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Aeromedical retrieval diagnostic trends during a period of Coronavirus 2019 lockdown

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Abstract

Background: Little is known on the trends of aeromedical retrieval (AR) during social isolation.
Aim: To compare the pre, lockdown, and post-lockdown AR patient characteristics during a period of Coronavirus 2019 (COVID-19) social isolation.
Methods: An observational study with retrospective data collection, consisting of AR between 26 January and 23 June 2020.
Results: There were 16 981 AR consisting of 1983 (11.7%) primary evacuations and 14 998 (88.3%) inter-hospital transfers, with a population median age of 52 years (interquartile range 29.0–69.0), with 49.0% (n = 8283) of the cohort being male and 38.0% (n = 6399) being female. There were six confirmed and 230 suspected cases of COVID-19, with the majority of cases (n = 134; 58.3%) in the social isolation period. As compared to pre-restriction, the odds of retrieval for the restriction and post-restriction period differed across time between the major diagnostic groups. This included, an increase in cardiovascular retrieval for both restriction and post-restriction periods (odds ratio (OR) 1.12, 95% confidence interval (CI) 1.02–1.24 and OR 1.18 95%, CI 1.08–1.30 respectively), increases in neoplasm in the post restriction period (OR 1.31, 95% CI 1.04–1.64) and increases for congenital conditions in the restriction period (OR 2.56, 95% CI 1.39–4.71). Cardiovascular and congenital conditions had increased rates of priority 1 patients in the restriction and post restriction periods. There was a decrease in endocrine and metabolic disease retrievals in the restriction period (OR 0.72, 95% CI 0.53–0.98). There were lower odds during the post-restriction period for retrievals of the respiratory system (OR 0.78, 95% CI 0.67–0.93), and disease of the skin (OR 0.78, 95% CI 0.6–1.0). Distribution between the 2019 and 2020 time periods differed ($P < 0.05$), with the lockdown period resulting in a significant reduction in activity.
Conclusion: The lockdown period resulted in increased AR rates of circulatory and congenital conditions.

Introduction

The novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) originated in Wuhan China, and spread globally affecting millions of people. The major symptoms of coronavirus disease (COVID-19) include fever, cough, muscular soreness and dyspnoea,[1] with most deaths occurring in older patients with at least one comorbidity.[2] The current median reproductive number (R0) of COVID-19 is estimated by the World Health Organization (WHO) to be 1.95; however, recent studies indicate it could be closer to 2.79.[3]

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The WHO declared COVID-19 a pandemic on 11 March 2020.[4] COVID-19 rapidly spread throughout the world, with 118 319 cases reported on 11 March rising to more than 17 million by the end of July 2020.[5] The rapid spread of COVID-19 led many countries to close their borders to international travel and impose social distancing and lockdown isolation measures, aimed at reducing or minimising community transmition.[4]

Lockdown measures differed slightly between geographic areas throughout Australia, but generally included: closures of non-essential business, working from home, national/state border closures, interpersonal social distancing, curfews, limitations on outdoor activities, school closures, personal hygiene measures and recommendations associated with the use of personal protective equipment. Fines were issued for any major breaches.

The public health measures associated with controlling the virus, led to widespread economic disruptions,[6] and potentially positive environmental impacts,[7,8] such as reduced carbon emissions due to reduced travel. The global lockdown has also affected population health in other ways, such as reduced influenza transmission,[9] reduced accidents and injuries,[10] and potentially reduced preterm labour.[11] Many of these reports are anecdotal observations; however, it is likely that changes in work environments, social interactions and a focus on improved hand hygiene has reduced overall exposure to other non-COVID infectious diseases.

To date there has been little research that considers whether nationwide lockdowns contribute to changes in patient diagnostic reasons, including those who require emergency aeromedical retrieval.

We aimed to investigate:

- Whether the COVID-19 social lockdown/restriction was associated with differences in the rates and diagnostic reasons for people requiring aeromedical retrieval throughout Australia.
- Whether the diagnostic proportions during the COVID-19 social lockdown/restriction period differed to patient diagnostic proportions seen in 2019.

