

**RDIMS: 481626**

**RCN SURGEON COMMUNICATION 04/20**

**RETURN TO DIVING FITNESS AFTER RESPIRATORY INFECTION  
WITH COVID-19 ILLNESS**

Ver 1 – 05 Jun 20

Ver 2 – 29 Jul 21 Updated to include additional references from allied forces / dive medicine organizations. Minor update to testing required (Exercise Saturation measurement) & minor update in severity definition. Improved presentation of level of authority / fitness standard through tables instead of text.

References:

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- O. CF Health services Inst 6638-80 – COVID-19 FHP recommendations

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Q. COVID-19 return to Dive Duty Status BUMED guidance for undersea Medicine – May 2021 (US Navy)

R. ADCI - Physician Diving Advisory Committee. Coronavirus related items (<https://www.adci-int.org/files/COVID%20STATEMENT%20PDAC%20FINAL.pdf>)

S. DMAC33 – Return to diving after COVID 10, Dec 2020 (<http://www.dmac-diving.org/guidance/DMAC33.pdf>)

### Abbreviations

ADMO	Advanced Diving Medical Officer
ADPA	Advanced Diving Physician Assistant
AGE	Arterial gas embolism
BDPA	Basic Diving Medical Officer
BDPA	Basic Diving Physician Assistant
CAF	Canadian Armed Forces
CCS	Canadian Cardiovascular Society
CDSM	Consultant in Diving and Submarine Medicine
CFEME	Canadian Forces Environmental Medicine Establishment
CFHIS	Canadian Forces Health and Information System
COVID-19	Coronavirus Disease 2019
CM	Cardiomyopathy
CT	Computerized tomography
CUMA	Canadian underwater mine-countermeasure apparatus
CXR	Chest X-ray
DCS	Decompression sickness
DCI	Decompression illness
DMedPol	Directorate of Medical Policy
ECG	Electrocardiogram
EUBS	European Undersea and Baromedical Society
DMO	Dive Medicine Officer (BDMO or ADMO)
DMPA	Dive Medicine Physician Assistants
HBOT	Hyperbaric oxygen treatment
HCP	Health care practitioner
ICU	Intensive care unit
MEL	Medical employment limitation
MO	Medical officer
PCR	Polymerase chain reaction
POS	Pulmonary overpressure syndrome
PT	Physical training
SOBOE	Shortness of breath on exertion
TCat	Temporary category
UHMS	Undersea and Hyperbaric Medical Society

## **BACKGROUND**

1. Fitness to dive in the context of respiratory illness has typically been treated on a case-by-case basis after appropriate clinical recovery, reassessment, investigations and specialist consultation, when necessary. However, the advent of COVID-19, which brings early reports of unexpected and significant lung damage secondary to infection, triggered a requirement for this policy.
2. A preliminary Austrian report by Dr Hartig (Ref. A) documented 6 divers, some showing significant radiologic changes on CT and associated physiologic changes with "oxygen deficiency" under stress, suggesting shunting. These 6 divers reportedly had COVID-19 several weeks prior, with symptoms not severe enough to be hospitalized. Hartig made recommendations that divers recovering from COVID-19 should have a thorough exam by a diving physician before returning to diving. While not peer-reviewed, this data in conjunction with peer-reviewed data regarding pulmonary damage during COVID-19 (Ref. B) raises safety concerns for those with a history of COVID-19 infection and an occupation requiring exposure to the hyperbaric/diving environment and potential extremes of physiological performance.
3. Despite the availability of multiple guidance documents for assessing fitness to dive in patients with history of COVID-19 (ref D, Q-S), the data required for a unified standard approach for assessing and confirming fitness to dive in the diver with suspected or confirmed COVID-19 remains lacking. UHMS acknowledged this concern, and is now in the process of formulating specific recommendations. One health center (UCSD) and the US Navy have also published some relevant guidance (Ref. D & Q). The level of evidence concerning COVID-19 and diving fitness is mostly anecdotal and expert opinion based. Although evidence on COVID-19 overall is increasing rapidly, large cohorts of hospitalized patients usually represent groups of subjects with median age over 60 with multiple comorbidities, which is not representative of our population of military divers. Different strains of COVID-19 may have different effects on various organ systems. As such, the recommendations in this Communication are based on CAF CDSM consensus that draws input from our international military and civilian undersea medicine colleagues.

## **PURPOSE**

4. The purpose of this communication is to guide DMOs and DMPAs during the assessment of, and determination of fitness for divers who have recovered from COVID-19 infection. These recommendations are based on clinical judgment, expert undersea and hyperbaric physician opinion, AUMB specialist recommendation and scientific evidence available at this time. Infection prevention and control measures and disease transmission mitigation are detailed elsewhere (Ref. E).

## **IDENTIFICATION OF CASES and MELs**

5. The CAF has divers across several units within RCN, CA, RCAF and SOFCOM lines, which include Clearance divers, Port Inspection Divers, Ships Team divers, Combat divers, SAR Techs and other MOSIDs for which hyperbaric exposure may occur, such as DMO/DMPA,

Aviation Physiology Technicians and Aviation Medical Training Officers. The guidance within this document will apply to “confirmed” cases, but a low threshold should be applied to include probable cases as well. Although we now have very effective immunizations against COVID-19, the risk of infection is not completely eliminated. Suggestive symptoms should trigger appropriate assessment.

6. Divers diagnosed as confirmed or considered to be high possibility probable COVID-19 cases require medical employment limitations (MELs) which will be determined by the severity of their illness. This must include the MEL “UNFIT DIVING until reviewed by ADMO or CDSM”. The local ADMO is responsible to assess the patient and discuss potential consequences of COVID-19 with the local dive chain of command, as needed. The local ADMO will also be responsible to engage a CDSM to assist with, or record, final fitness determination.

### SEVERITY OF ILLNESS

7. While COVID-19 more often adversely affects those over 50 years of age and with comorbidities such as moderate to severe respiratory disease, diabetes, chronic liver and kidney disease, CAD and hypertension, there is still potential that young, fit military divers will experience a severe presentation. DFHP also estimates that 13% of positive cases may be asymptomatic (although literature reports very wide range of numbers). As with diving fitness disposition secondary to other respiratory illness, a severity-of-illness-based approach is the most reasonable given current evidence. The first step in determining fitness for duty is to classify the severity of illness as either asymptomatic, mild, moderate, or severe on the basis of 4 factors: 1) the nature of symptoms, 2) testing, 3) imaging, and 4) the nature of treatment. We suggest the following considerations and guidance for classification of the severity of COVID-19 patients:

**TABLE 1- Determination of COVID-19 illness severity**

	Asymptomatic	Mild	Moderate	Severe
Symptoms	None	Fever, Cough, rhinorrhea, sore throat, muscle Ache Atypical: Nausea, Vomiting, