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ORIGINAL ARTICLE

Impact of COVID-19 on Diagnostic Cardiac Procedural Volume in Oceania: The IAEA Non-Invasive Cardiology Protocol Survey on COVID-19 (INCAPS COVID)

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Objectives The INCAPS COVID Oceania study aimed to assess the impact caused by the COVID-19 pandemic on cardiac procedure volume provided in the Oceania region.

Methods A retrospective survey was performed comparing procedure volumes within March 2019 (pre-COVID-19) with April 2020 (during first wave of COVID-19 pandemic). Sixty-three (63) health care facilities within Oceania that perform cardiac diagnostic procedures were surveyed, including a mixture of metropolitan and regional, hospital and outpatient, public and private sites, and 846 facilities outside of Oceania. The percentage change in procedure volume was measured between March 2019 and April 2020, compared by test type and by facility.

Results In Oceania, the total cardiac diagnostic procedure volume was reduced by 52.2% from March 2019 to April 2020, compared to a reduction of 75.9% seen in the rest of the world ($p<0.001$). Within Oceania sites, this reduction varied significantly between procedure types, but not between types of health care facility. All procedure types (other than stress cardiac magnetic resonance [CMR] and positron emission tomography [PET]) saw significant reductions in volume over this time period ($p<0.001$). In Oceania, transthoracic echocardiography (TTE) decreased by 51.6%, transoesophageal echocardiography (TOE) by 74.0%, and stress tests by 65% overall, which was more pronounced for stress electrocardiograph (ECG) (81.8%) and stress echocardiography (76.7%) compared to stress single-photon emission computerised tomography (SPECT) (44.3%). Invasive coronary angiography decreased by 36.7% in Oceania.

Conclusion A significant reduction in cardiac diagnostic procedure volume was seen across all facility types in Oceania and was likely a function of recommendations from cardiac societies and directives from government to minimise spread of COVID-19 amongst patients and staff. Longer term evaluation is important to assess for negative patient outcomes which may relate to deferral of usual models of care within cardiology.

Keywords COVID-19 • Coronavirus • Cardiac imaging • Cardiac investigations

Introduction

Coronavirus disease 2019 (COVID-19) has had a profound impact on health care systems internationally, affecting every aspect of medical practice [1,2]. COVID-19 has not only been associated with specific cardiac complications [3–6], particularly in patients with pre-existing cardiovascular disease, but has impacted on service provision [7,8]. At the time of writing, 939 deaths have occurred within Oceania due to COVID-19 [9]—the impact of COVID-19 on cardiovascular mortality due to disruption of cardiac care may prove to be even more significant than direct mortality from the virus.

Employing new triaging protocols for tests and procedures with enhanced safety measures for patients and staff has been an integral part of the pandemic response. Changes have been variably implemented, both globally and locally, depending on COVID-19 caseload and local practices. These measures have resulted in a substantial reduction in cardiology services in most centres worldwide compared to usual practice. This reduction in activity should be carefully balanced with continued provision of timely cardiac investigations and treatment, to minimise the risk of adverse outcomes in both the short and long-term.

The International Atomic Energy Agency (IAEA) Non-invasive Cardiology Protocol Survey on COVID-19 (INCAPS COVID) was designed and implemented by the IAEA's Division of Human Health. IAEA is part of the UN family of organisations to support the establishment or strengthening of medical imaging facilities to help member states address the burden of cardiovascular disease, cancer, and other health conditions. The IAEA has performed numerous investigations into international cardiac imaging practices over the past decade—most notably INCAPS 1, an international multicentre evaluation of nuclear cardiology practices [10]. The INCAPS COVID multicentre, international survey assessed the impact of the pandemic on cardiac imaging laboratories worldwide. The survey found that global cardiac procedure numbers declined by 42% from March 2019 to March 2020, and 64% from March 2019 to April 2020 [11]. This decrease varied significantly between countries, with the most marked reductions in the Middle East and Latin America.

This paper outlines data collected from Oceania (Australia, New Zealand and Papua New Guinea), analysing the regional impact on local cardiac health care facilities caused by the first wave of COVID-19 in early 2020.

Methods

Survey Design and Conduct

INCAPS COVID was an observational, cross-sectional survey completed online by 909 centres in 108 countries in May and June 2020. Each centre provided data across various cardiac imaging modalities—both functional and anatomical, invasive and non-invasive—performed within their institution at three different time-points. Within Oceania, 63 health care facilities were surveyed. Sites were recruited voluntarily and efforts were undertaken to ensure extensive and diverse participation worldwide; there was direct communication from the INCAPS COVID executive committee and national coordinators to potential participants and contacts including those registered in IAEA-compiled databases of medical imaging facilities. Promotion using social media outlets, engagement of professional organisations via their databases, and "word of mouth" were also used. In Oceania, such societies included the Australasian Society of Nuclear Medicine (AANMS), Australian and New Zealand Society of Nuclear Medicine and the Conjoint Committee of Cardiac CT Coronary Angiography, with the permission of the Cardiac Society of Australia and New Zealand (CSANZ), the Royal Australasian Society of Radiology and the AANMS. Once engaged, participations were asked to collaborate with other departments within the same institution to produce only one submission per centre.

