Medical examination of divers after COVID-19 infection: a prospective, observational study using published (original and revised) guidelines for evaluation

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Abstract
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Introduction: The COVID-19 pandemic raised significant concerns about fitness to dive due to potential damage to the pulmonary and cardiovascular systems. Our group previously published guidelines (original and revised) for assessment of these divers. Here, we report a prospective, observational study to evaluate the utility of these guidelines.
Methods: Recreational, commercial, and scientific divers with a history of COVID-19 were consented and enrolled. Subjects were evaluated according to the aforementioned guidelines and followed for any additional complications or diving related injuries.
Results: One-hundred and twelve divers (56 male, 56 female, ages 19–68) were enrolled: 59 commercial, 30 scientific, 20 recreational, two unknown (not documented), one military. Cases were categorised according to two previous guidelines ('original' $n = 23$ and 'revised' $n = 89$): category 0 ($n = 6$), category 0.5 ($n = 64$), category 1 ($n = 38$), category 2 ($n = 2$), category 3 ($n = 1$), uncategorisable due to persistent symptoms ($n = 1$). One hundred divers (89.3%) were cleared to return to diving, four (3.6%) were unable to return to diving, four (3.6%) were able to return to diving with restrictions, and four (3.6%) did not complete testing. Regarding diving related complications, one diver had an episode of immersion pulmonary oedema one year later and one diver presented with decompression sickness and tested positive for COVID-19.
Conclusions: Most divers who presented for evaluation were able to return to diving safely. Abnormalities were detected in a small percentage of divers that precluded them from being cleared to dive. Guidelines were easily implemented by a variety of clinicians.

Introduction

The emergence of the novel SARS-CoV-2 virus and subsequent COVID-19 pandemic raised significant concerns in the diving community regarding fitness to dive due to potential damage to the pulmonary and cardiovascular systems. Early reports in the pandemic suggested divers who recovered from COVID-19 may not be able to dive again due to permanent lung damage or that they would be at risk for pulmonary barotrauma or decompression sickness as a result of the lung injury from the infection.[1] There was also concern that divers could potentially have abnormal gas diffusion as a result of the chronic lung disease or complications from viral myocarditis.[2,3]

As the disease spread rapidly around the world, it became apparent that a uniform approach to assessing divers after recovering from COVID-19 before returning to dive would be necessary. These guidelines would need to be sensitive enough to protect divers from serious injury, but not overly restrictive or cost prohibitive. Our group published guidelines and then revised them two years later as vaccines were developed and the virus evolved.[4,5]

These guidelines are intended to be used on divers who have fully recovered, are asymptomatic from the symptoms of COVID-19, and have returned to their baseline exercise tolerance. The primary aim of this study was to evaluate the outcomes of COVID-19 infection in a cross-section of divers using the aforementioned guidelines. A secondary aim was to evaluate the feasibility of their use and implementation and to identify opportunities to improve and possibly modify the guidelines.

Methods

This study is an IRB approved (#201437), prospective, observational study. Subjects were enrolled beginning in January 2021 through June 2023. All divers at least 18 years of age who presented to our dive clinic during this time (including commercial, recreation, scientific, and military divers) with a history of COVID-19 were eligible for enrollment. A COVID-19 history was confirmed with positive testing, either at home or in a hospital or clinic setting. Positive COVID-19 antibody testing (without history of vaccination) could also be used to confirm diagnosis. Divers who presented to our emergency department with a diving related emergency with a history of COVID-19 were also eligible.

All subjects gave their written, informed consent. The majority of divers received an in-person evaluation either in clinic or in the emergency department; divers who were physically unable to attend dive clinic due to geographical constraints were evaluated via telemedicine.

A history of the patient's COVID-19 illness and sequelae, as well as a diving history, were obtained from the patient and from available medical records in the electronic medical record or supplied by the patients. Testing was obtained at our institution if possible, but we also reviewed results of outside records when necessary if testing was done elsewhere. We reviewed the original records of spirometry and imaging (not just interpretations) when able. If available, the patient's spirometry and imaging results were compared to prior values. Based on this history, divers were categorised using the previously published guidelines.[4,5] Divers enrolled prior to February 2022 were evaluated according to the original guidelines and divers enrolled after were evaluated according to the revised guidelines. Testing was ordered and completed according to guideline recommendations (see Tables 1 and 2). Return to dive guidance was based on these testing results and any additional pertinent information. These evaluations were performed by four faculty physicians who oversee the diving medicine clinic, with assistance from rotating fellows, residents and medical students.

