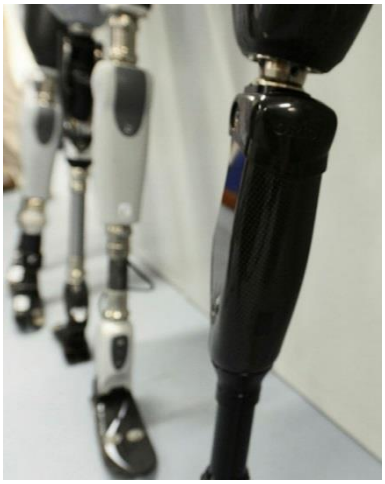
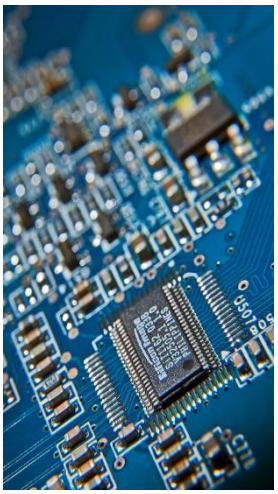
Strategic Command

Headquarters Defence Medical Services Group





Avoiding the Walker Dip: A Strategic Delivery Plan for DMS Research 2021-26

i) Abbreviations

CBRN	Chemical-Biological-Radiological-Nuclear
CCC	Combat Casualty Care
DASA	Defence and Security Accelerator
DHE	Defence Healthcare Engagement
DLOD	Defence Lines of Development
DMS	Defence Medical Services
DMSRSG	Defence Medical Services Research Steering Group
DST	Defence Science & Technology
DSTL	Defence Science & Technology Laboratory
FLC	Front Line Command
HD	Higher Degree
KCL	Kings College London
MOD	Ministry of Defence
MSKI	Musculoskeletal injury
NFCI	Non-Freezing Cold Injury
NIHR	National Institute for Health Research
PTSD	Post Traumatic Stress Disorder
RCI	Research & Clinical Innovation
REDCap	Research Electronic Data Capture System
RDAWG	Research Defence Academic Working Group
SDP 21	Strategic Delivery Plan for DMS Research 2021-26
TBI	Traumatic Brain Injury
TRL	Technology Readiness Level

1. Foreword

History confirms that medicine advances in war and conflict, but between conflicts there is the potential that military medicine regresses through a lack of research or disinvestment. This has been described objectively as the 'Walker Dip'.[1] Paradoxically, the very time for research is between major conflicts to ensure that Defence is effectively positioned to predict and be responsive to the next threats.

Through consultation with key stakeholders, and in particular our Front Line Commands, this Research Strategic Delivery Plan for the next five years describes the objective methodology to set our new priorities, aligned to the needs to support evidence-based clinical capability development. It also sets out how the strategy is aligned to the available finite resource considerations, including how we will increasingly lever external funding to optimise public value for money while meeting our research ambitions.

The strategy builds on the successful iconic representation of DMS research from 2014, which was refreshed in 2017. This is the 'Research Tree'. Six themes have been identified as the principal 'branches' of research activity, which are non-hierarchical and are integrated across multidisciplinary academic departmental domains. These are optimising **mental health**; preventing and treating **musculoskeletal injury** (MSKI); delivering a workforce that is "**ready and able**"; tackling **endemic, epidemic & environmental** threats; **closing the sophistication gap**; and **combat casualty care** (CCC) to stretch the envelope of injury management far forward.

Anticipating the emerging threats in the future operating environment, or at the very least retaining the agility to rapidly adapt to these if they emerge unexpectedly, is what will create our future advantage. Yet this depends on effective translation of the research outputs to implement changes in clinical process, practice, guidelines, equipment and training. How the research findings are disseminated and how impact is measured is a key component of the revised strategy, which describes these effects within a strengthened military medical research ecosystem. It is through better proving benefit that we can more effectively compete for future financial support. Separately, our proven continuous clinical quality improvement is central to sustaining an innovative environment that encourages both recruitment and retention, and demonstrates our reliability as a military ally.

I commend this revised, insightful, targeted research strategy as a realistic framework on which to plan our military medical capability development.

Major General TJ Hodgetts CBE QHS OStJ
Surgeon General

[1] Walker AJ. The 'Walker Dip'. JRNMS 2018:104(3) http://dx.dpi.org/10.1136/jrnms-104-173

2. Introduction

Continuous innovation is essential to prevent the cyclical stagnation and regression of military medicine between conflicts, which has repeatedly demonstrated through history an intellectual deficit to be repaid in the lives of Service Personnel at the start of every major campaign

DMS Medical Director, 2014

Investment in cutting-edge research is crucial for Defence Medical Services (DMS) to retain its position as a world leader in military healthcare. The DMS Research Strategic Delivery Plan 2021 (SDP 21) is the second comprehensive review of research strategy undertaken since the conclusion of combat operations on Op HERRICK. As with the 2014 review, avoiding the 'Walker Dip' by ensuring that the DMS are optimally placed to deliver the highest quality evidence-based care to those in our care is at the centre of the strategy.

The 2014 review involved wide consultation with internal and external stakeholders and gave life to the iconic Research Tree (fig. 1) that has guided DMS research efforts for the past seven years[2].

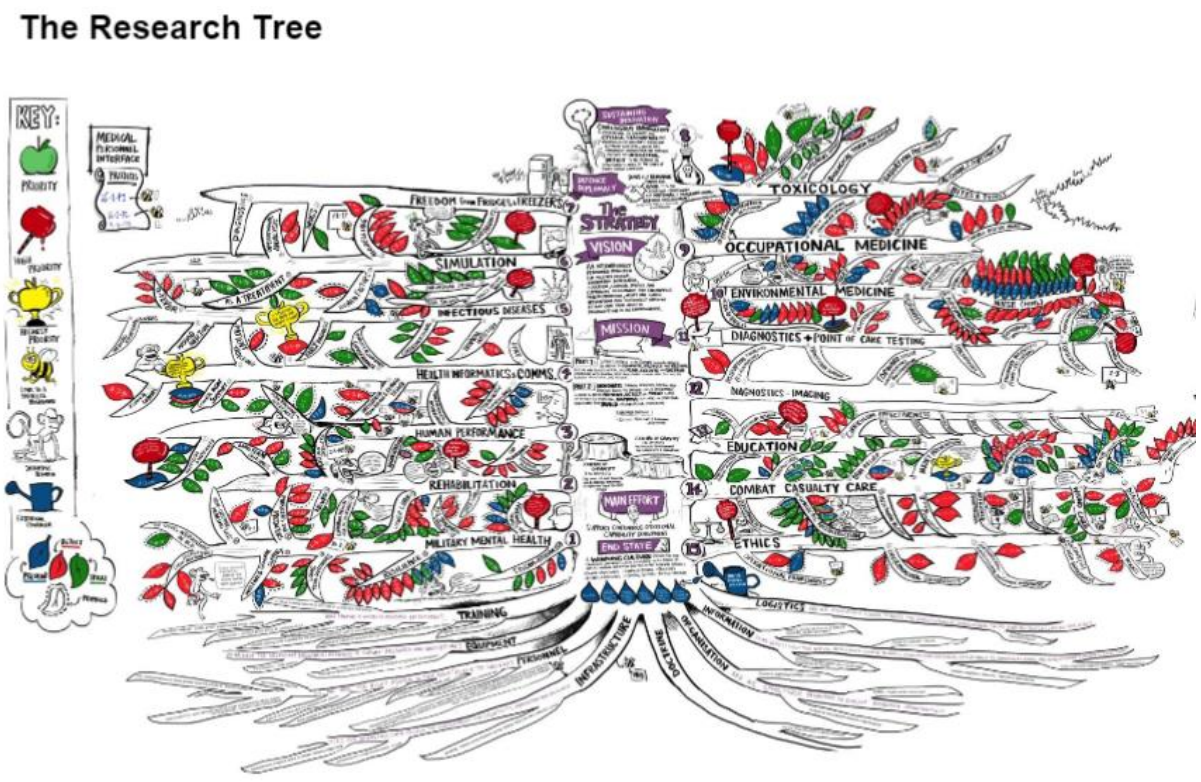


Figure 1. The Research Tree

The Tree is structured as follows:

- Roots: the internal conditions to promote research and innovation in Defence medicine along the Defence Lines of Development (DLOD): training, equipment, personnel, information, doctrine, organisation, infrastructure, logistics.

[2] Hodgetts T, Mahoney P. Deconstructing complexity: an innovative strategy for military medical research. *J R Army Med Corps* 2016;162(2):82-4. doi: 10.1136/jramc-2015-000514

- Trunk: the core strategy and overall direction including the vision and mission highlighted below.
- Branches: the research domains that reflected collective opinion of where effort should be focused: mental health, rehabilitation, human performance, health informatics and communications, infectious diseases, simulation, freedom from fridges and freezers, toxicology, occupational medicine, environmental medicine, diagnostics and point-of-care testing, diagnostics and imaging, education, combat casualty care, ethics.
- Leaves: individual research projects that should be pursued (blue = prevent, red = detect, green = treat).

SDP 21 does not seek to grow a new tree but it does go beyond a simple refresh of priorities as occurred in 2017. Priority research topics for the coming years will be highlighted under research themes but attention is also paid to underlying research capability (specifically the DLOD tree roots of training, infrastructure, and organisation) and the way in which research impact is promoted, captured and disseminated (the DLOD information root).

The Vision and Mission remain constant:

Vision: An internationally renowned organisation for military medical innovation in research, education, clinical practice and capability development that encompasses health promotion, injury and illness prevention and continually improving patient care from insult to rehabilitation in all environments.

Mission (part 2): Innovate through invention, adoption and analysis across the defence lines of development in order to better prevent, detect and treat illness or injury on operations, improve outcomes in operational healthcare and build organisational reputation.

