OUTBACK AUSTRALIA

EMERGENCY CARE AT THE EXTREMES OF ACCESS

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One of the biggest challenges of any expedition or team travel to off-the-beaten-track locations, is the fact that you are far away from any comprehensive medical care. It is tempting to believe that this may be an insurmountable barrier to high quality medical support of remote groups. However, in adversity often comes opportunity. If we are willing to expand our horizons or think outside the box, it is possible to learn from other medical specialities. This article presents some alternative approaches to overcoming problems in rural and remote medicine that have been used in remote areas of Australia that may be applicable to expedition and sports medicine.

BARRIERS TO EMERGENCY CARE ACCESS IN REMOTE AUSTRALIA

Australia is home to some 26 million people, with the majority of residents living within 2-3 hours of the coast. Rural, regional and remote Australia consists of those areas that lie outside the major capital cities, and comprises over 8 million people (around a third of the total population) living on about 98% of the Australian landmass.

Illness and injury for remote Australians can range in acuity from minor to critical – and the more severe the injury, the more that availability of highly skilled emergency care services matters. The literature tells us that the health of regional Australians is poorer than their city counterparts, they die at a younger age, carry a higher burden of chronic disease, and have less access to (and are less likely to seek) medical services. There are three major barriers to acute care for severe illness or injury - distribution of high acuity emergency/ICU beds, distance to critical care services, and access to appropriate emergency clinicians.

DISTRIBUTION OF CRITICAL CARE BEDS

The availability of inpatient critical care beds can be thought of as a proxy for overall high acuity health facility access in a region. While both urban and regional centres in Australia have ambulance and emergency healthcare facilities, these services become sparse in remote areas. Australia's geography lends itself to a "hub and spoke" pattern of critical care services to mostly coastal urban centres where population density is highest (Figure 1).

While 151 Australian ICUs are in metropolitan areas, only 38 of these are in rural/regional areas. This indicates that communities in rural and remote areas have markedly less access to, not only critical care, but also to inpatient and specialty care in general.

Thus novel approaches to access are crucial to ensure there is a quality of medical care to these communities, lessons from which can be used on expeditions or if traveling with teams to remote and out-of-the-way parts of the world.

DISTANCE

Distances in Australia are enormous. It is a vast continent – the whole of Europe would easily fit in its landmass. This has a huge impact on medical care.

For example, in the central Australian corridor, a patient living equidistant between tertiary care centres across the Northern Territory and South Australia will have to either travel up to 750km, or wait for urgent emergency care to arrive by air from the same distance (Figure 3). A Western Australian study similarly found that aeromedical patients had an average retrieval distance of 700 km per mission. Similarly, a review of patients flown in Queensland from 1994-2006 showed 6% of aeromedical patients from primary scenes had critical clinical conditions, with trauma accounting for 77% of primary retrievals direct from remote locations.

With these distances, remote volunteers, clinic and regional hospital staff are often required to care for very unwell patients

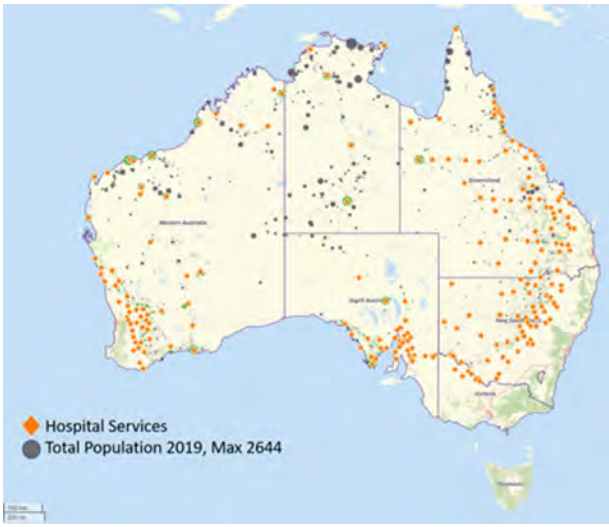

Figure 1: Distribution of regional / remote hospital services (left, image c/o Royal Flying Doctors' Service) compared with the "hub and spoke" of burn care in Australia and New Zealand (figure based on information from https://anzba.org.au/care/burn-units).