Patients were followed up via subsequent clinic visits as required by their employer and/or by additional chart review or telephone calls.

Results

One-hundred and twelve divers were enrolled: 59 commercial, 30 scientific, 20 recreational, two unknown (not documented in chart), one military. Demographics: 56 male and 56 female, age range 19–68, mean age of 38 and a median age of 35. One-hundred divers (89.3%) were cleared to return to diving without restrictions, four (3.6%) were unable to return to diving, four (3.6%) were able to return to diving with restrictions, and four (3.6%) did not complete recommended testing. Most divers had isolated cases with seven having two or more episodes of COVID-19. We categorised all but one according to our previously published guidelines (original n = 23 and revised n = 89) (detailed in Case Vignette 2). The distribution of the divers' classification and outcomes is shown in Table 3.

SPIROMETRY AND IMAGING

Spirometry was obtained in 66 divers. Spirometry was considered abnormal if FEV_1, FVC, or PEF were below the lower limit of normal (NHANES III reference values), or $FEV_1/FVC < 0.75$.[6] Diffusion capacity of the lungs for carbon monoxide (DLCO) was not measured in all divers (due to varying location of testing). Seven divers initially had abnormal spirometry: one received a return to diving with restrictions designation, two were unable to return to diving, and four were cleared to return to diving (see Table 4). Abnormalities showed both obstructive and restrictive patterns. Imaging was obtained on 67 divers. Six had initially abnormal imaging: two received return to diving with restriction designation, one was unable to return to diving, two were cleared to return to diving, and one remained uncategorised based on failure to follow-up (see Table 4). Abnormal imaging findings varied, including persistent ground glass opacities to interstitial lung abnormalities, consistent with findings of sequelae of COVID-19.[7]

Divers with abnormal imaging and/or spirometry fell into the following categories: five divers with isolated abnormal spirometry (Category 1, n = 4, Category 0.5, n = 1); four divers with isolated abnormal imaging alone (Category 2, n = 1, Category 1, n = 2, Category 0.5, n = 1); two divers with abnormal imaging and abnormal spirometry (Category 3, n = 1, Category 2, n = 1) (See Table 5).

Although imaging and spirometry is not required for Category 0.5 divers, 36 of these divers received spirometry and/or imaging as part of yearly dive physical for either commercial or scientific diving. Of these 36 workups, three were abnormal. One had abnormal spirometry concurrent with a coexisting non-COVID upper respiratory infection, which resolved with repeat testing upon recovery. One had decreased FEV_1/FVC ratio but had normal FEV_1 and FVC. The final case had mild hyperinflation evident on chest X-ray but normal spirometry. All three were ultimately cleared to return to diving.

A NOTE ON SPECIFIC CASES

Of those divers designated unable to return to diving, one did not receive any workup due to a history of syncope which merited the 'unable' designation. The other three divers were classified as unable to return to diving based on persistent hypoxia with home oxygen use, persistent shortness of breath, and abnormal spirometry with concurrent asthma history not controlled on medication. One diver (Category 1) was initially diagnosed with long COVID

Table 1

Original classification of divers and work up recommendations based on severity of COVID-19 suspected illness; the categories of divers are based upon presenting symptoms and severity of disease which guides their subsequent work up recommendations. Noted factors include oxygen requirement, imaging, need for and level of hospitalisation, and cardiac involvement. If results are unknown or unavailable, recommendations are for more extensive cardiac and pulmonary evaluations. A diver should be placed in the highest category where they meet any (not all) of the criteria. If there is doubt that the diver's self-reported exercise level meets appropriate criteria, or concern it would not reveal underlying cardiac or pulmonary disease, further testing is warranted. BIPAP – bilevel positive airway pressure support; BNP – brain natriuretic peptide; CK-MB – creatine kinase MB fraction; CPAP – continuous positive airway pressure support; CT – computed tomography; DVT – deep venous thrombosis; ECG – electrocardiogram; ICU – intensive care unit; PA – posterior-anterior; RSTC – Recreational Scuba Training Council