Methods

Setting

During the COVID-19 pandemic, the Royal Flying Doctor Service (RFDS) was tasked with transferring confirmed and suspected COVID-19 patients throughout Australia, in addition to its normal activity of 30 000–35 000 aeromedical transfers per year.[12] Australia spans 7.69 million square kilometres, with the majority of the 2018 Australian population (n = 24 992 860) residing in major cities (n = 18 003 544; 72.0%) or inner-regional areas (n = 4 445 356; 17.8%), with the remainder living in outer-regional (n = 2 052 366; 8.2%), remote (n = 291 213; 1.2%) and very remote (n = 200 381; 0.1%) areas.[13] With a fleet of 74 aircraft the RFDS provides extensive aeromedical retrieval for patients requiring treatment in inner-regional or major city hospitals.[14]

Study design

We conducted an observational study with retrospective data collection to investigate the diagnostic reasons patients were accessing aeromedical services throughout Australia. This analysis included all aeromedical retrievals conducted by the RFDS from 26 January to 23 June 2020. To determine whether this pandemic period differed to the same period in 2019, we included data from 26 January to 23 June 2019 to allow comparison.

An aeromedical retrieval was classified into two main categories, including primary evacuation (PE) (also known as primary retrieval) and inter-hospital transfer (IHT) (also known as a secondary retrieval). All repatriations were excluded from the analysis. A PE is generally staffed by a medical doctor and a nurse, while an IHT can only include a nurse or a medical doctor depending on the patient's severity.

Measures

Basic demographic information on age and gender was collected during the aeromedical retrieval. Aeromedical retrieval in-flight diagnoses were retrospectively coded to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10).[15] During the aeromedical retrieval patients were categorised into priority categories from 1 to 3, with priority 1 being the most urgent.

To investigate the association between the time and differences in the rates and diagnostic reasons for people requiring aeromedical retrieval throughout Australia, each patient interaction was allocated to either pre-restriction, restriction/lockdown, and post-restriction time period depending on the date they received treatment in 2020. All three periods were chosen to last for 7 weeks and were defined as follows: pre-restriction chosen as the baseline period (28 January to 15 March); restriction from the time that Australia went into lockdown (16 March to 4 May); and post-restriction where restrictions were gradually eased (5 May to 23 June).

The outcome measures included the number of patients across the three study periods (each 7 weeks in duration), the proportions and percentages for the ICD-

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10 diagnoses and patient demographics, across the three periods studied.

Statistical analysis

Continuous variables were summarised as medians and interquartile ranges (IQR). Categorical variables were summarised as counts and proportions. The association between the time period and the likelihood of requiring aeromedical retrieval due to a specific diagnostic reason in 2020 was investigated using logistic regression with magnitudes of association reported as odds ratios (OR) with respective 95% confidence intervals (95% CI) using pre-restriction period as a reference category. No *P*-values for individual diagnostic categories are reported due to the number of categories investigated. Ninety-five percent CI that do not include 1 are indicative of statistical significance at two-sided threshold of 0.05. The frequency distribution of the air ambulance retrievals across the three studies was compared between 2019 and 2020, using Chi-squared test. Statistical analyses were performed using Stata 15IC statistical software (StataCorp, College Station, TX, USA) with graphs implemented in the statistical software package R version 3.5.1. (R: A Language and Environment for Statistical Computing, Vienna, Austria).

Ethics approval

This project was deemed a low-risk quality assurance project. As this project involved routinely collected data, specific patient consent forms were not required.

Patient and public involvement

This study was developed and informed by patient priorities. The RFDS is an essential service, with the RFDS being the only healthcare service provider in many areas. This research is broadly aimed at understanding patient trends to promote and provide evidence-based services to the Australian public. RFDS stakeholders, including patients, will receive study results through various formats, including social media, newsletters, and via community engagement. Social engagement will also be used to determine community needs associated with COVID-19 lockdowns, especially with Aboriginal and Torres Strait Islander (Indigenous) communities. This will help to ensure our pandemic responses are culturally appropriate.

Results

There were 16 981 aeromedical retrievals throughout the 2020 study period including 1983 (11.7%) PE and 14 998 IHT (88.3%), as compared to 18 125 retrievals consisting of 2337 (12.9%) PE and 15 788 (87.1%) IHTs during the same date range in the year 2019.

The 2019 activity consistently increased across the three time periods from 5793 (32.0%), 6140 (33.9%) to 6192 (34.2%). However, in the pandemic study period there were observed differences in the distribution, in terms of the number of retrievals, with 5927 (34.9%), 5121 (30.2%) and 5933 (34.9%) prior, during and following social isolation restrictions respectively. The 2020 pandemic period resulted in a reduction in overall activity, as compared to the same time period in 2019. Historical trends were expected to increase with the Australian winter months (June, July, August); however, the lockdown period resulted in a reduction in activity as compared to the same timeframe in the prior year. Figures 1 and 2 show the overall activity as well as detailing state and territory trends in 2019 and 2020.

The median population age of patients that underwent an aeromedical retrieval by the RFDS during the 2020 pandemic study period was 52 years (IQR 29.0–69.0). There were 8283 (49.0%) males, 6399 (38.0%) females and 2299 (13.5%) missing gender, with the male median age being 55 (IQR 55–70) and the female median age being 47 (IQR 26–67) years, with the female median age reflecting retrievals that were related to pregnancy (n = 639; 3.8%).