2.1. Strengthening the research ecosystem

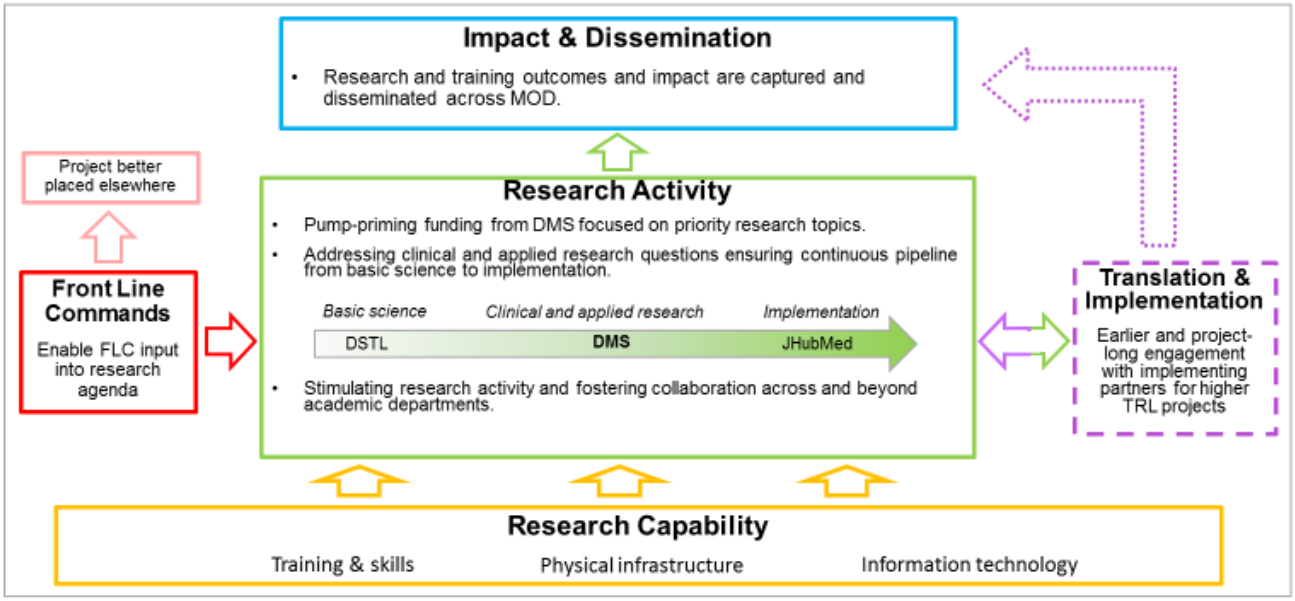


Figure 2. The DMS Research ecosystem

Fig 2 introduces the concept of the DMS Research ecosystem.

For research to flourish it must be underpinned by the right capability (Chapter 4. Enabling Innovation). There must be a cadre of clinicians, scientists, and allied health professionals that are suitably skilled to lead and conduct research. The available physical infrastructure must permit the timely and safe collection, storage, and exploitation of research material. Digital Infrastructure must support the capture of consistent, high-quality data as well as supporting the dissemination of research.

For research to have impact it must be informed by the needs of the end-user, providing operational and firm base benefit to Front Line Commands (FLCs). The process through which DMS research projects are conceptualised and assessed must enable this FLC input. Similarly, information must flow left-to-right along the translation pipeline so that implementing partners are engaged from the outset in higher technology readiness level (TRL) projects. To foster better connectivity across the research ecosystem, working groups will be established under each of the research themes outlined in Chapter 3 to cohere relevant research and deliver effective collaborations across services and departments.

Finally, funding for research is finite. For DMS Research and Clinical Innovation (RCI) to continue to justify its research budget allocation it must be proactive in facilitating clinical impact and forthright in communicating the impact its research is having. Chapter 5. Research Impact focuses on increased synergy with RCI Implementation, better reporting of research outcomes from award holders to RCI, including longer-term follow-up of higher degree students, and better showcasing of impact by RCI to the wider MOD community. Because of the finite funding available we must make our own processes for supporting research as agile as possible and build stronger bridges with internal and external funding agencies. This includes improving links to the Defence and Security Accelerator (DASA), National Institute for Health Research (NIHR), charitable foundations, and Research Councils under UK Research and Innovation.

3. Research Priorities

3.1. Prioritisation methodology

Stakeholders from across DMS, FLCs, DST/Dstl, Scientific Advisors, and academic institutions were engaged through an online survey. Each stakeholder was asked to suggest up to five priority research topics under the following headings: prevention, acute care, management of disease and rehabilitation. The request for research topics rather than specific research questions was deliberate in order to allow ongoing academic agility to address emerging questions under priority topics over the next five years.

52 responses were received with 383 topic suggestions. The number of individuals who fed into the prioritisation exercise is likely much higher as many of the 52 responses were devised following consultation with, and submitted on behalf of, academic cadres.

3.1.1. Aggregation into research themes and priority topics

The goal of the prioritisation exercise was to devise 5-6 overarching research themes under which priority topics would sit. To get to theme level a series of stepwise aggregations were conducted:

1. Suggestions were aggregated within each of the five headings to create **low-level topics**. For example, under prevention ‘supplementation to avoid heat injury’ and ‘individual susceptibility to heat exhaustion’ were combined under ‘heat’.
2. Low-level topics were aggregated where significant similarities existed to create **mid-level topics**. For example, under prevention ‘heat’, ‘vibration’, ‘noise’, ‘cold’, and ‘altitude’ were combined into ‘prevention of environmental insult’.
3. **High-level topics** were created by aggregating mid-level topics across the five headings. For example, ‘prevention of environmental insult’ was combined with ‘treatment of environmental insult’ and ‘rehabilitation following environmental insult’ to create an ‘environmental medicine’ topic.
4. Finally, if a high-level topic was deemed sufficiently broad and descriptive it was classed as a **research theme**, e.g., ‘mental health’. If value could be added by combining high-level topics this was done, e.g., ‘environmental medicine’ and ‘infectious disease’ were combined to create an ‘endemic, epidemic, and environmental’ theme given the close links between infectious disease and adverse environmental conditions and the collaborations this would encourage. The most frequently suggested and strategically important mid-level topics from step 2 were used as initial priority topics under the final research themes.

The aggregation process and outcomes were reviewed and ratified by the DMS Research Academic Working Group in September 2021.

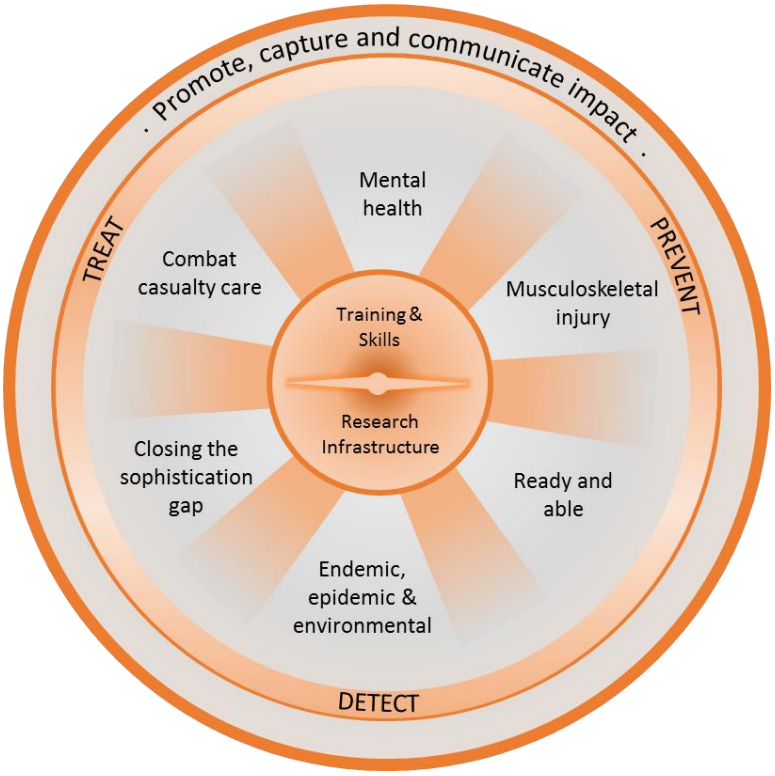


Figure 3. Research priorities underpinned by strengthened capability and imperative to capture and communicate research impact

The six priority research themes are depicted in Figure 3:

- Optimising **mental health**
- Preventing and treating **musculoskeletal injury** (MSKI)
- Delivering a workforce that is "**ready and able**"
- Tackling **endemic, epidemic & environmental** threats
- **Closing the sophistication gap**
- **Combat casualty care** (CCC) – pushing the envelope of care far forward

Many of the research themes align with priority questions specified by the Research Tree and 2017 prioritisation exercise. This is not surprising given the enduring nature of the challenges faced within each theme. Only through persistence and continued strategic alignment of effort will clinical impact be achieved.

The themes play to existing strengths of the DMS research portfolio, including the CCC programme, MSKI and environmental medicine, whilst also stimulating and reorienting research in other areas such as training and deployment suitability and mental health intervention.

Most importantly, the research themes are relevant now and in future:

i. Closing the sophistication gap speaks to an ambition to exploit technological advance to uplift the medical capability of smaller, lighter and more agile units projected far forward into austere environments to match that of higher roles;

ii. The Covid-19 pandemic and the UK's withdrawal from Afghanistan are likely to have lasting and severe impacts on the mental health of service personnel;
iii. The deployment of service personnel to harsh climates e.g. West Africa is likely to continue;
iv. the general physical fitness of the service recruitment pool is likely to reduce further, and;
v. different skill sets will be required in multi-domain conflict.

As with the Research Tree, prevention, detection, and treatment cut across themes and priority topics.

The themes and the priority topics are non-hierarchical – each is as important as the next – hence their circular depiction in Figure 3.

No single academic department or cadre owns any of the six themes. They are multidisciplinary by design and collaboration between clinicians, allied health professionals, laboratory scientists, public health experts etc. is needed to meet the challenges of the Future Operating Environment.

The following sections describe each of the research themes in more detail and suggest initial priority topics for investigation based on the prioritisation exercise. These topics will evolve over the period of SDP 21 and will flex in line with lessons learned on Operations fed back to the Defence Academic Working Group.

3.2. Mental Health

Box 1. Mental Health priority topics

- Novel intervention
- Mental health promotion strategies
- Recovery pathways and reintegration

The mental health of service personnel is of paramount importance both in the firm base and on operations. Current research within the UK Armed Forces suggests that the prevalence of common mental health disorder is 22%, post traumatic stress disorder (PTSD) is 6% and alcohol misuse is 10%. Operational stressors are known to contribute to this[3].