Category 0 ***NO*** *history of COVID-19-suspected illness*	**Category 1** ***MILD*** *COVID-19-suspected illness*	**Category 2** ***MODERATE*** *COVID-19-suspected illness*	**Category 3** ***SEVERE*** *COVID-19-suspected illness*
Definition: Divers who have no history of COVID-19 suspected illness should proceed with normal evaluations. Additionally, we would use these criteria in those who may have had a positive screening PCR or antibody test, but without any history of illness or symptoms consistent with COVID-19.	**Definition:** • Did not seek health care or received outpatient treatment only without evidence of hypoxaemia. • Did not require supplemental oxygen. • Imaging was normal or not required.	**Definition:** • Required supplemental oxygen or was hypoxic. • Had abnormal chest imaging (chest radiograph or CT scan). • Admitted to the hospital but did NOT require mechanical (intubation) or assisted ventilation (BIPAP, CPAP) or ICU level of care. • If admitted, had documentation of a normal cardiac work up including normal ECG and cardiac biomarkers e.g., troponin or CK-MB and BNP.	**Definition:** • Required mechanical (intubation) or assisted ventilation (BIPAP, CPAP) or ICU level of care. • Cardiac involvement defined as abnormal ECG or echocardiogram, or elevated cardiac biomarkers e.g., troponin or CK-MB and BNP (or absence of documented work up). • Thromboembolic complications (such as pulmonary embolism, DVT, or other coagulopathy).
Work up recommendations: • Initial/periodic exam per professional group or RSTC guidelines. • Chest radiograph only if required per professional group or RSTC guidelines. No additional testing required.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Spirometry. • Chest radiograph (PA and lateral); if abnormal, obtain chest CT. If unknown (or unsatisfactory) exercise tolerance*, perform exercise tolerance test with oxygen saturation.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Spirometry. • Chest radiograph (PA and lateral); if abnormal, obtain chest CT. • ECG. • Echocardiogram (if no work up was done as an inpatient. Can forgo if had negative work up). • If unknown (or unsatisfactory) exercise tolerance*, perform exercise tolerance test with oxygen saturation. • Investigation and management of any other complications or symptoms per provider and professional group or RSTC guidelines.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Spirometry • Chest radiograph (PA and lateral); if abnormal, obtain chest CT. • ECG. • Repeat cardiac troponin or CK-MB and BNP to ensure normalisation. • Echocardiogram. • Exercise Echocardiogram with oxygen saturation. • Investigation and management of any other complications or symptoms per provider and professional group or RSTC guidelines.

Table 2

Revised classification of divers and work up recommendations based on severity of COVID-19 suspected illness; the categories of divers are based upon presenting symptoms and severity of disease which guides their subsequent work up recommendations. Noted changes are the addition of Category 0.5 for those with very mild disease and primarily upper respiratory symptoms. Otherwise, interpretations and acronym definitions are as noted in Table 1. * for example, cough that is productive, prevents from sleeping, or requires medication, ultimately defined at the discretion of the evaluating physician

Category 0 ***NO*** *history of COVID-19-suspected illness*	**Category 0.5** ***VERY MILD*** *COVID-19-suspected illness*	**Category 1** ***MILD*** *COVID-19-suspected illness*	**Category 2** ***MODERATE*** *COVID-19-suspected illness*	**Category 3** ***SEVERE*** *COVID-19-suspected illness*
Definition: No history of COVID-19 or asymptomatic positive screening test.	**Definition:** • Isolated upper respiratory or systemic symptoms (rhinorrhea/ congestion/ pharyngitis/ loss of taste or smell), fevers, fatigue, or myalgias but WITHOUT lower respiratory or cardiac symptoms. Returned to baseline exercise tolerance.	**Definition:** • Symptomatic COVID-19 including any of the following: Any lower respiratory or cardiac symptoms, including chest pain, palpitations, significant* cough, shortness of breath with exertion or at rest. • Outpatient treatment only without evidence of hypoxemia. • Did not require supplemental oxygen • Imaging was normal or not required • Returned to baseline exercise tolerance.	**Definition**: • Required supplemental oxygen or was hypoxic. • Had abnormal chest imaging (chest radiograph or CT scan). • Admitted to the hospital but did NOT require mechanical (intubation) or assisted ventilation (BIPAP, CPAP) or ICU level of care. • If admitted, had documentation of a normal cardiac work up including normal ECG and cardiac biomarkers e.g., troponin or CK-MB and BNP. • Returned to baseline exercise tolerance.	**Definition:** • Required mechanical (intubation) or assisted ventilation (BIPAP, CPAP) or ICU level of care. • Cardiac involvement defined as abnormal ECG or echocardiogram, or elevated cardiac biomarkers e.g., troponin or CK-MB and BNP (or absence of documented work up). • Thromboembolic complications (such as pulmonary embolism, DVT, or other coagulopathy). • Returned to baseline exercise tolerance.
Work up recommendations: • Initial/periodic exam per professional group or RSTC guidelines. • Chest radiograph only if required per professional group or RSTC guidelines. No additional testing required.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Chest radiograph only if required per professional group or RSTC guidelines. No additional testing required.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Spirometry. • Chest radiograph (PA and lateral); if abnormal, obtain chest CT. If unknown (or unsatisfactory) exercise tolerance*, perform exercise tolerance test with oxygen saturation.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Spirometry. • Chest radiograph (PA and lateral); if abnormal, obtain chest CT. • ECG. • Echocardiogram (if no work up was done as an inpatient. Can forgo if had negative work up). • If unknown (or unsatisfactory) exercise tolerance*, perform exercise tolerance test with oxygen saturation. • Investigation and management of any other complications or symptoms per provider and professional group or RSTC guidelines.	**Work up recommendations:** • Initial/periodic exam per professional group or RSTC guidelines. • Spirometry • Chest radiograph (PA and lateral); if abnormal, obtain chest CT. • ECG. • Repeat cardiac troponin or CK-MB and BNP to ensure normalisation. • Echocardiogram. • Exercise Echocardiogram with oxygen saturation. • Investigation and management of any other complications or symptoms per provider and professional group or RSTC guidelines.