The leading retrieval reasons throughout the study period included diseases of the circulatory system (n = 3082; 18.15%), injury (n = 2768; 16.3%) and diseases of the digestive system (n = 1535; 9.0%). There were significantly lower numbers of aeromedical retrievals performed during the period of social isolation (n = 5121; $P < 0.05$), compared to the pre-isolation period (n = 5927). Table 1 shows diagnostic trends.

There were six confirmed and 230 aeromedical COVID-19 cases, with the majority (n = 134; 58.3%) conducted during the social isolation period. It should be noted that all the areas that these patients came from did not have? pathology testing services. As such, all suspected cases were treated as confirmed cases. Cases in the pre-restriction period (n = 10; 0.2%) had no cases requiring assisted ventilation (mechanical and non-invasive) or vasopressor management; however, within the restriction and post-restriction periods there were 13 cases of mechanical ventilation, 4 cases of non-invasive ventilation and 19 cases of vasopressor management. None of the confirmed COVID-19 (n = 6) cases required

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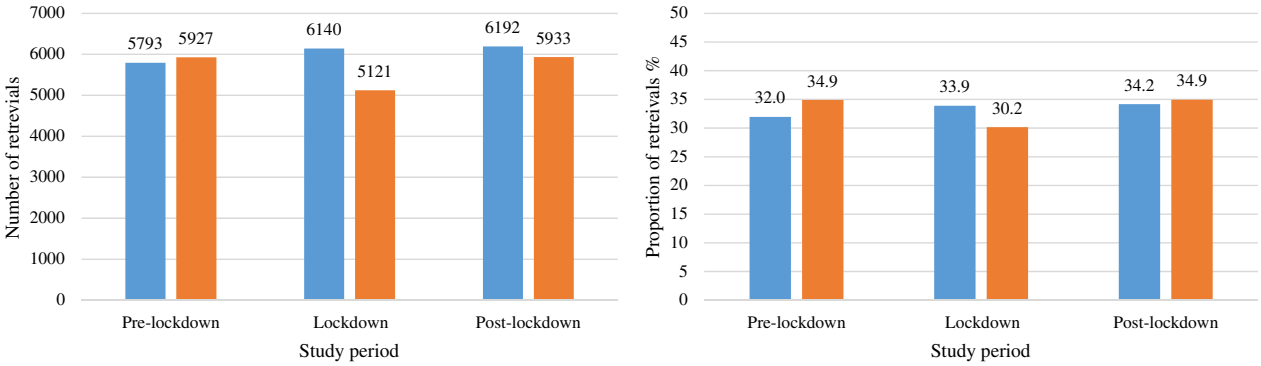

Figure 1 The year 2020 pandemic period compared to the same timeframe in the year 2019. (■), 2019; (■), 2020.

mechanical ventilation, vasopressor management or non-invasive ventilation. Four (67.0%) of the COVID-19 patients were of low severity, with the remaining two cases being high to moderate severity due to age and associated comorbidities, such as diabetes and/or hypertension.

Cardiovascular retrievals decreased in overall number during lockdown (n = 945; 18.45%), but started to increase in number during the post-lockdown period (n = 1143; 19.3%). Compared to the pre-restriction period there was an increase in odds of cardiovascular retrievals during the lockdown and post-restriction periods (OR 1.12, 95% CI 1.02–1.24 and OR 1.18, 95% CI 1.08–1.30 respectively), indicating a relative increase compared to other reasons for retrievals. The most common diagnosis in this group was ischaemic heart disease (n = 1506; 8.9%), with the leading reason being acute myocardial infarction (AMI). There were similar rates of AMI, with 370 (37.2%) during the pre-restriction, 348 (36.8%) in lockdown and 425 (37.2%) in post-restriction. Of interest, cardiogenic shock increased from one (0.1%) case during the pre-restriction, to three (0.3%) cases during the lockdown period and then decreased to zero (0.0%) in the post-restriction period. The restriction