DMS has a strong portfolio of mental health epidemiology research, conducted in collaboration with international experts at Kings College London (KCL), that underpins occupational service evaluations. Whilst epidemiology is important, SDP 21 puts the

[3] Stevelink SA, Jones M, Hull L, Pernet D, MacCrimmon S, Goodwin L, Wessely, S, 2018. Mental health outcomes at the end of the British involvement in the Iraq and Afghanistan conflicts: a cohort study. *The British Journal of Psychiatry*, *213*(6), 690-697.

development and application of novel mental health interventions front and centre. This covers both the management of acute stress responses and chronic long-term conditions.

Mental health promotion, and equipping service personnel with the tools to identify when their mental health is at risk and when to seek help, can improve both health and functioning. The use of off the shelf prevention and intervention packages in the military context is particularly difficult; research should address the bespoke requirements for prevention and intervention that exist between FLCs and within their component parts.

Whilst most personnel thrive in the military environment a significant minority continue to experience poor mental health[4] or emotional challenge leading to moral injury and downstream mental health conditions. Support for these individuals could also be improved with a better understanding of the recovery phase, the risk of relapse and how to reintegrate them into their operational role. High-quality research is the only way to address these issues.

3.3. Musculoskeletal Injury

Box 2. MSKI priority topics

- Injury prevention and 'prehabilitation'
- Lower limb injury
- Shortened time to return to service
- Self-guided tech-enabled rehabilitation
- Physical-mental comorbidity

Almost half of all recruits will incur musculoskeletal injury (MSKI) during their initial military training, with lower limb injury the most frequent and associated with the longest rehabilitation time[5]. Better understanding of the patterns of injury associated with training and operations, the like of which will continue to be enabled via DMS investment in the ADVANCE longitudinal cohort, has opened the door to interventions targeting those injuries most costly in morbidity, training time, and resources. Developing 'prehabilitation' interventions for such injuries that go beyond pre-fitness test programmes is an urgent priority.

Likewise, once an individual incurs an MSKI, it is imperative that their time out of service is reduced. Shortened time to return has been shown not only to benefit operational capability, but also the mental health of the individual[6]. The facilities at the Academic Department of Military Rehabilitation, co-located with the Defence Medical Rehabilitation Centre, provide

[4] Chui, Z., Fear, N. T., Greenberg, N., Jones, N., Jones, E., & Goodwin, L. (2020). Combat exposure and co-occurring mental health problems in UK Armed Forces personnel. *Journal of Mental Health*, 1-10.
[5] Sharma J, Greeves JP, Byers M, Bennett AN, Spears IR, 2015. Musculoskeletal injuries in British Army recruits: a prospective study of diagnosis-specific incidence and rehabilitation times. *BMC Musculoskeletal Disorders 16, 106.*
[6] House of Commons Defence Committee, *Mental Health and the Armed Forces, Part One: The Scale of mental health issues* (HC). Eleventh Report of Session 2017–19, HC813.

world-leading infrastructure to facilitate research into the optimal frequency and intensity of rehabilitation to enable the quickest recovery from injury or critical illness.

A recurring priority of SDP 21 is the use of technology to promote and restore health. As with mental health interventions there are numerous off the shelf MSKI rehabilitation packages available but little evidence is available regarding effectiveness or adherence in military populations. Enabling effective self-guided MSKI prehabilitation and rehabilitation in the firm base and on operations should be a realistic near-term target.

There are substantial gaps in our knowledge of the prevalence and management of comorbid physical (predominantly MSKI) and mental health conditions. In order to treat the whole and not its component parts more must be done to close these gaps. Likewise research into the prevention and treatment of MSKI in servicewomen should continue to be pursued as a one-size-fits all approach is likely to be costly and ineffective.

3.4. Ready and Able

Box 3. Ready and Able priority topics

- Deployment suitability
- Lifestyle intervention
- Use of simulation for medical training

One priority topic that came through strongly in FLC responses was the need for research into factors affecting deployment suitability and how they can be assessed and mitigated. These factors range from physiological ones relevant to all deployable personnel e.g. is an individual particularly susceptible to environmental insult or living with an underlying mental health condition? – to competencies specific to a medical / clinical role e.g. does an individual possess the necessary medical skillset to perform a given task; do they possess appropriate non-clinical skills to thrive in teams with differing dynamics? Thus, deployment suitability is closely linked to the other two priority Ready and Able topics specified in Box 3 and also interfaces with Endemic, Epidemic, and Environmental, and Mental Health research themes.

An individual's lifestyle choices affect their health status in the here and now and have significant knock-on effects on immune health and susceptibility to injury. It is important that we better understand the drivers of unhealthy behaviours in both servicemen and women whether they relate to smoking, alcohol, oral health, sexual health, or diet and nutrition and the shift in behaviours that occurs when on operations versus in the firm base. Equally, we must develop more innovative ways of nudging service personnel towards healthier choices.

Skill fade outside of combat operations is an enduring challenge across clinical roles. The development of technological solutions that simulate realistic operational conditions represents the best method of mitigating skill fade and should be pursued as a priority.

