respiratory tract infection. *Military Medical Research* has received various articles describing the manifestations of COVID-19 on different systems. From the hematological point of view, COVID-19 can cause coagulation dysfunction as a result of systemic inflammatory reactions leading to microvascular damage, abnormal coagulation system activation, manifesting pathologically as a small-vessel vasculitis and extensive microthrombosis [29]. COVID-19 also causes hepatic injury, manifesting primarily as deranged liver function tests. Mechanisms to account for this include direct hepatocyte injury, drug-induced liver injury, hypoxic-ischemic microcirculation disorder, or underlying liver diseases [30]. In addition, patients with severe COVID-19 had significantly higher liver enzyme elevations compared to mild cases, seeming to suggest a positive relationship between COVID-19 severity and extent of liver injury. COVID-19 also affects the gastrointestinal system, manifesting non-specifically as anorexia, nausea, vomiting, and diarrhea, supported by positive results of gastrointestinal tract and stool RNA samples [31]. In several studies, the occurrence of diarrhea ranges from 2.0 [32] to 49.5% [33]. This may be associated with the fact that ACE2, the binding receptor for SARS-CoV-2, is highly expressed in the ileum and colon [34]. In a cross-sectional study in China involving 187 patients with confirmed severe COVID-19 infection, it is purported that the SARS-CoV-2 virus neuroinvades via olfactory sensory neurons, colonising olfactory bulb tissue. Increased expression of ACE2 in the nasopharynx may lead to an increased risk of olfactory and taste symptoms [35]. The authors also propose using olfactory or taste disturbance as an early-warning symptom to

screen for patients potentially infected with COVID-19, especially in the absence of rhinitis. The consequences of COVID-19 infection on various organ systems are aplenty, and it is prudent to be aware of such unique manifestations when encountering patients with COVID-19 infection with associated atypical symptoms.

Prognostication of COVID-19

Prognostication of COVID-19 patients is another interesting field of study that has garnered research attention. Presenting complaints range from completely asymptomatic with a positive diagnostic SARS-CoV-2 polymerase chain reaction (PCR) swab test, to full-blown pneumonia with acute respiratory failure that can be life-threatening. Prognostication of infected patients plays an important role in determining which patients will require closer monitoring and intervention, as well as selecting patients who will benefit from further drug therapy. A Chinese study on 2541 confirmed COVID-19 patients found that older age, lymphopenia, respiratory rate ≥ 30 /min, and high IL-6 levels were independent high-risk factors associated with poor prognosis [36]. The study also developed a nomogram which serves as a quick visual aid to estimate the risk of fatal outcomes. Zhou et al. [37] proposed a workflow for risk stratification of COVID-19 patients via simple scoring of clinical, blood and imaging tests. Its efficacy, however, has yet to be tested in a patient population, and may be limited by the need for routine chest CT. C5178a and A249d mitochondrial DNA (mtDNA) variants are found to be associated with a reduced risk of severe COVID-19, while the A4833G, A4715G, T3394C, and G5417A variants were related to an increased risk of severe COVID-19 [38]. Testing for common mtDNA variants via a simple blood test may eventually play a role in stratifying patients infected with COVID-19, providing an additional triage tool to enhance clinical assessment.

Treatment and preventive measures

The current research on COVID-19 treatment is heterogenous, with many proposed treatment strategies with claims of effectiveness. A review by Xu et al. [39] comprehensively synthesized the current evidence pertaining to investigational therapies for COVID-19, and their role as adjuncts to standard supportive care. Given that there is so much more yet to be discovered about COVID-19, articles like such efficiently centralizes the myriad of existing data, providing new insights by harnessing the findings of existing knowledge.

As the COVID-19 pandemic progresses, finding a medical cure may be important, but a long-term sustainable solution to combat such spread involves preventive measures. Peng et al. [40] proposed a novel bionic nanoparticle vaccine, which has the benefits of desirable

biocompatibility, as well as being able to simulate the whole virus structure, including its infection process, to efficiently trigger antibody production. With such advances, the ability to eventually develop “universal” influenza vaccines is promising. For patients who fall through the cracks, early detection can serve as the next line of defence. Rapid diagnostic kits such as the antigen rapid test or the SARS-CoV-2 reverse-transcription polymerase chain reaction (RT-PCR) test may yield false positive results. Adedokun [41] described the clinical entity termed “silent hypoxemia” where patients can be completely asymptomatic or minimally symptomatic, but subsequently deteriorate insidiously without warning, sometimes to the extent of progression to respiratory failure without the warning of respiratory distress. Pulse oximetry can screen asymptomatic patients with low oxygen saturations for further workup, which additionally has the benefit of being portable and easily administered.

