CHALLENGES OF COVID-19 AEROMEDICAL RETRIEVAL: LESSONS LEARNT FROM CONDUCTING AEROMEDICAL TRANSFERS DURING A PANDEMIC

Gihan Ganesh BSc(Hons) MBBS FANZCA [1]

Gayle Christie MBChB FRCEM FIMC FAoME DRTM FACEM [1]

David McIlroy MBChB DipDHM FACEM[1]

Shelley Dutton BSN PGradDipMidwifery GradCertTranstnNurs [1]

Andrew Challen MBBS CSC FANZCA [1]

[1] Royal Flying Doctors Service of Australia, Western Operations

Corresponding Author:

Dr Gihan Ganesh

Address: Royal Flying Doctors Service of Australia (Western Operations), 3 Eagle Drive,
Jandakot, Western Australia 6164

Email: gihan.ganesh@gmail.com

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All authors conceived the idea of the process and designed the methods described in this project. GG produced the initial and subsequent drafts of the manuscript with GC, DM, SD and AC providing critical reviews. GC supervised the project. All authors provided input and approved the final version of the manuscript.

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ABSTRACT

The COVID-19 pandemic has presented a unique and challenging environment for aeromedical organisations. We present lessons learnt during the development and implementation of our operational processes and procedures at The Royal Flying Doctor Service (RFDS) Western Operations for the transfer of suspected COVID-19 patients. To date, we have conducted 105 such fixed-wing transfers. The unique geography and health care system of Western Australia mandates that long-range, fixed-wing transfers are often required to centralised tertiary care. These lessons learnt provide a framework for the essential logistical, equipment and human factor considerations for developing an effective system. The translation of predominantly hospital-centric protocols into the aviation environment requires careful forethought, effective leadership and teamwork. Conducting COVID-19 suspected aeromedical retrievals significantly impacts all aeromedical retrieval operations and aeromedical personnel that should be realised by an aeromedical organisation.

BACKGROUND

The COVID-19 pandemic has highlighted the challenges inherent in the transfer of patients with highly contagious pathogens. The inherent risks in this setting include:

- inability to maintain appropriate physical distancing[1],
- prolonged patient exposure time[2]
- the requirement to perform aerosol-generating procedures[3].
- the potential risk of high viral load within the enclosed aircraft cabin.
- inability to extricate from the environment

Aeromedical organisations must ensure both staff safety and confidence to conduct these missions and preserve operational capability through well-developed procedures, training, and appropriate personal protective equipment (PPE) in an evolving and uncertain environment. A further consideration is the potential for aeromedical staff to become vectors for community pathogen transmission; therefore, prevention is both a social and moral obligation. It follows that a comprehensive process which considers the precautionary steps before, during and after patient contact is required.

DEVELOPMENT OF THE COVIC1-19 AEROMEDICAL TRASNFER PROCESS

Team Selection, Leadership and Communication

Early identification and careful selection of appropriately experienced personnel to form a COVID-19 protocol development team is essential. Comprising representatives from aviation, engineering and clinical services, the protocol development team must be motivated, have strong problem-solving capabilities and require adequate resourcing. There is a responsibility of clinical staff to impress upon non-clinical managers and executives the importance of thorough preparation and facilitate an understanding of the demands inherent in undertaking these missions. Managers, in turn, are instrumental in securing funding, liaising across health sector collaborators and providing insight into projected operational impact. We recommend a senior member of staff is appointed as clinical lead for the organisation's pandemic response. This individual is to act as a conduit for the dissemination of timely and accurate information to front line personnel. Overwhelming and incorrect information distributed amongst staff poses a significant barrier to effective implementation of protocols. They also play a vital role in demonstrating a commitment to placing staff safety as a priority, further reflected in all policies and procedures.

Understanding the Implications of COVID-19 in the Aeromedical Retrieval Environment

Droplet transmission of COVID-19 presents a significant challenge when an aircraft Environment Control System (ECS) causes significant air movement within a cabin. A full understanding of an aircraft's specific ECS is required and discussions with engineers recommended. In our aircraft, this resulted in the reconfiguration of the on-board seating arrangements to sit staff outside of ECS airflow from patients and enabled the cockpit to be determined as low risk of droplet transmission, when an additional protective shield was installed. Infected patients are a known reservoir for respiratory pathogens[4]; therefore, once loaded, we deemed all exposed surfaces within the cabin as a potential fomite risk. We found this gross simplification vital in order to deliver a practical solution.

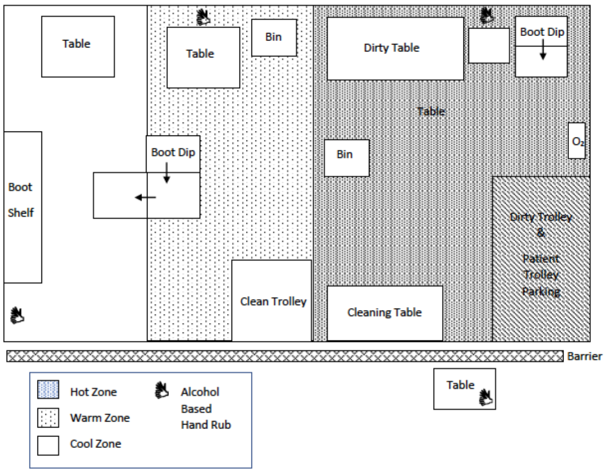
Minimising Contamination

An aircraft requires significant preparation in order to minimise potential contamination during missions. A pre-flight checklist is necessary to verify and minimise deviation from a set standard[5] to ensure full decontamination is possible post-flight. Equipment storage methods were modified to utilise rigid plastic boxes that enabled both compartmentalisation and easier decontamination. The process requires careful design and testing to ensure it is both streamlined and effective but minimises any cross-contamination risk.