Data Collection Instrument

The survey was conducted using the International Research Integration System (IRIS) online data collection platform. The survey consisted of three parts: (1) basic health care facility data; (2) subjective questions regarding availability of personal protective equipment (PPE) and changes in practices within cardiac imaging departments during the first-wave of the pandemic; and (3) a count of the volume of different cardiac tests and procedures performed in March 2019 (pre-COVID-19 era) compared to March 2020 and April 2020 (COVID-19 era). Qualitative data regarding the second component is addressed in the main INCAPS COVID registry manuscript [11]. This paper focusses on the third part of the survey—the reduction in volume of cardiac procedures from March 2019 to April 2020 across centres within Oceania. Comparison was made between Oceania and the rest of the world for each modality. Within the Oceania dataset, comparison was made according to whether the institute was located in a metropolitan or regional setting, was public or private, located in a hospital premise, or acted as a teaching facility. There were also considerable reductions in volume from March 2019 to March 2020, but since there was an even greater reduction by April 2020, the two timepoints of March 2019 and April 2020 were chosen for analysis in this paper. The data required self-reporting and a team was engaged to review all data entries. Any data that appeared inconsistent was followed up directly by email or telephone with the original institution for verification.

Categorisation of Participating Sites

The centres within Oceania were classified into various groups including public or private sites, and teaching or non-teaching sites. Metropolitan sites included any sites within Australian capital cities, excluding Darwin. Regional sites included Darwin, all of New Zealand, Port Moresby in Papua New Guinea, and all other Australian sites outside of capital cities. 'Hospital sites' were those which provided any hospital-based services (including inpatient services only, and mixed hospital and outpatient services); 'Outpatient sites' only provided outpatient services.

Statistics

Percentage reductions were calculated for each test modality, comparing procedure volume in March 2019 to that in April 2020. The percentage volume reduction for each procedure type performed within Oceania over this time period was compared to the reduction seen in the remaining countries ("Rest of the World"). This comparison was performed for each procedure type using a paired t-test with a two-tailed p-value of <0.05 denoting statistical significance.

Within the Oceania sites, percentage reductions across the same time period were calculated for each procedure type, and compared across various groups—including metropolitan vs. regional sites, public vs. private sites, hospital vs. outpatient sites, and teaching vs. non-teaching sites. These percentage reductions were compared using the Wilcoxon rank-sum test, with $p<0.05$ denoting significance.

Results

Oceania Compared to the Rest of the World

The survey assessed 63 centres within Oceania, including 51 centres in Australia, 11 in New Zealand, and one site in Papua New Guinea. In Oceania, the total cardiology procedure volume reduced by 52.2% from March 2019 to April 2020, compared to the greater reduction of 75.9% seen in the rest of the world ($p<0.001$) (see Figure 1, Table S1).

Within Oceania, all procedure types (other than stress cardiac magnetic resonance [CMR] and positron emission tomography [PET]) exhibited significant reductions in volume over this time period ($p<0.001$). In Oceania, transthoracic echocardiography (TTE) decreased by 51.6%, transoesophageal echocardiography (TOE) by 74.0%, and stress tests by 65% overall, which was more pronounced for stress electrocardiograph (ECG) (81.8%) and stress echocardiography (76.7%) compared to stress single-photon emission computerised tomography (SPECT) (44.3%). Invasive coronary angiography decreased by 36.7%.

Compared to the drop in volume seen in the rest of the world, the reductions seen in Oceania were significantly less dramatic across all procedure modalities ($p<0.05$)—except stress CMR and PET volumes that were not significantly different to reductions seen elsewhere. Overall, an estimated 14,293 cardiac procedures were not performed in April 2020 across the sites surveyed, which would have been completed within Oceania during this month (assuming March 2019 procedure rates).

No statistically significant difference was found in total procedure volume reduction between groups within Oceania in terms of public vs private, hospital vs outpatient, teaching vs non-teaching, or metropolitan vs regional sites (see Figure 2).

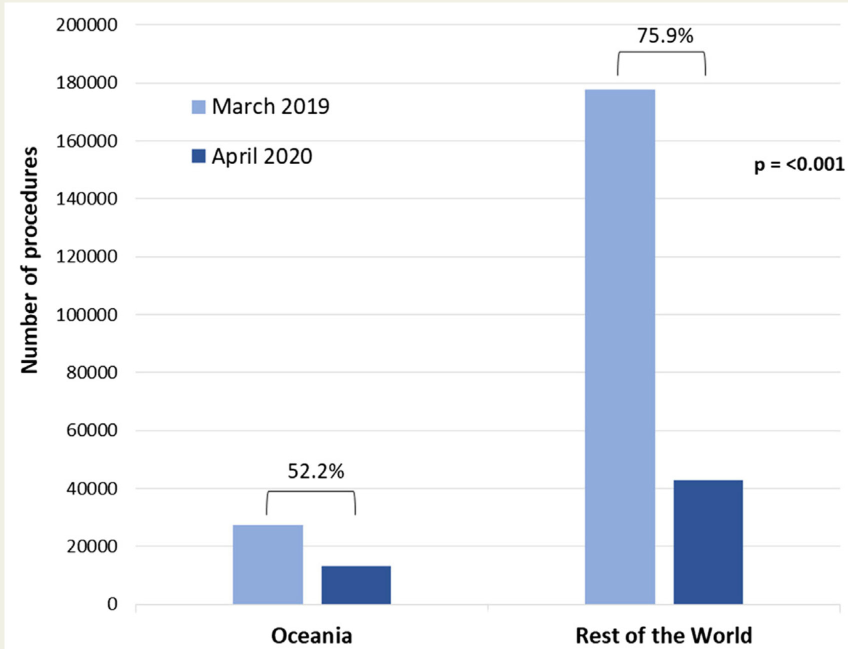

Figure 1 Oceania vs Rest of the World – Total Procedure Volume March 2019 and April 2020.
Although Oceania had a considerable reduction in procedure volume between March 2019 and April 2020 (52.2%), a significantly greater reduction was seen in the Rest of the World over this time period (75.9%) ($p<0.001$).

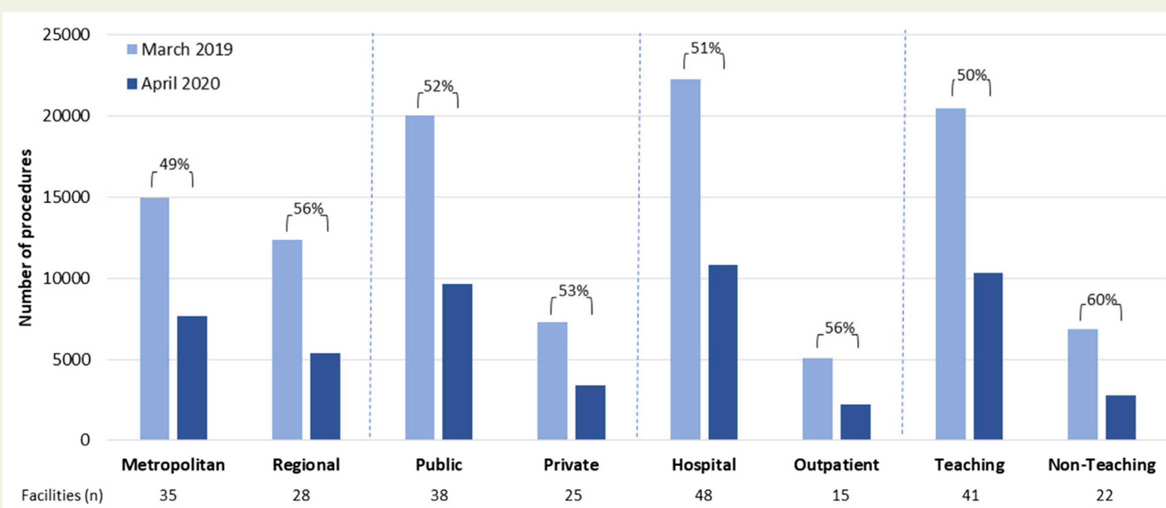

Figure 2 Reduction in total procedure volumes across all site types in Oceania from March 2019 to April 2020.
There was no statistically significant reduction in procedure volume between metropolitan vs regional (p=0.29), public vs private (p=0.71), hospital vs outpatient (p=0.71), or teaching vs non-teaching centres (p=0.39).

Metropolitan vs Regional Sites

Within Oceania, the sites surveyed comprised 35 metropolitan sites and 28 regional sites. The overall reduction in procedure volume from March 2019 to April 2020 was 48.9% in metropolitan sites, which was not significantly different compared to 56.4% in regional centres (p=0.29) (see Figure 3, Table S2).

Comparing different procedure types across the two groups, most were not significantly different, except in TTE procedure volume where regional centres were more

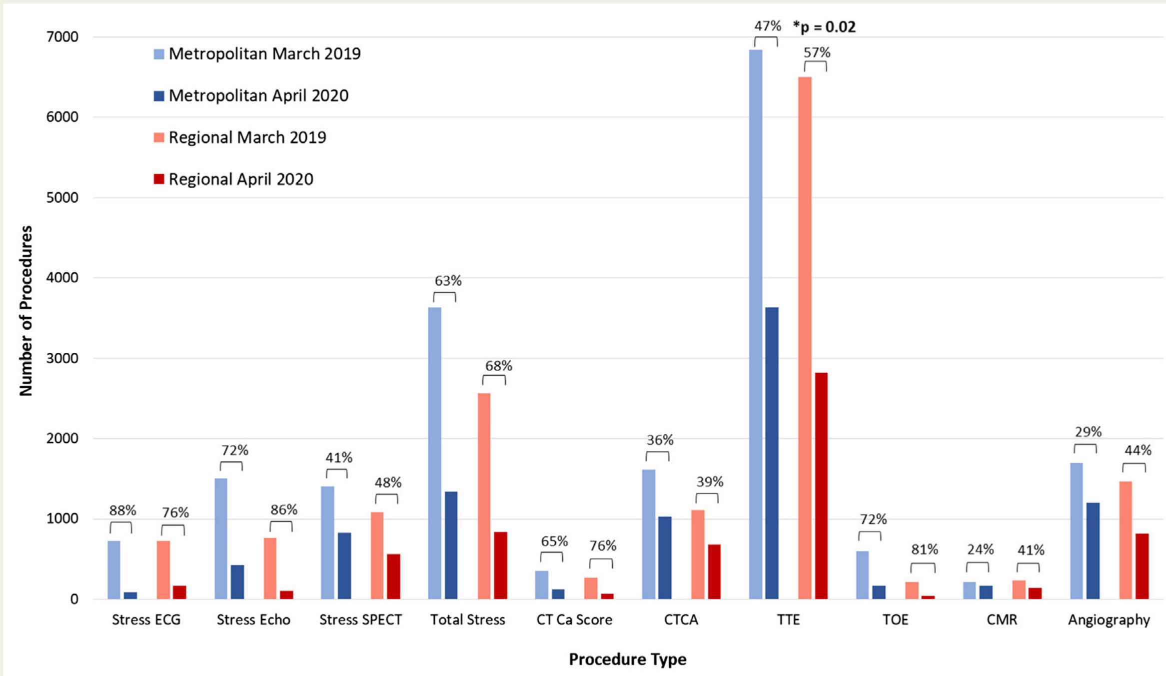

Figure 3 Reduction in Procedure Volume by Procedure Type from March 2019 to April 2020 – Metropolitan sites vs Regional sites.
There was a statistically significant difference in reduction in TTE procedure volume between metropolitan and regional centres (p=0.02). In all other procedure types, the reduction seen is similar.
Abbreviations: Stress echo, stress echocardiography; Total Stress, combined stress ECG, stress echocardiography & stress SPECT; CT Ca Score, computed tomography calcium score; TTE, transthoracic echocardiography; TOE, transoesophageal echocardiography; CMR, cardiac magnetic resonance imaging; Angiography, invasive angiography.

affected with a reduction of 56.6% compared to 46.9% in metropolitan sites (p=0.02).