Further, the very nature of traditionally defined clinical roles is under question due to a global shortage of suitably qualified personnel and a shift towards smaller, agile forward units (see 3.6 Closing the Sophistication Gap). Research has a key role to play in understanding how we develop individuals with more flexible skillsets and effectively break down established barriers between medical roles without jeopardising clinical care.

3.5. Endemic, Epidemic & Environmental

Box 4. Endemic, Epidemic & Environmental priority topics

- Diagnosis and treatment of infectious disease
- Individual susceptibility to environmental threats
- Treatment of heat illness and NFCI
- Reversal of hearing loss and injury due to whole body vibration

Recent deployments have seen service personnel placed in some of the most challenging environments on earth. Exposure to extreme temperatures, disease vectors, and infection caused by poor sanitation have led to significant morbidity.

Acute gastrointestinal disease is recognised as the most common illness of deploying soldiers on Op HERRICK affecting up to 40% of deployed personnel[7]. When infection due to airborne and vector borne diseases are added to the mix, often in combination with each other, the impact of infectious disease is multiplied further. Malaria, other undifferentiated febrile illnesses, respiratory viral infections, tuberculosis, bacterial skin infections & cutaneous leishmaniasis have all been a significant challenge for UK military personnel in recent years.

The diagnosis and treatment of infectious disease in deployed personnel is therefore a priority, especially in light of the growing threat of antimicrobial resistance. Meeting this challenge will require extensive input of DMS Pathology and engagement with the world-leading infectious diseases academic community within the UK.

The management of infectious disease outbreaks is often central to defence healthcare engagement (DHE) activities. DHE more broadly is a core activity that will continue to receive DMS investment to tackle emerging health threats, strengthen military health systems, and provide humanitarian relief. Better understanding of how to conduct effective and sustainable DHE, and how to evaluate its impact, is within the scope of SDP 21

The first step in reducing the burden of environmental insult is to understand what makes one individual susceptible to heat, cold, altitude, vibration, etc. whilst another is resilient to the conditions. Once this is understood the environmental threat can be mitigated by preparation, prophylaxis, rapid provision of pre-identified treatment, or deployment elsewhere.

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[7]Connor P, Hutley E, Mulcahy HE, Riddle MS, 2013. Enteric disease on Operation HERRICK. *J R Army Med Corps*, *159*(3): 229-236.

Previous years have seen advances in our understanding of the aetiology and pathology of heat and cold injury. The focus for the period of SDP 21 is on the prevention and treatment of heat injury and non-freezing cold injury (NFCI).

The hearWELL collaboration has set an example for the clinical impact that can be delivered when resources are aligned and the right research partners are engaged. As well as continuing to support hearWELL the ambition for the coming years is to mirror the progress obtained in noise induced hearing loss (NIHL) by coalescing research into the prevention and reversal of injury due to whole body vibration.

3.6. Closing the Sophistication Gap

Box 5. Closing the Sophistication Gap priority topics

- Telemedicine reach back and reach forward
- Rapid & rugged diagnostics
- Wearable tech / remote monitoring
- Blood, oxygen, imaging and pharmacy far forward

In line with the shift in Defence paradigm DMS will be increasingly active in smaller, agile, forward points of presence. As a result, fewer specialists will be in position, standard diagnostic and imaging equipment will be unavailable, and the resupply of medicines, blood products, and oxygen difficult. **The difference in achievable clinical outcome because of these far forward constraints versus fixed medical treatment facilities represents a sophistication gap that can only be closed through research-led innovation.** Progress in these areas will be achieved through close collaboration with Dstl and other partners working at earlier TRLs and innovation adopters, e.g., jHubMed. Wider collaboration shares the high risk inherent in 'generation after next investments' and brings with it an acceptance that many innovations will fail.

In forward positions junior medics should be able to communicate in real or near-real time with more senior specialists further back or in the UK to aid diagnosis and treatment decisions. The logical extension of this is to enable reach forward direction where senior clinicians can actively guide and control procedures at distance. Both reach back and reach forward technologies are already in limited use. The next step involves further refinement prior to demonstrating their clinical effectiveness on operations. Of course, technological advances are only part of the solution. We must also focus efforts on training military medics in a broader range of interventions than an individual clinician would typically experience when not on operations. There is clear overlap here with research topics under the delivery of a ready and able workforce outlined above.

The ability to diagnose (or indeed rule out) an important condition or identify undetected illness is the first step towards its successful treatment or the avoidance of unnecessary rearward evacuation. Diagnostic ability is even more crucial in forward positions with

increased distance to care. To close the sophistication gap research to develop rapid, sensitive, reliable, and portable diagnostics robust to environmental conditions is urgently needed.

The last decade has seen huge growth in the commercial wearable technology market. This has filtered through into numerous off the shelf products being promoted for use in the military. Simultaneously, multiple bespoke solutions have been developed in-house. The time has now arrived to choose the most promising wearable technologies – those that allow collection of the right signals at the right time, in a user-acceptable way – and to move forward at pace to the next stage of their development. In time this will allow the remote monitoring of personnel on forward operations and the ability to predict and pre-empt the onset of medical conditions or rapidly deploy specialist medical support.