Relationship between COVID-19 and the military

Military hospitals have demonstrated efficiency in combating the current COVID-19 pandemic via rapid protocol planning and standard operating procedures. Many approaches can be learnt from their experiences responding to such a public health crisis, which play an integral role by contributing to the current existing knowledge pool, providing new insights into the field of pandemic readiness and response. Scientific research on military medicine have also highlighted the importance of medical support in peacetime military operations. How we can further extend the scope of medical support afforded by the military in a pandemic setting is an important topic that requires further research. *Military Medical Research* examines these issues via its repertoire of publications, ensuring a diversity of trending scientific knowledge resources.

Zhang et al. [42] described their experience with an outbreak of *Mycoplasma pneumoniae* in a Chinese military academy. They reasoned that the high-intensity training and psychological stress decrease immunity, and environmental factors such as climate, high-density residences, and non-ventilated rooms accounted for the outbreak. Indeed, the congregation of military service personnel in a densely packed setting coupled with regular and frequent close interpersonal interaction acts as a catalyst for disease spread.

Dutton et al. [43] described the evolving role of the military in pandemics, such as COVID-19, and how the austere environment creates challenges when the military is deployed to assist in pandemic medical efforts. While their medical facilities system is meant for triage and stabilization of battlefield injuries, it was not designed to provide potentially long-term respiratory support to

large acute volumes of patients. They drew parallels to the Spanish Influenza epidemic of 1918 (amidst World War I) and the typhoid fever epidemic of 1898 (amidst the Spanish-American War), where the infective pathogen led to greater fatalities of military personnel compared to combat casualties. Infectious diseases can be sufficiently devastating to affect the trajectory of war, and remind us never to underestimate the lethality of contagious pathogens.

War and infectious diseases are intimately intertwined. War affects disease in that it provides a conducive environment with highly clustered soldiers who interact closely on a day-to-day basis, providing ease of human-to-human transmission. The physical and psychological degradation of war on the human body may also possibly undermine the immune system, making one more susceptible to contracting disease. Disease also affects war, by increasing the already dismal casualty numbers sometimes more than what is caused by combat alone, or via strategies used to incorporate biological agents as weapons [44] to gain an upper hand against the enemy. Indeed, the lethal, invisible and covert nature of infectious diseases makes it a difficult enemy to identify, until its disastrous effect on the human body manifests, which by then may be too late.

Wound healing and organ regeneration

Advances in wound healing

Wound healing is a unique genre relevant to both military and non-military medicine. Surviving casualties of non-lethal injuries eventually require definitive wound care, a potentially arduous long-drawn process fraught with threats of complications. In the non-military setting, wound healing is also a widely-discussed topic, inevitably encountered in patients undergoing surgery, or in patients suffering from vasculopathy with a slow-healing foot ulcer, for instance. Albeit to a smaller extent, the civil setting is also not exempt from high-energy blast energy injuries. A database analysis on 2098 explosions over 18 years found a decreasing but significant trend on the number of explosions in China. Casualties importantly lack training and personal protective equipment, and are thus prone to more severe injuries compared to soldiers [45]. Given the ubiquitous nature of penetrating or blast injuries in both the military and non-military setting, a firm grasp of the principles of wound healing is necessary. Fu [46] proposes that for optimal wound healing to take place, treatment should focus on optimisation at the cellular level, such as by removal of reactive oxygen species, before enhancing the wound bed via chemical or surgical debridement.

A few authors investigated the effect of novel methods for wound healing in animal studies. Wei et al. [47]

studied Bama pigs and discovered that recombinant human epidermal growth factor at a concentration of 10 ng/ml can promote the proliferation and migration of epithelial cells and fibroblasts to the greatest extent, and can be further enhanced by vacuum sealing drainage. Yang et al. [48] improved the use of LL-37 peptide to promote wound healing by incorporating it into chitosan hydrogel, improving its stability in the wound environment, thus improving the healing of pressure ulcers in a mouse model. Kaltenborn et al. [49] discussed the technique of ex vivo limb perfusion via a hypothetical experiment and prototype, hypothetically applied in the evacuation and treatment of a fictive patient. Novel studies are important in providing a stepping stone for further research, especially in a field still under active exploration.