Public vs Private Sites

Twenty-five (25) sites were private centres and 38 sites were public. The overall reduction in procedure volume from March 2019 to April 2020 was very similar, with a reduction of 53.4% in private sites compared to 52.0% in public centres (p=0.71) (Figure 4, Table S3). Comparing different procedure types across the two groups, there was no significant difference between public and private centres.

Hospital vs Outpatient Sites

Forty-eight (48) sites were hospital-based (or mixed hospital/outpatients) and 15 sites were purely outpatient-based. The overall reductions in procedure volume from March 2019 to April 2020 were not significantly different, with a reduction of 51.4% in hospital-based sites compared to 56.3% in outpatient-based centres (p=0.71) (Figure 5, Table S4).

A trend towards a difference in reduction in stress echocardiography and CMR was seen, with hospital centres seeing a greater drop in volume than outpatient only centres (82.0% vs 64.7% reduction, and 33.9% reduction vs a small increase of 8.3% respectively), but this was not statistically significant.

Teaching vs Non-Teaching Sites

Forty-one (41) sites were teaching centres and 22 sites were non-teaching sites. The overall reduction in procedure volume from March 2019 to April 2020 was 49.7% in teaching sites which was comparable to 59.9% in non-teaching centres (p=0.39) (Figure 6, Table S5). A statistically significant difference was seen in the reduction of stress echocardiography in teaching centres (82.9%) compared to non-teaching sites (65.7%) (p=0.02). There was also a trend towards a more impressive reduction in TTE and TOE within teaching centres (p=0.06). Other test modalities saw a similar magnitude of reduction across the included time period.

Melbourne vs Rest of Oceania

Sites within Melbourne were compared to the rest of Oceania, due to a further spike in Melbourne COVID case numbers just prior to the time of writing (this was seen during a second wave in July/August 2020, and hence was not captured in this survey). There was no significant difference in reduction in procedure volume between March

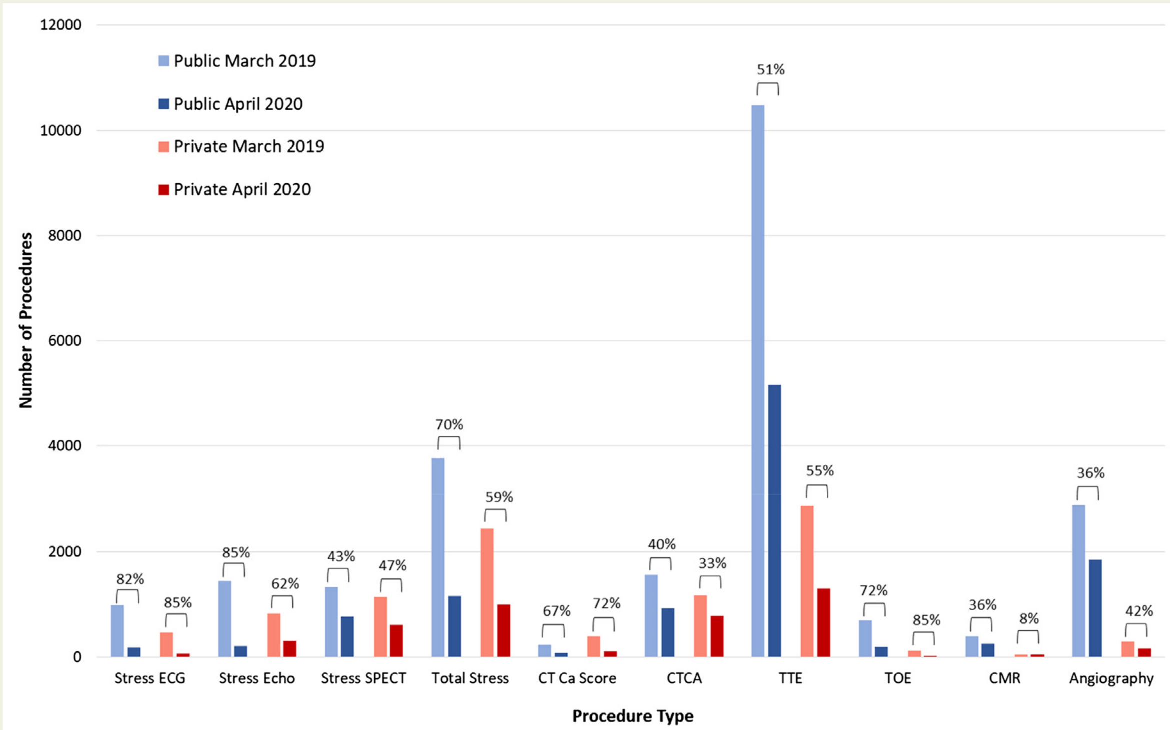

Figure 4 Reduction in Procedure Volume by Procedure Type from March 2019 to April 2020 – Public sites vs Private sites. There were no statistically significant reductions in procedure volumes between public and private sites in Oceania ($p>0.05$).
Abbreviations: Stress echo, stress echocardiography; Total Stress, combined stress ECG, stress echocardiography & stress SPECT; CT Ca Score, computed tomography calcium score; TTE, transthoracic echocardiography; TOE, transoesophageal echocardiography; CMR, cardiac magnetic resonance imaging; Angiography, invasive angiography.

2019 and April 2020 between the 15 sites within metropolitan Melbourne and the 48 sites within the rest of Oceania (53% vs 52% respectively, p=0.37).

Discussion

Our study demonstrated a reduction of 52.2% in all cardiac procedures between March 2019 and April 2020 as a direct consequence of the COVID-19 pandemic in Oceania. Although this change is important, it was significantly smaller than that seen in the "Rest of the World" (75.9%). With a lesser reduction, only time will tell as to whether this will lead to a reduced future cardiac morbidity and mortality compared to other countries. One (1) possible explanation for this difference may be the timing of the survey. In March and April 2020, the number of COVID-19 community infections in Oceania was significantly smaller than in other countries such as China, United States, Italy, Spain, United Kingdom and Iran. Since April 2020, after an initial fall in numbers, there was a major second peak in July and August, with a "state of disaster" declared in Victoria, Australia. Further surveys during this second peak might have resulted in falls similar to other countries, with potential future cardiac implications.

No difference was found between groups within Oceania, in terms of public vs private, hospital vs outpatient, teaching vs non-teaching, or metropolitan vs regional sites. All facility types saw a moderate, but significant decline in activity. Certain procedure types saw differences in reductions, which may reflect study availability according to the type of centre. Significant differences were found in the reduction in TTE procedure volume, with regional centres considerably more affected compared to metropolitan sites (56.6% compared to 46.9%, p=0.02). No obvious explanation for this is evident. Conversely, stress echocardiography volume in teaching sites was more significantly affected than non-teaching sites (82.9% vs 65.7%, p=0.02). There was also a trend towards stress echocardiography in hospital sites being more affected than outpatient sites. This trend may reflect a greater effort by hospital and teaching sites to reduce procedure volumes to allow greater hospital capacity for COVID-19 patients—there was anticipation that these sites were more likely to attract COVID-19 related admissions and should have prepared accordingly. It may also reflect that more anatomic or functional testing options are available at teaching hospitals, so these tests, which minimise patient contact, can be utilised rather than close contact investigations such as echocardiography. It is also possible that financial concerns would find

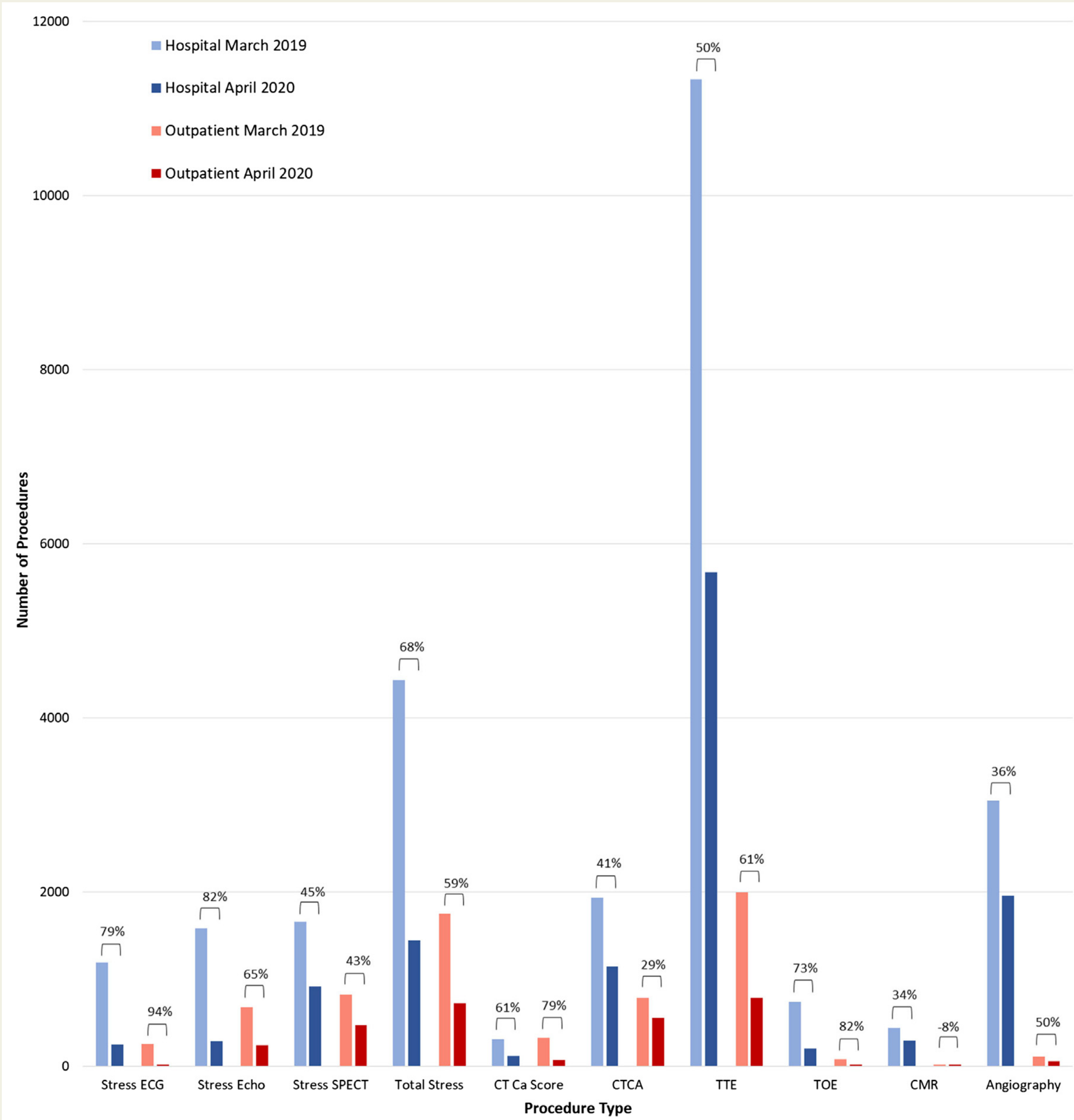

Figure 5 Reduction in Procedure Volume by Procedure Type from March 2019 to April 2020 – Hospital vs Outpatient sites. There was no statistically significant reductions in procedure volumes between hospital and outpatient sites in Oceania ($p>0.05$).
Abbreviations: Stress echo, stress echocardiography; Total Stress, combined stress ECG, stress echocardiography & stress SPECT; CT Ca Score, CT calcium score; TTE, transthoracic echocardiography; TOE, transoesophageal echocardiography; CMR, cardiac magnetic resonance imaging; Angiography, invasive angiography.

certain centres more reluctant to cancel procedures, as funding is more dependent on procedure volumes rather than government or institutional support.

The impact on non-invasive testing appears to be less for those tests that are not aerosol-generating procedures (AGPs), such as SPECT (primarily pharmacological in the COVID-era) and computed tomography coronary angiography (CTCA), while tests that include an exercise component or transoesophageal echocardiography were greatest affected. Further waves of COVID or similar outbreaks could lead to a sustained move towards less aerosol-generating investigations. Reductions in transthoracic echocardiography and cardiac interventions appear moderate and are more in line with other countries.

Rearrangement and prioritisation of health services have been a critical element of preparing for the COVID-19 pandemic. In March 2020, the Australian government introduced a policy to cancel all non-urgent surgery and

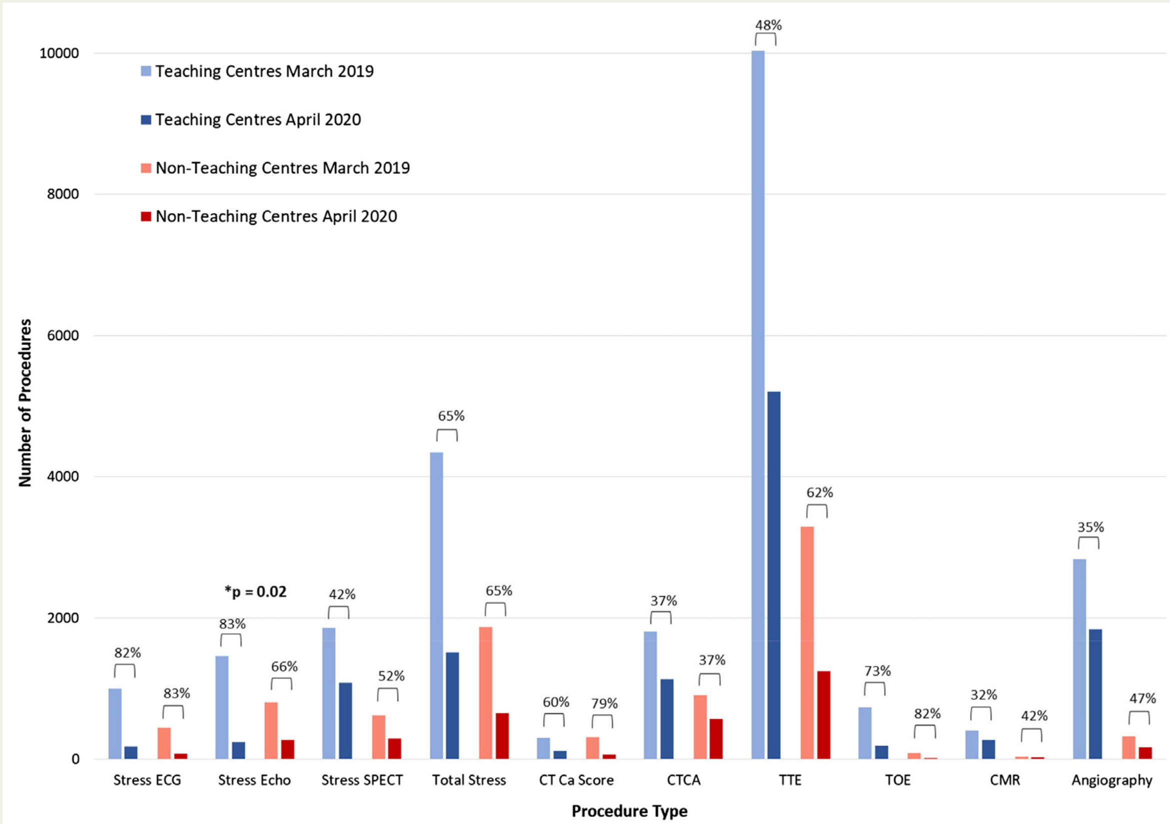

Figure 6 Reduction in Procedure Volume by Procedure Type from March 2019 to April 2020 – Teaching vs Non-Teaching sites.
There was a statistically significant reduction in stress echocardiography procedure volume between teaching and non-teaching centres (p=0.02). In all other procedure types, the reduction seen is similar.
Abbreviations: Stress echo, stress echocardiography; Total Stress, combined stress ECG, stress echocardiography & stress SPECT; CT Ca Score, computed tomography calcium score; TTE, transthoracic echocardiography; TOE, transoesophageal echocardiography; CMR, cardiac magnetic resonance imagine; Angiography, invasive angiography.