Perhaps the most complex barrier to closing the sophistication gap is the provision of supporting infrastructure usually found in a fixed facility. As well as diagnostic capacity discussed above, this includes the supply of blood products and oxygen, CT imaging capability, and pharmacy provision. We can navigate around these barriers with logistical solutions – cold-chain storage innovations, drone re-supply etc. – or we can attempt to remove the barrier with product innovation – developing portable CT technology, utilising fresh whole blood, etc. More than any other priority topic, addressing these issues will require involvement across DMS, FLCs, Dstl and industry.

3.7. Combat Casualty Care

Box 6. Combat Casualty Care priority topics

- Prolonged field care
- Assessment and treatment of traumatic brain injury (TBI)
- Blast injury
- Effective pain relief

Blast and ballistic injury will continue to be a priority area for DMS research in conjunction with Dstl and key academic partners. Combat Casualty Care as a whole has significant overlap with the Closing the Sophistication Gap research theme but extends further up to medevac and role 4 provision. Here too, collaboration with partners working at earlier TRLs and those implementing innovation is key.

Prolonged field care[8] is in itself an umbrella priority with important sub-topics from the point of wounding (particularly when evacuation does not meet doctrinal timelines), through resuscitation, to surgery in resource-constrained environments and prolonged hold at all echelons. Some of the questions raised are purely biomedical in nature e.g., optimal fluid resuscitation strategies, analgesia and wound care whilst others necessitate involvement of

[8] Smith M, Johnston K, Withnall R, 2021. Systematic approach to delivering prolonged field care in a prehospital care environment, *BMJ Mil Health 167*(2): 93-98.

wider disciplines e.g., social science to understand small team clinical leadership, decision making, and team dynamics.

Recent investment in traumatic brain injury (TBI) research should yield results which will allow better prognostication in mild TBI through the identification of novel biomarkers. Future priorities include acute treatment of mild, moderate and severe TBI to reduce hours lost due to medical downgrade and risk of post-traumatic complications (e.g., epilepsy), and the assessment and treatment of closed head injury when access to imaging is limited.

In order to optimise long-term outcomes further research is required into the mechanisms of blast injury and effective surgical reconstruction following trauma, including the use of regenerative medicine techniques. Treatment of burns, Chemical, Biological, Radiological and Nuclear (CBRN) injury, and eye trauma warrant particular attention.

Finally, the ability to provide effective relief from both acute and chronic pain is a major research priority. Service personnel experiencing chronic pain are more likely to be medically discharged, less likely to engage and comply with rehabilitation regimes, and may continue to suffer long-term debilitation in civilian life[9].

[9] Vallerand AH, Cosler P, Henningfield JE, Galassini P, 2015. Pain management strategies and lessons from the military: A narrative review, *Pain Res Manag 20*(5): 261-268.

4. Enabling Innovation

The Research Tree was anchored by the Defence Lines of Development (DLODs) as its roots. Whilst the leaves have been well tended and substantial research progress has been made, the roots will continue to require regular attention. In order for the branches to remain strong and the leaves to flourish SDP 21 focuses on two areas of underlying research capability spanning the DLODs of training, infrastructure, and organisation.

4.1. Training and Skills

4.1.1. Military Medical Research Training

Across Defence there is a huge number of motivated and highly skilled individuals working in early-career clinical, allied health professional, and scientific services roles. This is the pool from which the future of Defence medical research will be drawn, and the onus is on DMS to nurture it as best we can. Many of these individuals will be interested in conducting research but feel they lack the skills to do so or the knowledge about who to talk to and where to begin their journey.

Within the period of SDP 21 RCI plans to establish a military medical research training course for aspiring researchers across all clinical, AHP and scientific roles including groups such as nurses, physiotherapists, occupational therapists, biomedical scientists, pharmacists, environmental health staff and radiographers.

The modular course will progress from introductory material, through research project design; data management and analysis; ethics, legal and regulatory processes; dissemination; and the conduct of research within MOD.

As well as taught learning, the course will offer access to an experienced mentor with first-hand experience of conducting military medical research.

4.1.2. Enabling access to the right expertise

Producing high-quality research relies on various areas of expertise. Some of these can be taught through modular teaching – research design, ethics, data management and analysis, etc. – and will be through the training course outlined in the previous section. Other aspects rely on specialist knowledge. It is unrealistic to expect an early career clinical academic to master health economic analysis or highly advanced statistics, for example.

To ensure the quality of the evidence generated by DMS researchers, access to individuals possessing specialist expertise must be enabled, even if this expertise is found outside of Defence.

It is an ambition of SDP 21 to prime a cadre of academics in relevant fields that are able to act as an *ad hoc* resource on a project-by-project basis.

4.2. Research Infrastructure

In the same way that producing high-quality research is impossible without individuals with the necessary skills, it also requires enabling physical and digital infrastructure.

4.2.1. Physical infrastructure

Despite the large number of patients that were treated at the Queen Elizabeth Hospital Birmingham following repatriation from Iraq and Afghanistan no tissue samples (including soft tissue, bone and blood) were collected during initial wound surgery for future research use.

Such samples are crucial for understanding trauma patterns and developing novel treatments. In recent years substantial amounts of research funding have been allocated to create models and simulations to investigate high-energy conflict wounds in lieu of available human tissue.