Table 3

Diver COVID-19 classification and return to dive status; RTD – cleared to return to diving; RTDWR – cleared to return to diving with restrictions; URTD – unable to return to diving; Unknown – those who did not complete recommended testing or failed to return for follow-up

Status	Category 0	Category 0.5	Category 1	Category 2	Category 3	Uncategorised
RTD	6	61	33	-	–	–
RTDWR	–	2	-	2	–	
URTD	–	–	2	–	1	1
Unknown	–	1	3	–	–	
Total	6	64	38	2	1	1

Table 4

Diver spirometry/imaging results and return to dive status; RTD – cleared to return to diving, RTDWR – cleared to return to diving with restrictions, URTD – unable to return to diving; Unknown – those who did not complete recommended testing or failed to return for follow-up

Parameter	RTD	RTDWR	URTD	Unknown
Abnormal spirometry	4	1	2	–
Abnormal imaging	2	2	1	1
Totals	6	3	3	1

Table 5

Diver spirometry/imaging results and COVID-19 categorisation; number of divers by category with abnormal spirometry, imaging, or both

Category	Spirometry abnormal only	Imaging abnormal only	Both abnormal
0.5	1	1	0
1	4	2	0
2	0	1	1
3	0	0	1
Totals	5	4	2

syndrome but was cleared for return to diving based on complete resolution of symptoms and otherwise normal workup. Regarding diving related complications, it was noted that one diver had an episode of immersion pulmonary oedema one year after having COVID-19 and one diver presented with decompression sickness and tested positive for COVID-19 (though asymptomatic).

Below are two case vignettes that highlight challenges in evaluating and counseling divers after COVID-19 infection.

Case 1

A 55-year-old male recreational diver without significant past medical history presented for clearance to return to dive after COVID-19 infection. The visit was three months after initial infection. During his initial illness, he presented to the emergency department after developing fever (39.4°C, 103°F) and cough. He had a positive COVID-19 test in the emergency department, abnormal chest X-ray with bilateral consolidations, and a peripheral oxygen saturation of 85%. He had not received a COVID-19 vaccination. He was admitted to the hospital and treated with supplemental oxygen for eight days. After discharge, he observed decreased exercise tolerance, shortness of breath and hypoxia and tachycardia with exertion. This was documented using a home pulse oximeter showing oxygen saturations in mid-80s and heart rates in 130s when walking between rooms in the house. Over time, this resolved and at time of presentation he felt he was back to aerobic exercise baseline and noted oxygen saturation of 95–97% with exercise. He was also discharged with incentive spirometer and reported an increase in vital capacity from 1 L to 4 L. Physical examination in clinic was unremarkable. He had previously completed approximately 180 dives; he was a certified divemaster with plans to become instructor.

Based on his symptoms and history, the patient was designated Category 2 (moderate disease) and work up recommendations included electrocardiogram (ECG), two-view chest X-ray or chest computed tomography (CT), echocardiogram and stress echocardiogram, exercise tolerance test with oxygen saturation, and spirometry.