procedures regardless of COVID-19 risk, to conserve PPE, protect staff and allow capacity for COVID-19 cases [12]. This was reflected in reduced activity within Australian cardiology departments in March/April 2020; however, this was not to the extent seen in many other countries. This represents a lower caseload of COVID-19 patients at that time, probably related to effective measures implemented, including government-mandated lockdowns and social distancing. Health care workers are at increased risk of contracting COVID-19 [8,13]. Focus has been on minimising risk to staff and patients, acknowledging that patients referred for cardiac procedures are often older with comorbidities that put them at higher risk for adverse outcomes with COVID-19. Telehealth and isolated workstations for reading of cardiac imaging exams have also been promoted where possible [14,15]. However, these cardiac investigations require at least a component of face-to-face interaction and a patient's reluctance to enter a medical facility may also contribute to the reduction in test volume. These measures have so far been successful in preventing the health system within Oceania from being overwhelmed with COVID-19 cases, and thus allowed more activity to continue (albeit at a lower level).

International cardiac imaging societies have released numerous guidelines and consensus statements with advice on managing patients during the COVID-19 pandemic. Such recommendations likely contributed towards the reduction in volume of procedures seen in this survey. The American Society of Nuclear Cardiology published a guidance and best practices for reestablishment of non-emergent care in nuclear cardiology laboratories during the pandemic [16]. Likewise, the Society of Cardiovascular Computer Tomography developed guidance for use of cardiac CT, including use of CTCA as preferred to TOE for left atrial appendage assessment, and in carefully selected patients with myocardial injury and possible acute coronary syndrome (ACS) to avoid invasive angiography [17].

CSANZ guidelines for coronary angiography during the pandemic aimed to reduce exposure of laboratory staff to infection and minimise the need to disable laboratories for cleaning after cases [18]. They suggested that ideally all patients undergoing urgent angiography should be treated as potentially infected, as was done in Italy and China [19]. Urgent angiography for ACS should be performed only suspected COVID patients if they have clear clinical evidence of ongoing severe ischaemia. CTCA was advocated as a substitute for patients with stable symptoms or positive functional tests.

CSANZ guidelines for echocardiography suggested evaluation of workforce arrangements, with vulnerable staff members excluded from scanning suspected cases, and rotating staff to avoid cross-infection [20]. All non-urgent studies should be postponed, and exams ideally deferred until COVID status is confirmed, while encouraging focussed point-of-care ultrasound use. TOE is a potential AGP and should be avoided where possible, and exercise stress echocardiograms were also not recommended due to higher risk of droplet spread. Cardiac PET has been suggested as an alternative to TOE in high risk patients for endocarditis detection; despite this, in Oceania, no increase in cardiac PET was seen over the analysed period, possibly reflecting the absence of reimbursement.

Strengths of this study include the wide-ranging involvement of metropolitan and regional sites across Oceania, including private and public facilities, and hospital and outpatient-based services. The survey asked for estimated numerical counts of procedure volumes, an easily obtainable metric that is an objective measure of activity. The invitation to complete the survey was extended to all health professionals performing cardiac investigations. The list of societies invited to send the survey to their membership was extensive (though not complete), including as wide a range of investigations as possible.

The reduction in activity within cardiology raises the question of whether investigative and treatment delays will produce negative health outcomes. A European Society of Cardiology (ESC) survey of cardiologists regarding ST elevation myocardial infarction (STEMI) admissions during COVID-19 found that a major consequence of the pandemic was that many ACS patients did not attend hospital—in fact, respondents perceived that the number of patients admitted to cardiology units had decreased by 50% on average, with 62.3% reporting an increase in the proportion of late presentations [21]. An Austrian study of 19 percutaneous coronary intervention (PCI) centres found a significant decline in ACS presentations to hospital over a 4-week period in March 2020, early in the COVID-19 outbreak when large-scale public health measures including social distancing and quarantining were introduced [22]. An Australian observational study from Austin Health found a four-fold increase in symptom-to-door-time in ACS patients requiring PCI in March/April 2020, compared to a similar period in 2014 to 2019—from a mean of 2.4 hours up to 11.1 hours delay [23].

Limitations

Only three periods of time were assessed, and the peak of the pandemic occurred at different times in different places; specifically, a second peak in parts of Oceania came after the survey period was completed. In order to assess the ongoing effects of this second peak, a repeated set of data collection is planned. Only a limited number of sites in each country was surveyed, this being on a voluntary basis, which introduces selection bias. It remains possible that the impact on volume reductions varies significantly for different reasons at two similar centres within one city, and this may not have been captured in this data. Only one centre was recruited from Papua New Guinea, a developing nation, but small numbers may result in an inability to draw meaningful conclusions. The data collected was taken from a survey, and there is no objective means for verification of this data by the authors. The timepoints at which data were collected were 13 months apart, and this survey assumes March 2019 was a representative month in terms of cardiac procedure activity in the pre-COVID era. Further detailed data would have been useful to determine the underlying driving factors for reduction within each procedure type—for example, confirming whether practice changed to perform more pharmacological stress studies to reduce the volume of AGPs. Alternatively, reduction in SPECT may have been driven by institutional recommendations, or simply by lack of tracer supply due to reduced flights. Study investigators attempted to include a wide range of institutions, but many sites have institutional preferences for one modality over another.