Figure 2: The size of Australia compared to Europe.

Figure 3: ICU beds (orange dots) in Central Australia (source: Royal Flying Doctor Service of Australia).

until an aeromedical retrieval e team arrives at a remote location or they are able to be transferred from a clinic or community facility to secondary or tertiary care via aeromedical retrieval. This results in inevitable delays to definitive imaging, diagnosis and care, due to both the distances involved and compounding factors of aeromedical logistics, resource availability and weather conditions.

This remoteness mirrors the isolation felt whilst on an expedition - trauma is also the most common reason for medevac on expeditions, and unreliable communication is also a concern. What lessons learned can be adopted by expedition and sports medicine practitioners in similar settings, far from definitive care?

ACCESS TO EMERGENCY CLINICIANS

It is difficult to attract and retain doctors, nurses and other clinicians in remote and rural settings in which expression of full scope of practice is often limited by lack of volume. Additionally, prehospital road ambulance services may not be available in rural and remote communities at all, thus initial clinical interventions in Australia may be commenced by:

- **Laypersons on scene** – this is most likely for remote agricultural properties and small communities without a sufficient population base to host permanent emergency services. These laypersons may or may not have first aid training.
- **Trained volunteers** – emergency services – fire or police, with basic life support and first aid training. Small communities may have a country fire service or state funded police services who are trained first responders for especially road accidents.
- **Trained volunteers – health responders** – volunteers may be trained as first responders by state ambulance services as part of a regional or remote network. Volunteers may also be permanent community residents or community leaders trained by the Royal Flying Doctor Service to provide first aid, BLS and to give, under medical direction, hospital-grade medications via oral or IM routes.
- **Remote area nurses/community paramedics / mine site paramedics** – trained practitioners with both primary care and prehospital emergency training, but without critical care resources or support
- **Non-critical care doctors** – mid-size communities may have a local General Practitioners (GPs, or Family Medicine Doctors) with additional expertise in emergency care, known as Rural Generalists (RGs). Such doctors may have access to a small community hospital to which they respond in case of emergency. There are networks of rural and remote RGs who also are part

of rural first responder networks, with additional prehospital training.

- Specialist GPs - Additional subspecialty skills may be held by GP-Obstetricians, providing additional support for obstetric, gynaecological and neonatal patients, and GP-surgeons who provide surgical support within their defined scope of practice. Regional and remote surgery is also supported by the development and implementation of the Diploma of Rural Generalist Anaesthesia (DRGA) by the tripartite colleges Australasian College of Rural and Remote Medicine (ACRRM), Royal Australasian College of General Practitioners (RACGP) and Australian and New Zealand College of Anaesthetists (ANZCA). This unique program equips doctors with a focussed set of anaesthetic skills through a formal training program and certification. Rural General Anaesthetists (RGAs) are employed in areas of need in rural and remote Australia, both hospital-based and based with aeromedical organisations as retrieval doctors.

These volunteers and broadly scoped clinicians are often required to care for remote patients, supported via telehealth advice, until a critical care retrieval team arrives, or until the patient's condition improves sufficiently to remain at their current location.

INNOVATION IN PROCESSES, PEOPLE AND PLATFORMS - HOW DO WE BRIDGE THE GAP? (OR: "IT'S MORE THAN JUST TECH")

In order to overcome distribution, distance and access gaps, bridging the emergency care gap for remote Australians requires thinking about service delivery in new ways. This may involve combining elements of care together in new ways, facilitated by emerging technologies; reconsidering clinical models of care and training workforces in new ways that reflect case distribution of local areas, or remote response outside of traditional road, rotary and fixed wing services for populations who may be difficult to access due to distance, geography or environmental factors.

PROCESSES

In outback Australia, there are many small communities that lack a population size sufficient to support full time health professionals, let alone full time emergency care services. While organisations like the Royal Flying Doctor Service (RFDS) deliver telehealth, fly-in primary and allied healthcare clinics, emergency medication kits (medical chests) and retrieval services to many of these communities, the question remains: how can hospital grade emergency care be provided to these communities when emergencies occur, immediately, when there are no local resources to activate?