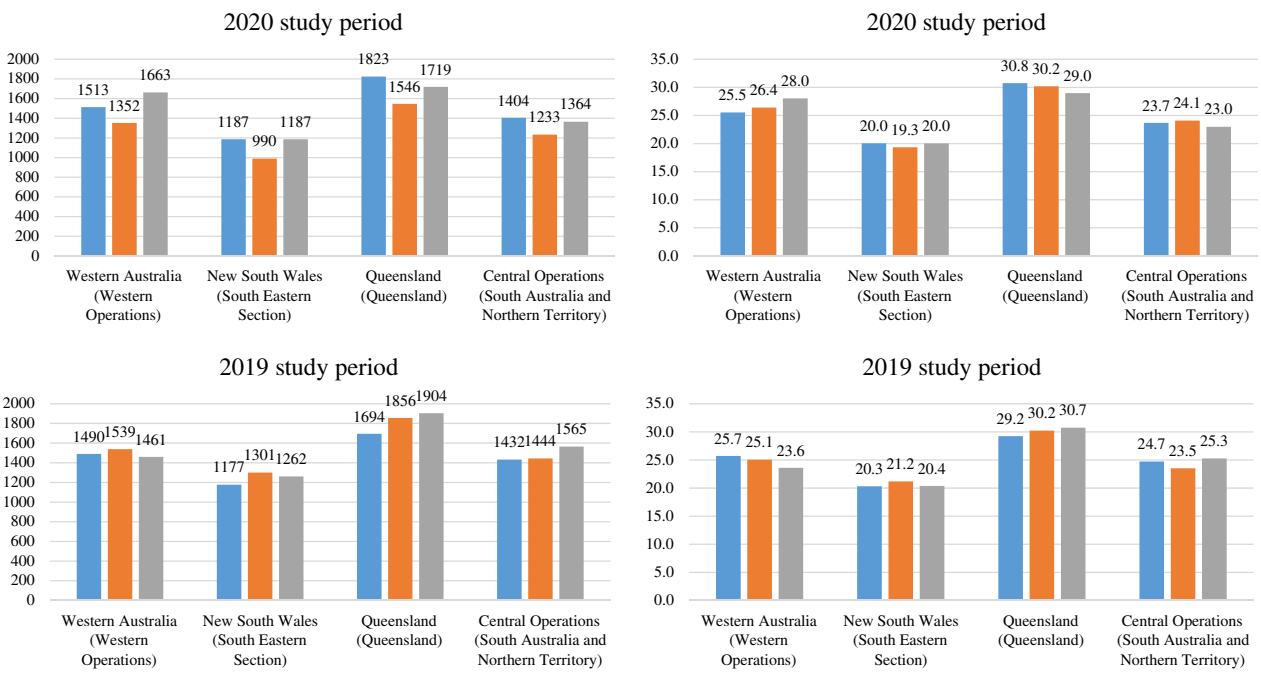

Figure 2 The year 2020 pandemic period compared to the same timeframe in the year 2019, Australian state and territory breakdown. Note: Figure 3 only includes the RFDS sections and operations that conducted aeromedical retrievals. It should be noted that the RFDS Victoria conducted many road transports for confirmed and suspected COVID-19 patients. (■), Pre-lockdown; (■), lockdown; (■), post-lockdown.

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Table 1 Aeromedical retrieval diagnosis with significant changing trends prior, during, and post a period of COVID-19 restrictions