Conclusion

Cardiac diagnostic procedures have decreased in volume in all regions of Oceania, but to a lesser degree than the rest of the world, and in a full range of varying facilities. While this has allowed adjustment in resource utilisation during the COVID-19 pandemic, concerns remain as to whether this will translate to adverse patient cardiac outcomes in future years. Care must be taken to avoid ignoring cardiac conditions while attention and resources are diverted to COVID-19, especially given the likelihood of the pandemic remaining for months or years to come. Further assessment of resource utilisation during future spikes in COVID-19 cases within Oceania may prove to be critical. This pandemic has offered a unique opportunity to reassess health care practices and may allow considerable positive change, and potentially more appropriate resource allocation. Longer term evaluation will be important to assess if patient outcomes have been negatively affected by the reduction in services and deferral of usual modes of care.

Appendices. Supplementary Data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.hlc.2021.04.021.

References

[1] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395:497–506. Lancet.

[2] Ghebreyesus TA. World Health Organisation WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020. WHO 2020.

[3] Li B, Yang J, Zhao F, Zhi L, Wang X, Liu L, et al. Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China. Clin Res Cardiol. 2020;109:531–8.

[4] Zheng YY, Ma YT, Zhang JY, Xie X. COVID-19 and the cardiovascular system. Nat Rev Cardiol. 2020;17:259–60.

[5] Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan China: a retrospective cohort study. Lancet. 2020;395:1054–62.

[6] Driggin E, Madhavan MV, Bikedli B, Chuich T, Laracy J, Biondi-Zoccai G, et al. Cardiovascular considerations for patients, health care workers, and health systems during the COVID-19 pandemic. JACC. 2020;75:2352–71.

[7] Biondi-Zoccai G, Landoni G, Carnevale R, Cavarretta E, Sciarretta S, Frati G, et al. SARS-CoV-2 and COVID-19: facing the pandemic together as citizens and cardiovascular practitioners. Minerva Cardioangiol. 2020;68:61–4.

[8] Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus 2019 (COVID-19) outbreak in China: summary of a report of 72,314 cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020;323:1239–42.

[9] John Hopkins Coronavirus Resource Centre. COVID-19 Map. https://coronavirus.jhu.edu/map.html (accessed November 2020).

[10] Einstein AJ, Pascual TNB, Mercuri M, Karthikeyan G, Vitola JV, Mahmarian JJ, et al. Current worldwide nuclear cardiology practices and radiation exposure: results from the 65 country IAEA Nuclear Cardiology Protocols Cross-Sectional Study (INCAPS). Eur Heart J. 2015;36:1689–96.

[11] Einstein AJ, Shaw LJ, Hirschfeld C, Williams MC, Villines TC, Better N, et al. International impact of COVID-19 on the diagnosis of heart disease. J Am Coll Cardiol. 2021;77:173–85.

[12] Media Release from Prime Minister of Australia's office. 'Elective Surgery'. Australian Government Website, March 25th 2020.

[13] Adams JG, Walls RM. Supporting the health care workforce during the COVID-19 global epidemic. JAMA. 2020;323:1439–40.

[14] Andreini D, Arbelo E, Barbato E, Bartorelli AL, Baumbach A, Behr ER, et al. ESC Guidance for the Diagnosis and Management of CV Disease during the COVID-19 Pandemic. European Society of Cardiology. 2020.

[15] Zaman S, MacIsaac AI, Jennings GLR, Schlaich M, Inglis SC, Arnold R, et al. Cardiovascular disease and COVID-19: Australian/New Zealand consensus statement. Med J Aust 2020.

[16] Skali H, Murthy VL, Al-Mallah MH, Bateman TM, Beanlands R, Better N, et al. Guidance and best practices for nuclear cardiology laboratories during the coronavirus disease 2019 (COVID-19) pandemic: an information statement from ASNC and SNMMI. J Nucl Cardiol. 2020;27:1855–62.

[17] Choi AD, Abbara S, Branch KR, Feuchtner GM, Choshhajra B, Nieman K, et al. Society of Cardiovascular Computer Tomography Guidance for Use of Cardiac Computed Tomography Amidst the COVID-19 Pandemic Endorsed by the American College of Cardiology. J Cardiovasc Comput Tomogr. 2020;14:101–4.

[18] Lo STH, Yong AS, Sinhal A, Shetty S, McCann A, Clark D, et al. Consensus guidelines for interventional cardiology service delivery during COVID-19 pandemic in Australia and New Zealand'. Heart Lung Circ. 2020;29:e69–77.

[19] Zeng J, Huang J, Pan L. How to balance acute myocardial infarction and COVID-19: the protocols from Sichuan Provincial People's Hospital. Intensive Care Med. 2020;46:1111–3.

[20] Wahi S, Thomas L, Stanton T, Taylor A, Mahadevan D, Evans G, et al. CSANZ Imaging Council Position Statement on Echocardiography Services During the COVID-19 Pandemic. CSANZ website. 2020.

[21] Pessoa-Amorim G, Camm CF, Gajendragadkar P, De Maria GL, Arsac C, Laroche C, et al. Admission of patients with STEMI since the outbreak of the COVID-19 pandemic: a survey by the European Society of Cardiology. Eur Heart J Qual Care Clin Outcomes. 2020;6:210–6.

[22] Metzler B, Siostrzonek P, Binder RK, Bauer A, Reinstadler SJ. Decline of acute coronary syndrome admissions in Austria since the outbreak of COVID-19: the pandemic response causes collateral damage. Eur Heart J. 2020;41:1852–3.

[23] Toner L, Koshy AN, Hamilton GW, Clark D, Farouque O, Yudi MB, et al. Acute coronary syndromes undergoing percutaneous coronary intervention in the COVID-19 era: comparable case volumes but delayed symptoms onset to hospital presentation. Eur Heart J Qual Care Clin Outcomes. 2020;6:225–6.