Setting up a Decontamination Area

A critical part of developing a safe COVID-19 aeromedical retrieval process is establishing a functional decontamination area, for use upon completion of the retrieval mission. The area we devised utilised the *Department of Fire and Emergency Services* (DFES) directive[6] hot, warm and cool zoning (*Figure 1*) that applies the principle of sequential reduction in potential viral load. The requirements for a suitable area are that it is enclosed and cordoned off, has direct access to aerodrome apron, and at least 4 by 8 metres in size. Demarcation of zones needs to be clear, and positioning of equipment ergonomically sound.

Figure 1



Legend: *Decontamination zones and overall positioning of equipment utilised by Royal Flying Doctors Service, Western Operations for COVID-19 decontamination.*

IMPLEMENTATION

Personal Protection Equipment (PPE)

PPE selection was based on requirements to protect from droplet and contact transmission. Additional considerations for PPE were:

- need for protection in austere weather,
- comfort and durability during long transfers
- visibility.

PPE selected must undergo testing for suitability in the associated aeromedical environment. Given the innate risks associated with COVID-19 patient transfers a conservative strategy and high standard of PPE is recommended. We utilised PPE that included a combination of coveralls with 50mm reflective strips, double surgical gloves (inner coverall and outer coverall), N95/P2 mask, visor and boots. The coveralls selected were hooded and rated for International Standards Organisation (ISO) type 5 protection (airborne particle protection) and type 6 protection (light spray protection) and CE marked to meet the European standards for chemical protection type 3. When available, Powered Air Purifier Respirator (PAPR) devices were incorporated for the highest risk patients and procedures. PPE was maintained from donning prior to patient exposure until the completion of the mission and commencing the decontamination process.

Decontamination

The decontamination process requires forethought and adequate trialling to co-ordinate the movement of patient, personnel, and equipment from the aircraft, prevent error and ensure practicality.

Once within the decontamination area, aide memoires provided a visual reference for staff. Being less familiar with PPE, we advocated that pilots doff first following a checklist delivered by the clinical crew following which they followed a similar checklist to assist clinical staff. In our experience, this helped develop a team approach to the decontamination and utilised the pilots' familiarity with checklists. Verbal delivery of the checklists increased both compliance and engagement, in keeping with previous studies[7]. Doffing is known to be one of the highest risk times for contamination[8], and thus, a two-person process was mandated to mitigate the risks of doffing while fatigued following a long transfer. Following doffing, equipment was decontaminated. Procedures were designed to prevent any contact of the crew's skin or mucous membranes with potentially contaminated surfaces (equipment, flight PPE). Alcohol-based hand rub was utilised to sterilise hands during the decontamination procedure that was based upon Ebola protocols[9] but rationalised for COVID-19. Decontamination of the aircraft was conducted with a fogger utilising Australian Therapeutic Goods Administration approved *Nanoncyin ®* solution. The decontamination processes aim to return assets to service as soon as possible and requires a clear distinction between clean and contaminated.

Operational Impact

A robust and reproducible risk assessment tool was a key component of the tasking process, as determining a mission as COVID-19 risk has significant implications; reducing operational capability and increasing both response- and on-scene time. Due to pre- and post-flight requirements, a COVID-19 mission would generally encompass the entire tasking availability for a flight crew. The risk assessment tool should be developed alongside other agencies that are involved with patient care from primary location to receiving hospital to ensure that it is consistent. The risk assessment by crews conducting the missions can be both influenced to be more conservative (inherent risks of transfer, see above) or more liberal (human factors of full PPE retrievals, see below). The risk assessment also needs to evolve with local epidemiology and involvement of infectious disease specialists prudent.

Human Factors and Education

COVID-19 transfers place extra cognitive burden and stress upon staff, therefore strict standardisation is of paramount importance for the protection of health care workers[10]. Training should be team-based and conducted face-to-face, encompassing both theoretical and practical components of PPE and the entire COVID-19 patient transfer process. Web-based learning resources provided reference and supplemental continuing education. Wearing COVID-19 PPE in flight impacts dexterity, reduces sensory input, increases fatigue and risks of dehydration. Clinical skills practice in PPE mitigated some of these issues and should include basic skills (e.g. cannulation), and advanced skills (e.g. rapid sequence inductions) with consolidation of learning through immersive simulation training. Time spent on training is invaluable to ensuring the value of a well-developed system is realised whilst increasing flight crew's operational confidence.

To effectively execute COVID-19 missions, mandatory pre-flight briefings were initiated[5]. Conducted by senior medical personnel, these enabled development of a shared mental model of patient care, and reduced the cognitive load of on-scene decision through pre-emptive case discussion and trouble-shooting.

Review and Audit

The process should be reviewed regularly through post flight debrief and audit to ensure it evolves accordingly as more evidence and experience is available.

CONCLUSION

The challenges that COVID-19 present to aeromedical transfers are eminently surmountable. With good leadership, the qualities of flexibility and resilience that led to the selection of many aeromedical staff can be utilised to incorporate a comprehensive system that facilitates the safe transfer of COVID-19 suspected patients.

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