Diagnosis (ICD-10: Chapter)	Sub-diagnosis	Pre-restrictions (%), 26 January to 15 March 2020	COVID-19 restrictions (%), 16 March to 4 May 2020	Post-restrictions (%) 5 May to 23 June 2020	Total
Diseases of the circulatory system (ICD-10: 9)	Total	994 (16.8)	945 (18.45) (OR 1.12, 95% CI 1.0–1.2)†	1143 (19.3) (OR 1.18, 95% CI 1.1–1.3)	3082 (18.15)
	Ischaemic heart diseases	487 (8.2)	456 (8.9)	563 (9.5)	1506 (8.9)
	Other forms of heart disease	240 (4.0)	212 (4.1)	255 (4.3)	707 (4.2)
	Cerebrovascular diseases	146 (2.5)	143 (2.8)	138 (2.3)	427 (2.5)
	Diseases of arteries, arterioles and capillaries	42 (0.7)	52 (1.0)	75 (1.3)	169 (1.0)
	Pulmonary heart disease and diseases of pulmonary circulation	28 (0.5)	32 (0.6)	37 (0.6)	97 (0.6)
	All other	51 (0.9)	50 (1.0)	75 (1.3)	176 (1.0)
	Primary evacuation	59 (8.3)	61 (10.8)	63 (9.8)	183 (7.8)
	Inter-hospital transfer	935 (21.6)	884 (23.2)	1080 (24.5)	2899 (18.4)
	Priority 1 patients (requiring medical and nursing)	110 (23.6)	113 (29.4)	132 (28.6)	355 (27.0)
Diseases of the respiratory system (ICD-10: 10)	Total	303 (5.1)	227 (4.4) (OR 0.86, 95% CI 0.7–1.0)	241 (4.1) (OR 0.78, 95% CI 0.7–0.9)	771 (4.5)
	Influenza and pneumonia	77 (1.3)	69 (1.3)	78 (1.3)	224 (1.3)
	Other acute lower respiratory infections	48 (0.8)	25 (0.5)	27 (0.5)	100 (0.6)
	Chronic lower respiratory diseases	40 (0.7)	36 (0.7)	43 (0.7)	119 (0.7)
	Other diseases of pleura	40 (0.7)	31 (0.6)	34 (0.6)	105 (0.6)
	Other diseases of upper respiratory tract	28 (0.5)	25 (0.5)	10 (0.2)	63 (0.4)
	All other	63 (1.1)	23 (0.45)	41 (0.7)	127 (0.1)
	Primary evacuation	78 (11.0)	50 (8.8)	49 (7.6)	177 (7.6)
	Inter-hospital transfer	225 (5.2)	177 (4.6)	192 (4.4)	594 (3.8)
	Priority 1 patients (requiring medical and nursing)	30 (6.4)	21 (5.5)	31 (6.7)	82 (6.2)
SARS-CoV-2	Total	10 (0.2)	134 (2.6)	86 (1.45)	230 (1.35)
	SARS-CoV-2 (ICD-10 code U07.1)	3 (0.1	3 (0.1)	0 (0.0)	6 (0.0)
	Suspected SARS-CoV-2, requiring full PPE	7 (0.1)	131 (2.6)	86 (1.4)	224 (1.3)
	Primary evacuation	5 (0.1)	31 (0.6)	23 (0.4)	59 (0.3)
	Inter-hospital transfer	5 (0.1)	103 (2.0	63 (1.1)	171 (1.0)
	Priority 1 patients (requiring medical and nursing)	0 (0.0)	23 (0.4)	7 (0.1)	30 (0.2)
	Mechanical ventilation	0 (0.0	8 (0.2)	5 (0.1)	13 (0.1)
	Non-invasive ventilation	0 (0.0)	4 (0.1)	0 (0.0)	4 (0.0)
	Vasopressor management	0 (0.0)	15 (0.3)	4 (0.1)	19 (0.1)
	Total	172 (2.9)	122 (2.4) (OR 0.82, 95% CI 0.6–1.0)	136 (2.3) (OR 0.78, 95% CI 0.6–1.0)	430 (2.5)

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Table 1 *Continued*

Diagnosis (ICD-10: Chapter)	Sub-diagnosis	Pre-restrictions (%), 26 January to 15 March 2020	COVID-19 restrictions (%), 16 March to 4 May 2020	Post-restrictions (%) 5 May to 23 June 2020	Total
Diseases of the skin and subcutaneous tissue (ICD-10: 12)	Infections of the skin and subcutaneous tissue	143 (2.4)	98 (1.9)	100 (1.7)	341 (2.0)
	Other disorders of the skin and subcutaneous tissue	26 (0.4)	20 (0.4)	31 (0.5)	77 (0.5)
	Urticaria and erythema	2 (0.0)	3 (0.1)	2 (0.0)	7 (0.0)
	Bullous disorders	1 (0.0)	0 (0.0)	2 (0.0)	3 (0.0)
	All other	0 (0.0)	1 (0.0)	1 (0.0)	2 (0.0)
	Primary evacuation	53 (7.4)	40 (7.1)	37 (5.7)	130 (5.6)
	Inter-hospital transfer	119 (2.8)	82 (2.1)	99 (2.2)	300 (1.9)
	Priority 1 patients (requiring medical and nursing)	3 (0.6)	6 (1.6)	1 (0.2)	10 (0.8)
Neoplasms (ICD-10: 2)	Total	134 (2.3)	130 (2.5) (OR 1.12, 95% CI 0.9–1.4)	174 (2.9) (OR 1.31, 95% CI 1.0–1.6)	438 (2.6)
	Malignant neoplasms	109 (1.8)	107 (2.1)	139 (2.3)	355 (2.1)
	Neoplasms of uncertain or unknown behaviour	10 (0.2)	13 (0.3)	24 (0.4)	47 (0.3)
	All other	15 (0.3)	10 (0.2)	11 (0.2)	36 (0.2)
	Primary evacuation	1 (0.1)	2 (0.4)	0 (0.0)	3 (0.1)
	Inter-hospital transfer	133 (3.1)	128 (3.4)	174 (4.0)	435 (2.8)
	Priority 1 patients (requiring medical and nursing)	4 (0.9)	1 (0.3)	1 (0.2)	6 (0.5)
Endocrine, nutritional and metabolic diseases (ICD-10: 4)	Total	108 (1.8)	68 (1.3) (OR 0.7, 95% CI 0.5–1.0)	88 (1.5) (OR 0.81, 95% CI 0.6–1.1)	264 (1.55)
	Metabolic disorders	50 (0.8)	17 (0.3)	33 (0.6)	100 (0.6)
	Diabetes mellitus	39 (0.7)	46 (0.9)	40 (0.7)	125 (0.7)
	All other	19 (0.3)	5 (0.1)	15 (0.3)	39 (0.2)
	Primary evacuation	36 (5.1)	10 (1.8)	8 (1.2)	54 (2.3)
	Inter-hospital transfer	72 (1.7)	58 (1.5)	80 (1.8)	210 (1.3)
	Priority 1 patients (requiring medical and nursing)	10 (2.1)	4 (1.0)	11 (2.4)	25 (1.9)
Congenital malformations, deformations and chromosomal abnormalities (ICD-10: 17)	Total	15 (0.25)	33 (0.6) (OR 2.56, 95% CI 1.4–4.7)	22 (0.4) (OR 1.46, 95% CI 0.8–2.8)	70 (0.4)
	Paediatric patients (<16 years)	15 (100.0)	32 (97.0)	20 (90.9)	67 (95.7)
	Infant patients (<1 year)	15 (100.0)	32 (97.0)	19 (86.4)	66 (94.3)
	Congenital malformations of the circulatory system	5 (0.1)	19 (0.4)	4 (0.1)	28 (0.2)
	Congenital malformations of genital organs	2 (0.0)	0 (0.0)	1 (0.0)	3 (0.0)
	Congenital malformations of the urinary system	2 (0.0)	0 (0.0)	1 (0.0)	3 (0.0)