As a first step, embracing the commercial market's approach to healthcare is crucial, as our populations will usually readily accept new technology. Some of the most difficult information to get from patients on a telehealth consult can be pulse oximetry, breath sounds and 12-lead ECG. As personal devices like Fitbits and Oura rings are expanding their diagnostic capability, it makes sense for the healthcare fraternity to integrate wearable tech into processes, rather than try to develop and rollout specific health care devices. As personal devices increase in accuracy and availability, it is not unreasonable to expect that laypeople will have access to digital stethoscopes and 12-lead ECGs in addition to the now somewhat ubiquitous heart rate and blood pressure home monitors.

These personalised wearable medical instruments, helping in diagnosis in remote care, can be used on expeditions and teams in remote settings – they are small, robust and can be stored in medical kits, remembering that they have an internal battery and need to be charged, so backup battery consideration is essential.

The evolution of unstaffed telehealth kiosks and pharmaceutical vending services has increased significantly in recent years. This concept was the inspiration for the design and development of the RFDS Virtual Emergency Centre (VEC) in William Creek, South Australia which opened in March 2024.

This small outback community with a population of around 17 people hosts up to 26,000 tourists along the Oodndatta track every year, and to support the community, the RFDS has provided fly-in primary care and dental clinics over many years. These clinics were set up by the local publican in a donga (transportable bedroom). When a more permanent clinic was built, the design ensured incorporation of not just primary care and oral health clinic facilities, but an additional telehealth kiosk plus an emergency treatment bay to care for emergencies.

The Virtual Emergency Centre, commenced a new service delivery model: an unstaffed, fully equipped emergency department led entirely remotely. With emergency signage, arriving patients are directed to:

- Press a doorbell, connected to the RFDS

Figure 4: William Creek, aerial view (image credit: flyingtheoutback.com.au).

Figure 5: Arabana Traditional Owners, community members, and RFDS stakeholders at the opening of the William Creek health hub. (Image: RFDS).

operations team hundreds of kilometres away. Upon seeing the patient via CCTV, the operations team communicates with the patient via intercom to determine their needs, buzzes them into a secure telehealth kiosk, and notifies the doctor that there is a patient to be seen. A first aid kit and AED are accessible for immediate use if required.

- The patient sits down, and the doctor appears on a screen in front on them, determines their presenting complaint, and instructs them how to attach devices for additional diagnostic information (oxygen/heart rate probe, BP cuff, pencil camera, hand-held ECG). If a simple illness is diagnosed, the doctor is able to send a prescription through to the closest pharmacy (approximately two hours drive away). But if the patient requires additional care, they can be buzzed into the adjacent treatment room which contains an oxygen concentrator, a bathroom, and a local community member (who is an RFDS "medical chest custodian") will be activated to respond.
- The "medical chest" program is a national program provided by the RFDS that provides laypersons (who are trained in first aid, BLS and intramuscular medication administration) to look after and stock a suite of hospital-grade medications such as GTN spray, IM/oral antibiotics, IM tranexamic acid, IM or intranasal opioids etc. These medications can be given under medical advice and supervision to commence treatment. Medical chest custodians respond to the Virtual ED, and with the support of the doctor on the telehealth unit, provide resuscitative care within their scope of training until an aeromedical retrieval team arrives.
- The clinic is supported by a system of Starlink satellite internet access, uninterrupted power supply, remote IT support and analogue business continuity plans, should technology fail.

In the first six months of operations, the RFDS documented patients both remotely resuscitated and subsequently retrieved by aeromedical teams, as well as retrieval avoidance by remote diagnosis and treatment, which has validated the service delivery model. There are plans to scale up into other locations.

PEOPLE

Convincing city dwellers to move to the country is notoriously difficult worldwide. Nonetheless, city-based health leaders often try to replicate "same but smaller" models in regional and remote communities. Remote area nursing and rural generalism are examples of cadres of clinicians whose skillsets have been expanded to provide care beyond the usually accepted metropolitan scope of practice. Are there additional models that could support remote populations in a similar vein?