Bioelectrical impedance analysis-guided fluid resuscitation in post-traumatic open abdomen patients managed to achieve a higher primary fascial closure rate and fewer complications compared to traditional resuscitation strategy [50]. In the military setting, Xu et al. [51] reviewed the literature on the role of platelet-rich plasma (PRP) on military drill injury, as well as discussed the pros and cons and surrounding controversies of PRP therapy. While there seems to be existing limitations to the use of PRP, the minimally-invasive nature of the treatment and its potential benefits make it an attractive option in the therapeutic armamentarium. An orthopaedic surgeon also analysed his experience with patients requiring soft tissue coverage using pedicled flap in the combat arena. The nuances of wound reconstruction in the military setting are explored, where emergency soft tissue cover is often required, but evacuation to a tertiary hospital with plastic surgery expertise may not be possible for various reasons [52].

Advances in organ regeneration

It is also pertinent to discuss the progress on organ regeneration, given that traumatic solid organ injury is a common finding in the wartime setting. Toll-like receptor 5 signalling can positively regulate and promote liver regeneration by enhancing proinflammatory responses in a mouse model [53], potentially opening up therapeutic applications for partial hepatectomy patients. Bilgiç et al. [54] performed experiments in a Wistar albino rat model, and showed that the use of autologous omentum in addition to primary repair for traumatic kidney injury attenuated the extent of inflammation and granulation, which may facilitate healing of kidney injury and reduce fibrosis and future functional loss. Progenitor cells within the omentum can migrate to damaged tissues and aid in the regeneration process. Neuroplasticity can also manifest in the central nervous system post-injury via the mechanism of cortical remapping, where functions lost as a

result to CNS damage is remapped to another part of the cerebral cortex [55]. In the repair of spinal cord injury, hydrogels have mechanical properties that mimic the extracellular matrix of the spinal cord, providing a scaffold for axonal growth and neuronal formation, removal of inflammatory cells and factors, eliminating spinal cord cyst formation, and inhibition of glial scarring [56]. Advances in organ regeneration and healing can revolutionize treatment modalities and optimise patient care. *Military Medical Research* provides a unique perspective on the ongoing discourse on wound healing and organ regeneration by providing an additional emphasis from a military standpoint, complementing experiments and studies performed in the civil setting.

Future needs

While *Military Medical Research* has met many of the objectives it set out to achieve ever since its establishment in 2014, this editorial serves as a timely opportunity to consolidate the journal's achievements thus far, and propose directions for future scientific work. New knowledge pertaining to both peacetime and wartime military medicine are still paramount in the journal's aim to promote the global development and progress of military medicine. Fresh innovative ideas regarding improvement of military medical efficiency, technological healthcare advancements, as well as soldier performance maximisation will definitely contribute to the forefront of military medical scientific knowledge. At the same time, general medical research articles are equally important, as they serve to keep everyone current about the latest cutting-edge technology and clinical data. The interaction between military and civilian medicine may not be apparent at first, but upon close scrutiny, many lessons that transpired from both military wartime and peacetime operations can be applied in the civilian context to optimise the delivery of healthcare.

Conclusions

Military Medical Research has come a long way since its establishment in 2014. With its acceptance of a wide range of articles, it stands the journal in good stead as a general medical journal with a military slant, standing out uniquely by discussing topics not be frequently seen in other conventional medical research journals, which can bring interesting insights and perspectives to various topics. Only with continued support by clinicians, researchers, and scientists from all fields of medicine, can medical knowledge be freely shared and built upon one another, allowing the frontiers and boundaries of medicine to be stretched.

Abbreviations

APACHE: Acute physiology and chronic health evaluation; CBRE: Chemical, Biological, Radiological and Explosive; CNS: Central nervous system; COVID-19: Coronavirus disease 2019; CPG: Clinical practice guideline; CSR: Combat stress reaction; DCR: Damage control resuscitation; EHS: Exertional heat stroke; GLM: Granulomatous lobular mastitis; mtDNA: Mitochondrial DNA; PCR: Polymerase chain reaction; PRP: Platelet-rich plasma; PTSD: Post-traumatic stress disorder; RT-PCR: Reverse-transcription polymerase chain reaction; SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2; SOFA: Sequential organ failure assessment; TBI: Traumatic brain injury.

Acknowledgements

Not applicable.

Author contributions

DYW conceived and supervised the study. JJS and DYW reviewed the literature and wrote the paper. Both the authors critically reviewed the content of the manuscript and approved the final version.

Funding

Not applicable.

Availability of data and materials

Not applicable.

Declarations**Ethics approval and consent to participate**

Not applicable.

Consent for publication

Not applicable.

Competing interests

All authors declare that they have no competing interests.

Author details

¹Department of Otolaryngology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore. ²Infectious Diseases Translational Research Programme, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore.

Received: 17 May 2022 Accepted: 26 May 2022

Published online: 10 June 2022

References

- Zeng XT, Jin YH, Liu TZ, Chen FM, Ding DG, Fu M, et al. Clinical practice guideline for transurethral plasmakinetic resection of prostate for benign prostatic hyperplasia. *Mil Med Res.* 2022;9(1):14.
- Yuan QQ, Xiao SX, Farouk O, Du YT, Sheybani F, Tan QT, et al. Management of granulomatous lobular mastitis: an international multidisciplinary consensus. *Mil Med Res.* 2022;9(1):20.
- Military Medical Research available from: <https://mmrjournal.biomedcentral.com/articles/collections>
- Xu H, Turnquist HR, Hoffman R, Billiar TR. Role of the IL-33-ST2 axis in sepsis. *Mil Med Res.* 2017;4:3.
- Zhou FH, Song Q. Clinical trials comparing norepinephrine with vasopressin in patients with septic shock: a meta-analysis. *Mil Med Res.* 2014;1:6.
- Zhang YL. Organization and implementation of mass medical rescue after an earthquake. *Mil Med Res.* 2014;1:6.
- Mutafchyski VM, Popivanov GI, Kjossev KC. Medical aspects of terrorist bombings—a focus on DCS and DCR. *Mil Med Res.* 2014;1:13.
- Xie T, Liu XR, Chen GL, Qi L, Xu ZY, Liu XD. Development and application of triage and medical evacuation system for casualties at sea. *Mil Med Res.* 2014;1:12.
- Butler Jr FK, Hagmann J, Butler EG. Tactical combat casualty care in special operations. *Mil Med.* 1996;161 Suppl:3–16.
- Li HL, Tang WJ, Ma YK, Jia JM, Dang RL, Qiu EC. Emergency response to nuclear, biological and chemical incidents: challenges and countermeasures. *Mil Med Res.* 2015;2:19.
- Rump A, Eder S, Hermann C, Lamkowski A, Ostheim P, Abend M, et al. Estimation of radiation-induced health hazards from a “dirty bomb” attack with radiocesium under different assault and rescue conditions. *Mil Med Res.* 2021;8(1):65.
- Liu SY, Song JC, Mao HD, Zhao JB, Song Q; Expert Group of Heat Stroke Prevention and Treatment of the People’s Liberation Army, and People’s Liberation Army Professional Committee of Critical Care Medicine. Expert consensus on the diagnosis and treatment of heat stroke in China. *Mil Med Res.* 2020;7(1):1.
- Xia DM, Wang XR, Zhou PY, Ou TL, Su L, Xu SG. Research progress of heat stroke during 1989–2019: a bibliometric analysis. *Mil Med Res.* 2021;8(1):5.
- Ashworth ET, Cotter JD, Kilding AE. Methods for improving thermal tolerance in military personnel prior to deployment. *Mil Med Res.* 2020;7(1):58.