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Table 1 *Continued*

Diagnosis (ICD-10: Chapter)	Sub-diagnosis	Pre-restrictions (%), 26 January to 15 March 2020	COVID-19 restrictions (%), 16 March to 4 May 2020	Post-restrictions (%) 5 May to 23 June 2020	Total
	Congenital malformations of eye, ear, face and neck	1 (0.0)	0 (0.0)	0 (0.0)	1 (0.0)
	Congenital malformations of the respiratory system	1 (0.0)	3 (0.1)	3 (0.1)	7 (0.0)
	All other	4 (0.1)	11 (0.2)	13 (0.2)	28 (0.2)
	Primary evacuation	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.0)
	Inter-hospital transfer	15 (0.3)	33 (0.9)	21 (0.5)	69 (0.4)
	Priority 1 patients (requiring medical and nursing)	2 (0.4)	6 (1.6)	3 (0.7)	11 (0.8)
Missing diagnosis (coded as ICD-10: 0)		878 (14.8)	603 (11.8)	800 (13.5)	2281 (13.4)
Total patients for the 2019/2020 study period		5927 (34.9)	5121 (30.2)	5933 (34.9)	16 981
Total primary evacuations for the 2019/2020 study period		717 (12.1)	597 (11.7)	669 (11.3)	1983 (11.7)
Total inter-hospital transfer for the 2019/2020 study period		5210 (87.9)	4524 (88.3)	5264 (88.7)	14 998 (88.3)
Total priority 1 patients (requiring medical and nursing) for the 2019/2020 study period		467 (7.9)	408 (8.0)	468 (7.9)	1343 (7.9)
Total patients for the 2018/2019 period		5793 (31.9)	6140 (33.9)	6192 (34.2)	18 125
Total primary evacuations for the 2018/2019 study period		742 (12.8)	798 (13.0)	797 (12.9)	2337 (12.9)
Total inter-hospital transfer for the 2018/2019 study period		5051 (87.2)	5342 (87.0)	5395 (87.1)	15 788 (87.1)
Total priority 1 patients (requiring medical and nursing) for the 2018/19 study period		407 (7.0)	431 (7.0)	480 (7.8)	1318 (7.3)

†The OR is in reference to the pre-lockdown time period.CI, confidence interval; OR, odds ratio; PPE, personal protective equipment.

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(n = 113; 29.4%) and post-restriction (n = 132; 28.6%) periods had higher rates of cardiovascular priority 1 patients, as compared to the pre-restriction period (n = 110; 23.6%).

Rates of aeromedical retrieval for injury (n = 2768; 16.3%) were consistent across the study periods, with 925 (15.6%) in pre-restriction, 852 (16.6%) restriction and 991 (16.7%) post-restriction. The leading retrieval reasons across the study periods were for injuries to the head (n = 437; 2.6%); injuries to the hip and thigh (n = 410; 2.4%), and injuries to the knee and lower leg (n = 284; 1.7%). The pre-restriction period had higher rates of high severity patients (n = 578; 67.8%), as compared to the restriction (n = 446; 52.3%), and post-restriction periods (556; 56.1%). Refer to Supporting Information Table S1 for details concerning diagnostic groups that did not significantly change throughout the study period.