The ECG showed sinus rhythm with sinus arrhythmia, nonspecific ST-T changes. The two-view chest X-ray four months post infection showed near resolution of prior extensive bilateral consolidations. A repeat chest X-ray three months later was unchanged, with the radiologist's report stating that this "*may represent residual scarring*". A chest CT (eight months post infection) showed "*chronic peripheral interstitial disease and scarring with subtle residual ground glass disease with mild reticular component. Areas of peripheral scarring and subpleural banding*

are present…likely the chronic sequelae of COVID-19." These findings would later be considered typical for interstitial lung abnormalities after COVID-19.[7] An exercise echocardiogram (seven months post infection) showed no inducible ischaemia and fair exercise tolerance (7.0 MET). Spirometry and DLCO (five months post infection) were both normal. A resting echocardiogram and exercise tolerance test with oxygen saturation were not obtained for this patient.

Recommendations: The main residual abnormality noted was scarring on the CT chest, presumably from infection. We advised the patient that the implication in diving from these images is unknown but may theoretically increase the risk of barotrauma. Patient acknowledged the risks but wished to continue diving. We discussed risk mitigation techniques, including very slow ascents and prolonged safety stops. We also discussed doing a trial dive in a pool or in very shallow, controlled conditions to make sure he can tolerate it. He agreed with this plan and, in follow up, was found to have made approximately 50 subsequent dives without complications.

Case 2

A 57-year-old male recreational diver without significant past medical history presented for clearance to return to dive after COVID-19 infection. His initial illness with COVID-19 was 11 months prior. He had a prolonged hospitalisation (127 days) requiring intensive care admission and support with high flow nasal cannulae and home oxygen at discharge. Work up in the hospital included chest X-rays and chest CTs that were notable for pneumothorax that resolved without intervention and bilateral ground glass opacities. An echocardiogram was normal. He had not received a COVID-19 vaccination.

Since returning home, the patient reported his exercise tolerance had continued to improve, but he still required oxygen supplementation. For example, his oxygen saturation dropped to the mid-80s walking upstairs. He was very motivated to return to diving and had started diving already, despite not having clearance from a physician. He reported that he had been using nitrox (32%) tanks at home and had dived in a lake without issues using 33% nitrox. He was also using albuterol and budesonide inhalers and nebulisers at home twice daily. Physical examination in the clinic was notable for mild dyspnoea at rest. The guidelines were not appropriate to apply to this patient, as he had clearly not returned to his exercise capacity baseline, despite initially claiming to be asymptomatic. However, we still used the same principles of guidance for those who had suffered severe COVID-19 infection (Category 3) to evaluate this patient, including spirometry, chest CT, and echocardiogram.

Spirometry obtained six months after infection showed FVC 1.69 L (33% predicted value), FEV_1 1.51 L (38%), FEV_1/FVC 89%, DLCO 11.12 ml·min·mmHg^{-1} (33%), TLC 2.93 L (40%), consistent with severe restrictive disease. These values were unchanged post bronchodilator challenge. Chest CT obtained 10 months after the initial illness showed patchy air space disease, ground glass opacities, and traction bronchiectasis that were stable when compared to a CT done three months prior. An echocardiogram was obtained and was normal. An ECG was not immediately available. Exercise tolerance test with oxygen saturation was not ordered because the patient was still requiring home oxygen.

Recommendations: In addition to a history of spontaneous pneumothorax and pneumomediastinum (in the setting of viral illness but not on positive pressure ventilation), this patient had significant residual structural pulmonary abnormalities, resulting in abnormal gas diffusion and pulmonary function testing, as well as an ongoing oxygen requirement. Due to a high risk of multiple complications, including barotrauma and hypoxia, we recommended the patient stop diving.

Although uncommon, the above cases are representative of some of the residual changes noted in divers after COVID-19. Case 1 represents an example of return to diving with restrictions: although there were persistent changes noted on the CT scan, the implication of these findings with regards to risk in diving is still unknown. The subject was already certified and very much wished to return to diving and so was given counseling on the implications of potential risk and risk mitigation. It should be noted that this was a recreational diver and advice may have been different in a commercial or scientific diver.

Discussion

To our knowledge, this study represents the first and largest prospective study to date of divers post-COVID-19 infection. Reassuringly, the vast majority of our divers were able to return to diving safely after evaluation. However, we believe that our study highlights the importance of divers receiving, at minimum, an evaluation by a physician after infection and focused testing based on initial severity of symptoms.