- Yang MM, Wang L, Zhang Y, Yuan R, Zhao Y, Hu J, et al. Establishment and effectiveness evaluation of a scoring system for exertional heat stroke by retrospective analysis. *Mil Med Res.* 2020;7(1):40.
- Jin HX, Teng Y, Dai J, Zhao XD; Members of the Emergency Medicine Committee of the People’s Liberation Army. Expert consensus on the prevention, diagnosis and treatment of cold injury in China, 2020. *Mil Med Res.* 2021;8(1):6.
- Kong LZ, Zhang RL, Hu SH, Lai JB. Military traumatic brain injury: a challenge straddling neurology and psychiatry. *Mil Med Res.* 2022;9(1):2.
- Solomon Z, Mikulincer M. Combat stress reactions, post traumatic stress disorder and somatic complaints among Israeli soldiers. *J Psychosom Res.* 1987;31(1):131–7.
- Mareth TR, Brooker AE. Combat stress reaction: a concept in evolution. *Mil Med.* 1985;150(4):186–90.
- Miao XR, Chen QB, Wei K, Tao KM, Lu ZJ. Posttraumatic stress disorder: from diagnosis to prevention. *Mil Med Res.* 2018;5(1):32.
- Boscarino JJ, Figley CR, Adams RE, Urosevich TG, Kirchner HL, Boscarino JA. Mental health status in veterans residing in rural versus non-rural areas: results from the veterans’ health study. *Mil Med Res.* 2020;7(1):44.
- Raza Z, Hussain SF, Ftouni S, Spitz G, Caplin N, Foster RG, et al. Dementia in military and veteran populations: a review of risk factors—traumatic brain injury, post-traumatic stress disorder, deployment, and sleep. *Mil Med Res.* 2021;8(1):55.
- Harrison EM, Easterling AP, Schmied EA, Hurtado SL, Glickman GL. Chronotype and self-reported sleep, alertness, and mental health in U.S. sailors. *Mil Med Res.* 2021;8(1):43.
- Baig MR, Beck RD, Wilson JL, Lemmer JA, Meraj A, Meyer EC, et al. Quetiapine augmentation of prolonged exposure therapy in veterans with PTSD and a history of mild traumatic brain injury: design and methodology of a pilot study. *Mil Med Res.* 2020;7(1):46.
- Yang DM, Geng TT, Harrison AG, Wang PH. Differential roles of RIG-I like receptors in SARS-CoV-2 infection. *Mil Med Res.* 2021;8(1):49.
- Zheng Y, Zhou LL, Su Y, Sun Q. Cell fusion in the pathogenesis of COVID-19. *Mil Med Res.* 2021;8(1):68.
- Pang NY, Pang AS, Chow VT, Wang DY. Understanding neutralising antibodies against SARS-CoV-2 and their implications in clinical practice. *Mil Med Res.* 2021;8(1):47.
- Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak—an update on the status. *Mil Med Res.* 2020;7(1):11.
- Song JC, Wang G, Zhang W, Zhang Y, Li WQ, Zhou Z. Chinese expert consensus on diagnosis and treatment of coagulation dysfunction in COVID-19. *Mil Med Res.* 2020;7(1):19.
- Wang Q, Zhao H, Liu LG, Wang YB, Zhang T, Li MH, et al. Pattern of liver injury in adult patients with COVID-19: a retrospective analysis of 105 patients. *Mil Med Res.* 2020;7(1):28.
- Luo X, Zhou GZ, Zhang Y, Peng LH, Zou LP, Yang YS. Coronaviruses and gastrointestinal diseases. *Mil Med Res.* 2020;7(1):49.
- Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet.* 2020;395(10223):507–13.
- Fang D, Ma J, Guan J, Wang M, Song Y, Tian D, et al. Manifestations of digestive system of hospitalized patients with coronavirus disease 2019 in Wuhan China: a single-center descriptive study. *Chin J Dig.* 2020;40(3):151–6. [Article in Chinese]