There was a decrease in number of retrievals for respiratory diseases during restriction and an increase in number during the post-restriction period. There were significantly lower odds of retrieval for respiratory diseases in the post-restriction period compared to pre-restriction, indicating a relative decrease of respiratory system retrievals compared to other reasons (OR 0.78, 95% CI 0.67–0.93). The restriction (n = 21; 5.5%) period had lower rates, while the post-restriction period had higher rates (n = 31; 6.7%) of respiratory priority 1 patients, as compared to the pre-restriction period (n = 30; 6.4%).

The number of retrievals for diseases of the skin and subcutaneous tissue was in the restriction period compared to the pre-restriction period, however in the post restriction period the number was higher than in the two prior periods as was the odds of retrieval (OR 0.78, 95% CI 0.62–0.98) indicating a relative increase of retrievals in the post-restriction period.

The number of retrievals for neoplasm were similar in the restriction period compared to the pre-restriction period, however in the post restriction period the number was higher than in the two prior periods as was the odds of retrieval (OR 1.31, 95% CI 1.04–1.64) indicating a relative increase of neoplasm retrievals in the post-restriction period.

There were lower numbers of retrievals both in the restriction and the post-restriction period for the endocrine and metabolic diagnostic groups. The odds of retrieval for this diagnostic group in the restriction period was significantly lower than the odds in the pre-restriction period (OR 0.72, 95% CI 0.53–0.98), indicating relatively less retrievals for this diagnosis in the restriction period compared to the pre-restriction period. There were 125 cases of confirmed diabetic ketoacidosis, with 39 (36.1%) in the pre-restriction period, 46 (67.6%) in the restriction period, and 40 (45.45) in the post restriction period. This included 17 (15.7%), 10 (14.7%) and 11 (12.5%) T1DM cases in the pre-restriction, restriction, and post restriction periods respectively. Of concern was that T2DM cases increased from 16 (14.8%) in the pre-restriction period, to 30 (44.1%) cases in the restriction period and 22 (25.0%) in the post-restriction period. These results indicate an increase in poorly managed DM in the restriction period.

The number of retrievals for congenital conditions diagnosis was low across the three periods, however higher in the restriction and post-restriction period than in the pre-restriction period. The odds of retrieval for congenital conditions during the restriction period was significantly higher than in the pre-restriction period (OR 2.56, 95% CI 1.39–4.71). The restriction (n = 6; 1.6%) and post-restriction (n = 3; 0.7%) period also had slightly higher rates of congenital priority 1 patients, as compared to the pre-restriction period (n = 2; 0.4%).

Discussion

As an essential service, the RFDS provides emergency aeromedical support throughout Australia, as reflected in recent COVID-19 activity reports.[16] The main findings from this paper indicated that there were relatively more retrievals for diseases of the circulatory system, and congenital malformations, deformations and chromosomal abnormalities, during the social isolation period compared to the pre-isolation period. During the post-isolation period there was an increase in number of retrievals for diseases of the circulatory system and for neoplasms, however a reduction for respiratory disease, and skin conditions. The increases of cardiovascular and neoplasm treatment during this period may indicate a rebound effect in patients subsequently seeking treatment following social isolation. Furthermore, the decrease in respiratory and skin infections during the post-lockdown period may indicate that social distancing is also influencing other disease transmission rates, such as influenza.

Many of the retrievals for the circulatory system were for ischaemic heart disease, such as AMI and angina pectoris. It is unclear why there were relatively less circulatory cases but a higher proportion during the lockdown period. This may reflect patients delaying early intervention due to social isolation measures and limitations in accessing primary healthcare services.[17,18] This appeared to be the case, as there were more serious circulatory system cases during the post-lockdown period.

Cardiovascular disease, older adults, those with respiratory disease, and diabetes are at the highest risk of

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complications from COVID-19 infection. While many of our patients would not be considered old, with a median age of 52 years old, many of the retrievals were for endocrine disease, and specifically uncontrolled diabetes. Many of these patients come from rural and remote areas, which also have high rates of metabolic syndrome.[18] Uncontrolled diabetes, or chronic hyperglycaemia, negatively affects the immune system increasing morbidity and mortality due to increased infection risk and organic complications.[19] For example, those with Influenza A (H1N1) and diabetes, have triple the risk of hospitalisation and quadruple the risk of intensive care unit admission once hospitalised.[20] It is likely that COVID-19 infection coupled with diabetes would have similar rates,[20] as the mortality rates in China indicate that 42.3% of their COVID-19 deaths had diabetes.[21]