Remote support model

In the COVID-19 pandemic, there was an increased reliance on the telehealth model across multiple areas of healthcare with state of the art systems designed to provide

Figure 6: Remote doorbell and intercom at the William Creek VEC.

Figure 7: William Creek telehealth kiosk room.

Figure 8: RFDS William Creek emergency treatment room, with telehealth unit and medical chest custodian treating a patient (supplied).

clinicians an ability to comprehensively manage a patient remotely.

The RFDS is building on this foundation with not just regular primary and emergency telehealth, but plans for a trial of remote ultrasound in the near future: doctors on telehealth directing remote area nurses or paramedics on obtaining ultrasound images which are digitally transmitted in real time, with virtual image interpretation directing treatment. RFDS is also working with the Australian Stroke Alliance to develop a world-first brain scanner that can be taken by retrieval teams to patients with stroke symptoms. Scanners would obtain images which are interpreted through AI algorithms, sent immediately to a tertiary neurologist via portable Starlink or satellite transmission, then validated with remote treatment commenced prior to or during transfer - rather than waiting for imaging after arrival several hours later at the cost of millions of brain cells.

Remote imaging is the next frontier – home ultrasound or microwave imaging will become an interesting area of care.

PLATFORMS

Australia has a unique tyranny of distance, and any healthcare solution - infrastructure, device, drone or aircraft - needs to function reliably in 50°C heat, 85% humidity and flood conditions. If you picture the NASA Mars rover and its issues, outback Australia can feel uncomfortably similar. There are emerging opportunities to lead emerging solutions arising from the challenges of its populations, geography and environment.

Drones

Delivery of routine medications, vaccines, blood samples and blood products is well validated across Rwanda and India, especially through Covid when vaccine demand far outstripped transport supply chains. In 2021 India started participating in the World Economic Forum's Medicine from the Sky project, which focusses on global healthcare supply chains, especially for what is termed the "last mile" of care when road infrastructure peters out. In India with 1.4 billion people, 5-10% of the 30,000 government-run primary healthcare centres can be nearly inaccessible due to their geographic locations or vulnerability to natural disasters. At the same time, in 2020 India had about 50 drone manufacturers, 200 drone service organizations and nearly 5,000 drone pilots. India was one of the first countries to use drones to cover more than 15,000 km of ground distance to deliver 8,000+ Covid vaccines and medical supplies to patients. In Ghana in 2021, the company Zipline delivered at least 2.6 million COVID-19 vaccine doses by drone.

Rwanda has around 12 million people, but around 83% live in rural areas, making it difficult to predict where blood products will be most effectively stored for rapid access. The Rwandan government has set up two distribution hubs which now provide over 500 deliveries a day of blood in a cardboard box. In their first 13,000 deliveries, the blood had a median delivery time of around 40 minutes, compared to 2 hours by road, with far less blood wastage.

There is some fascinating work occurring in the field of remote vital signs and thermal imaging – in Canada, ambulance services

Figure 9: The Santos Cooper Basin-based HEMS service in South Australia, at the edge of the Simpson Desert.

Image source: https://www.linkedin.com/posts/santos-ltd_a-big-shout-out-to-santos-moomba-helicopter-activity-6963397822150819840-8tRw?utm_source=share&utm_medium=member_desktop

have been using line-of-sight drones to find ejected passengers from car crashes in remote areas for many years. In 2018 they received authorisation to commence drone use beyond line-of-sight to find people fallen through ice or lost in the wilderness. This has resulted in a validated reduction in treatment-free intervals in search and rescue operations, with potential applications for more widespread integration of drones into similar services. The University of South Australia is taking thermal imaging one step further – publishing data on drone cameras that can measure heart and respiratory rates from skin tone and movement. A person is filmed for 10 seconds, with vital signs calculated through AI algorithms with ~ 90% accuracy. This could be particularly helpful in establishing not just if a survivor is alive, but how critically injured they might be.