34. Zhang H, Kang Z, Gong H, Xu D, Wang J, Li Z, et al. Digestive system is a potential route of COVID-19: an analysis of single-cell coexpression pattern of key proteins in viral entry process. *Gut*. 2020;69:1010–8.
35. Li JH, Sun Y, Li MR, Yuan H, Yang CL, Huang CC, et al. A cross-sectional study of olfactory and taste disorders among COVID-19 patients in China. *Mil Med Res*. 2021;8(1):51.
36. Yang Y, Zhu XF, Huang J, Chen C, Zheng Y, He W, et al. Nomogram for prediction of fatal outcome in patients with severe COVID-19: a multicenter study. *Mil Med Res*. 2021;8(1):21.
37. Zhou TT, Wei FX. Primary stratification and identification of suspected Corona virus disease 2019 (COVID-19) from clinical perspective by a simple scoring proposal. *Mil Med Res*. 2020;7(1):16.
38. Wu Y, Wang XH, Li XH, Song LY, Yu SL, Fang ZC, et al. Common mtDNA variations at C5178a and A249d/T6392C/G10310A decrease the risk of severe COVID-19 in a Han Chinese population from Central China. *Mil Med Res*. 2021;8(1):57.
39. Xu X, Ong YK, Wang DY. Role of adjunctive treatment strategies in COVID-19 and a review of international and national clinical guidelines. *Mil Med Res*. 2020;7(1):22.
40. Peng XL, Cheng JS, Gong HL, Yuan MD, Zhao XH, Li Z, et al. Advances in the design and development of SARS-CoV-2 vaccines. *Mil Med Res*. 2021;8(1):67.
41. Adedokun KA. Early stage nonclinical pulmonary disorder in COVID-19 may present asymptomatic and fuel the contagion. *Mil Med Res*. 2021;8(1):22.
42. Zhang X, Han MN, Dong JH, Li XX, Hu XY, Wang Z, et al. Outbreak of *Mycoplasma pneumoniae* at a military academy. *Mil Med Res*. 2020;7(1):60.
43. Dutton LK, Rhee PC, Shin AY, Ehrlichman RJ, Shemin RJ. Combating an invisible enemy: the American military response to global pandemics. *Mil Med Res*. 2021;8(1):11.
44. Ho ZJ, Hwang YF, Lee JM. Emerging and re-emerging infectious diseases: challenges and opportunities for militaries. *Mil Med Res*. 2014;1:21.
45. Wang X, Du J, Zhuang Z, Wang ZG, Jiang JX, Yang C. Incidence, casualties and risk characteristics of civilian explosion blast injury in China: 2000–2017 data from the state administration of work safety. *Mil Med Res*. 2020;7(1):29.
46. Fu XB. Repair cell first, then regenerate the tissues and organs. *Mil Med Res*. 2021;8(1):2.
47. Wei S, Wang W, Li L, Meng HY, Feng CZ, Dong YY, et al. Recombinant human epidermal growth factor combined with vacuum sealing drainage for wound healing in Bama pigs. *Mil Med Res*. 2021;8(1):18.
48. Yang X, Guo JL, Han J, Si RJ, Liu PP, Zhang ZR, et al. Chitosan hydrogel encapsulated with LL-37 peptide promotes deep tissue injury healing in a mouse model. *Mil Med Res*. 2020;7(1):20.
49. Kaltenborn A, Krezdorn N, Hoffmann S, Gutcke A, Haastert-Talini K, Vogt PM, et al. Ex vivo limb perfusion for traumatic amputation in military medicine. *Mil Med Res*. 2020;7(1):21.
50. Wang K, Sun SL, Wang XY, Chu CN, Duan ZH, Yang C, et al. Bioelectrical impedance analysis-guided fluid management promotes primary fascial closure after open abdomen: a randomized controlled trial. *Mil Med Res*. 2021;8(1):36.
51. Xu PC, Xuan M, Cheng B. Effects and mechanism of platelet-rich plasma on military drill injury: a review. *Mil Med Res*. 2020;7(1):56.
52. Mathieu L, Plang S, de l'Escalopier N, Murison JC, Gaillard C, Bertani A, et al. Soft tissue coverage using pedicled flap in combat zone: a case series. *Mil Med Res*. 2020;7:51.
53. Zhang W, Wang L, Sun XH, Liu X, Xiao Y, Zhang J, et al. Toll-like receptor 5-mediated signaling enhances liver regeneration in mice. *Mil Med Res*. 2021;8(1):5.
54. Bilgiç T, Ince Ü, Narter F. Autologous omentum transposition for regeneration of a renal injury model in rats. *Mil Med Res*. 2022;9(1):1.
55. Nagappan PG, Chen H, Wang DY. Neuroregeneration and plasticity: a review of the physiological mechanisms for achieving functional recovery postinjury. *Mil Med Res*. 2020;7(1):30.
56. Wang Y, Lv HQ, Chao X, Xu WX, Liu Y, Ling GX, et al. Multimodal therapy strategies based on hydrogels for the repair of spinal cord injury. *Mil Med Res*. 2022;9(1):16.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