A striking finding was that there were significantly more infant patients retrieved for congenital malformations of the circulatory system during the lockdown period, most requiring an IHT from a rural area to a large metropolitan hospital mainly for cardiac surgery and congenital heart defects. This was due to limitations with accessing local cardiac surgeons/ units. There are limited data that detail the effects that COVID-19 has on the paediatric population, due to <1% of hospitalised cases to date being children younger than 10 years old.[22] While children seem less vulnerable to severe COVID-19,[23] those with congenital malformations are likely to have worse COVID-19 outcomes.[23]

During the lockdown period there were less aeromedical PE and IHT transfers for cancer, increasing significantly post-lockdown. This trend is believed to be related to many oncologists within Australia only conducting essential treatments. The lockdown period provided many challenges associated with cancer patient safety, specifically that patients would need to leave their homes and thus would expose themselves to infection.[24] Cancer treatment in itself predisposes patients to the more serious effects of COVID-19. For example, a recent study found that patients with cancer are at a greater risk of death and/or intensive care unit admission (OR 5.4, 95% CI 1.8–16.2).[25] Oncologists were required to weigh the risks of death and morbidity from COVID-19 against the benefits of cancer therapy. This risk is arguably amplified during aeromedical retrieval and transferring patients hundreds of kilometres from their homes into inner-regional and major city areas. The risks associated with transporting patients for cancer treatment are believed to be the main driver for a reduction in transfers during the lockdown period.

It was found that the retrievals for diseases of the respiratory system started to decline during the isolation period, and significantly reduced in the post-isolation period. This was mainly driven by reductions in acute respiratory disease retrievals. While influenza retrieval rates did not appear to reduce, reductions in overall respiratory disease match findings that social distancing for COVID-19 is reducing other respiratory disease transmission rates. For example, the Australian rates of confirmed influenza have significantly reduced since increased hygiene and social isolation measures have been in place, as compared to the winter months of 2019.[9] However, this trend could also be a result of a strong influenza vaccination campaign operated by the Australian Government during the early isolation periods. As per respiratory disease, skin infection retrieval rates started to decrease during the lockdown period, and significantly reduced in the post-lockdown period. As observed within Australia and internationally, non-pharmaceutical interventions, including border restrictions, quarantine and isolation, distancing, and changes in population behaviour, not only reduce COVID-19 transmission but also led to reductions in other diseases.[26]

The vast majority of aeromedical retrievals come from rural and remote areas of Australia.[13] These areas are characterised as having healthcare workforce shortages, coupled with higher social and economic disadvantage and higher rates of chronic disease, including cardiovascular and respiratory disease.[27] A potential contributor to the higher relative rates of retrievals for cardiovascular disease could be associated with limitations in these population groups able to access telehealth services, as traditional face-to-face services during the lockdown period were limited. As many remote Australian communities have limited access to COVID-19 testing and management facilities, coupled with higher chronic disease risk factors, it is likely that during mass infection many of these patients will require air ambulance transfer to inner-regional and major city hospitals.[16]

This study highlighted interesting trends during a period of social isolation and lockdown. Future research should consider whether the overall numerical reductions in cardiovascular disease were due to less clinical cases, or a result of less people seeking treatment. Attention to the higher rates of congenital malformations of the circulatory system should also be considered in the context of future paediatric research. A future research topic will include determining AMI patient outcomes following aeromedical retrieval, across the restriction periods, including determining mortality ratios. Future research should also consider social isolation trends within primary healthcare.

This study was limited to one medical service; however, this limitation was reduced by the RFDS being the largest aeromedical service in the world, providing services to the

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whole of the Australian continent during the study period. This study did not include primary healthcare interactions prior to aeromedical retrieval; however, this limitation will be addressed in a future study.

Conclusion

Social isolation measures led to a reduction in overall aeromedical activity, but increased significantly once the restrictions were lifted. During the social isolation period there were relatively more retrievals for cardiovascular disease, such as ischaemic heart disease, and congenital malformations of the circulatory system compared to pre-restriction. These population groups if infected with COVID-19 have significantly worse outcomes, and should be considered a high risk population group. Many of the Australian aeromedical retrievals come from rural and remote areas, characterised by vast geographical distances, often with significantly lower healthcare provision. If these community areas have community transmission of COVID-19, it is likely that aeromedical retrievals will increase for severe COVID-19 patients, with associated comorbidities such as cardiovascular disease.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web-site:

Table S1. Aeromedical retrieval diagnosis without significant changing trends prior, during, and post a period of COVID-19 restrictions.

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