Immediate resuscitation by drone is also being researched. Sweden documented the first life saved by dropping an AED from a drone to a patient in cardiac arrest in December 2021, when a 71 year old man started having chest pain while shovelling snow. A bystander saw him collapse in the driveway, calling emergency services and commencing CPR. A drone was dispatched and dropped a defibrillator directly to them within 3 minutes, which was used to successfully resuscitate him – and this impact has been replicated regularly since. While a 3 minute response time in remote Australia is optimistic, there is no reason that this kind of technology could not be applied to remote communities or cattle stations. For example, imagine a situation where a farm hand working remotely wears a personal alarm that they activate if they feel unwell / become injured. A drone is then sent from the launch pad at the base station with videocall, AED and emergency drugs for self-administration.

This can also apply to sporting teams: if a player were to collapse whilst training with no AED pitchside, the ability for a drone to drop an AED whilst CPR is in progress may well be the difference between a successful or unsuccessful resuscitation. A similar application would be possible for expeditions in remote areas - imagine a trekker in the Himalayas suffering a cardiac arrest far from the nearest medical clinic, for which a drone may make all the difference in survival, or whilst on Kilimanjaro with altitude sickness, for whom a drone could deliver oxygen.

Drone delivery clearly has opportunities for quality impact – what is harder to determine is the financial costs and return on investment of this kind of service. Distribution hub models of drone delivery rely on high volumes of deliveries to ensure the economies of scale required to make the service sustainable. RFDS is working with the Northern Australia Centre for Autonomous Systems in Darwin to trial various drones to see how they perform without continuous data connectivity, in extreme heat and cold and austere landing environments in order to adapt this technology to our unique setting.

eVTOL

While models of fixed wing and rotary response are well established globally in aeromedical emergency response, there is often a lack of redundancy in transport pathways, airstrips and accessibility, with night landings or flood conditions requiring additional thought and contingency. For example, what happens if fog rolls in after a 300 km journey and there is no nearby alternate landing strip? Helicopters are not always the answer – there is an outer range of response distance for an helicopter that may be insufficient for responding to, for example, the Simpson Desert where refuelling is not an option.

Electric or hydrogen powered fixed wing or vertical take-off and landing (eVTOL) platforms are a potential next step in aeromedical care. To complicate matters, in Australia, there are there are additionally known gaps in internet coverage that impact regulatory approvals for flight paths beyond line-of-sight, and with alternate non-fossil fuel sources there are refuelling considerations that have to be solved prior to launching such platforms. Australia is well positioned to be at the forefront with industry partners in trialling unique approaches such as battery or hydrogen power, or roaming edge and low earth orbit satellite connectivity in creative ways to combat the austerity of where our remote people live.

WHERE TO NEXT?

The vast land mass of Australia and

Figure 10: Render of Australian eVTOL (AMSL Aero).
Image source: https://www.flightsafetyaustralia.com/2024/05/vertical-challenger/

Figure 11: HyResource hydrogen projects map - spatial representation of hydrogen projects across Australia.
Image source: https://www.csiro.au/en/maps/Hydrogen-projects

distribution of the population across rural and remote areas poses significant challenges to ensure all Australians have equitable access to timely emergency care. The majority of health services are disproportionally situated in metropolitan areas, leaving remote populations with lower life expectancy and higher risk of mortality.

What is our vision for remote populations? Do we have one? Perhaps it should be substantive emergency care access within one hour for all – no matter where they live. While it is a ridiculously ambitious goal, the only way it can be achieved is working across industry and disciplines to harness seemingly unrelated opportunities for collaboration, partnership, innovation and validation. The use of telehealth, virtual emergency centres, wearable technology, remote ultrasound and drones may well assist us in achieving this goal.

Maybe, it is possible that together we can ensure rural and remote populations can also receive a high standard of emergency care, close to home, in a culturally appropriate, cost-effective manner. And by proving success and efficacy in this setting, it may also be possible to expand their use into other areas of remote medicine – for expeditions, teams or anywhere where medicine is needed in remote locations.

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