Within the period of SDP 21 it is RCI's ambition to establish a research biobank for the processing and storage of human tissue samples. The hope is that having ready availability of human tissue will expedite combat casualty care research and substantially reduce resource costs in the long term.

4.2.2. Digital infrastructure

In 2021, DMS Research Steering Group (DMSRSG) endorsed the continued use of the Research Electronic Data Capture (REDCap) system for operational data collection. REDCap enables consistent data entry and allows the collection of data offline for upload when an internet connection can be made. DMS have also provided funding for REDCap project support from the University of Birmingham. In the same way that the research biobank discussed above can futureproof combat casualty care research, the systematic collection of data in a consistent and exportable format will enable future researchers to address research questions that are yet to emerge. Similarly, better use should be made of the data resources already available through Defence Statistic Health (e.g. Joint Theatre Trauma Registry).

Box 7. Digital infrastructure ambitions

- Continue to support REDCap usage for operational data collection.
- Develop and implement a searchable medical research registry and collaborative research forum
- Ensure CORTISONE facilitates the use of routine data for research

There is a vast amount of medical research happening across MOD. Whilst clearly a good thing, we must also guard against redundancy of effort and ensure potential collaborators have visibility of work being undertaken in their field. To meet these needs, over the period of SDP 21 RCI will work with colleagues across Defence to implement a searchable registry of medical research activity and establish a Defence Medical Research Forum which brings together all of those conducting medical research on a regular basis to create an all-informed collaborative network.

RCI is also engaged in Project CORTISONE as the research benefit owner. RCI will use this engagement as an opportunity to shape CORTISONE functionality to meet the needs of the research community, e.g., improved epidemiological data, better tracking of patient outcomes through the care pathway.

5. Research Impact

5.1. Promoting impact

Through the twin pillars of Research and Implementation, DMS RCI is ideally structured to support researchers moving through the innovation pipeline towards clinical impact. Over the period of SDP 21 we will endeavour to put processes in place that make best use of this structure. This includes early contact between Implementation, jHubMed, and DMSRSG endorsees to determine which projects would benefit from input and mentorship from Implementation personnel. Earlier visibility of projects by jHubMed would help align research projects with innovation priorities, allow jHubMed to identify projects needing support, and put researchers in touch with jHubMed's extensive network of contacts in the relevant field. The extent of Implementation and jHubMed input would be decided on a project-by-project basis, but in all cases it would allow the researchers to maintain ownership of their outputs, receive the support they need to put these in the hands of the user, and positively impact patient care. A full description of the Research-Implementation interface can be found in the RCI Implementation Plan and the proposed Implementation and Innovation Strategy.

5.2. Capturing Impact

Capturing research outcomes is key to maintaining oversight of the DMS portfolio, enabling reporting to budget holders, reducing redundancy of research effort, and ultimately demonstrating that projects are producing clinical impact. It also allows effective evaluation of DMS research funding: If project outcomes are shown to lead to clinical impact, either in the near- or long-term, it suggests that DMS' structures and criteria for endorsing research are the right ones.

To enable better capture of research outcomes all DMS endorsed research projects will be required to complete project completion reports within three months of ending. These reports will focus on the 'so what?' questions: What were the main findings of the project? How will the outcomes lead to benefits to: servicemen and women (i.e. clinical care); Defence (e.g., built capacity, stronger relationships, wider engagement, IPR, etc.); and research team personnel (e.g., training received, skills developed, recognition earned, etc.)? How have the outcomes of the research been shared? What happens next? What questions remain outstanding?

Higher degree (HD) student projects endorsed by DMS will also be subject to a greater level of reporting. In addition to the project completion form, HD students will also be required to submit annual progress reports to i) keep RCI updated and, ii) develop skills in concise writing guided by JSP101 The Defence Writing Guide. It is also important that RCI can track the long-term impact of HD training on the individual's personal development and career trajectory. For this reason, a two-year follow-up report will be required approx. 48 months after award of the degree. All HD reports will be shared with the Defence Academy so they are equally informed.

It is also important we capture the academic impact of DMS research so we know how it has contributed to the wider literature that might one day translate into clinical impact. We will work closely with the Defence Medical Library to identify the most appropriate metrics that signal academic impact.

5.3. Communicating Impact

Once captured it is important that the impact of DMS research is communicated as widely as possible, not just through journal publications and conference proceedings. This has the dual benefit of alerting members of the Defence and academic communities to uptake opportunities and avenues for collaboration as well as demonstrating the value of DMS research up the Chain of Command.

DMS Research needs a more effective online presence. To this end a new outward facing MODNET website is being developed for users to engage with DMS Research. The plan is for part of this site to interface with the research registry discussed in 4.2.2. Digital Infrastructure whilst another part takes a case study approach to highlight recent impactful projects in more detail. Working closely with the Defence Medical Library should also allow links to online publications to be made available.

Although DMS has some social media presence it has been dormant for a long period. Re-energising social media output should help approved publications reach a larger audience within and outside of Defence.

Finally, the working groups established under each research theme will be encouraged to showcase their research programmes at Defence Medical Research Forum attended by stakeholders from Defence and academia.

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