In general, the initial severity of disease correlated well with abnormal findings/outcomes, though we did not necessarily find a strong relationship between abnormal imaging and abnormal spirometry, which underscores the need to obtain both and not rely solely on a single result. This finding is similar to those published by others. A retrospective study of 143 French military divers with COVID-19 found that 20 had persistent abnormal spirometry and 24 had abnormal chest CTs, but only three had both.[8] Another study found a higher rate of abnormal chest CTs in military divers post COVID-19 infection, but it should be noted that all subjects had chest CTs done, which likely have a higher sensitivity for abnormal findings, though the clinical significance is still unknown. The severity of disease was variable amongst these divers with a trend towards those who were hospitalised being more likely to have abnormal imaging.[9]

As the virus itself continued to evolve and particularly after the omicron variant became widespread, we noted that many of our divers presented with much milder, primarily upper respiratory infections, thus prompting the guideline revision and development of Category 0.5. Although this study was not designed to formally validate these categories, we do note that all of our category 0.5 divers (except one who failed to follow up) were able to return to dive. We suspect that the small percentage of abnormal findings in this category were either related to non-covid illness or likely the divers' baseline. These findings are similar to a study aiming to validate the South Pacific Underwater Medicine Society criteria for very mild disease (essentially identical to our own). They found that amongst 57 occupational divers who met very mild criteria, all had spirometry unchanged from their baseline and were able to return to diving without incident.[10] Another study of military hyperbaric personnel with asymptomatic or 'subclinical' COVID-19 (not hypoxic or hospitalised) found no significant difference in spirometry compared with non COVID-19 infected peers.[11]

Regarding the feasibility and ease of use of the guidelines, the authors and their colleagues found them easy to use in evaluation and guidance for recommended testing. It should be noted that the evaluation of these divers for this study was performed by a variety of physicians at the clinic (see acknowledgments), thus reinforcing that these guidelines are straightforward to interpret and implement by practitioners. Overall, the testing required was not significantly onerous and able to be accomplished in almost all subjects.

As evidenced by the case vignettes presented, the results of this testing and subsequent counseling of the divers may be nuanced. We ultimately labeled some divers as "*return to dive with restrictions*", but recognise that this is a broad categorisation and dependent on many factors. For example, restrictions or disqualifications for commercial or military divers are often much more clear-cut than for recreational divers. Divemasters or instructors may also have additional tasks or requirements that would make it impossible to modify their diving practices in that role. Additionally, any advice given to recreational divers to potentially mitigate risk is based on expert opinion, but lacks published evidence to support it. It is the authors' opinion and practice that these must be evaluated on a case-by-case basis, taking into account the type of diving and risk tolerance of the individual diver.

We acknowledge that the guidelines do have limitations. We did not specify a mandatory waiting time after infection to be evaluated, though functionally with the mandatory quarantine times, this was a minimum of 10–14 days. We suspect that if we had waited longer, we would have seen fewer initial abnormalities in spirometry. We do not necessarily recommend implementing a longer mandatory time to evaluation but note that it seems more likely to have transient abnormal values of spirometry immediately after infection, as with other non-covid viral respiratory infections.

We also did not specify time intervals for testing or retesting, nor specific types of exercise testing. This was done intentionally to allow flexibility for both divers and practitioners, but we acknowledge that it can make results hard to compare between divers. We also note that our guidelines only addressed cardiac and pulmonary symptoms, but that sequelae of COVID-19 can have a much broader impact. Future studies may need to address other organ system manifestations that could potentially affect divers such as neurologic and systemic (muscle fatigue, decreased exercise tolerance, other cardiac manifestations, postural orthostatic tachycardia syndrome, long COVID).

We did not find a significant incidence or correlation with diving accidents such as decompression sickness, barotrauma, or immersion pulmonary oedema, but given the relatively low incidence of these disease states, we would expect to need a larger sample size and longer follow up period to evaluate such an association.

Conclusions

In conclusion, using the previously published guidelines to evaluate divers after COVID-19, we found that the vast majority of divers were able to return to diving safely, particularly those with relatively mild infections (categories 0.5 and 1).[4,5]

The persistent abnormal findings observed are still of unknown clinical significance to divers and further work will need to be done to better understand their physiologic implications and consequences. These guidelines were relatively easy to adopt and implement by multiple practitioners. It is our stance that work up and evaluation of divers after COVID-19 is still indicated, even if the divers are asymptomatic. At this time, these authors do not have intentions to modify the guidelines or change evaluation protocols for divers who have had COVID-19, though we are open to modifications if indicated in the future.

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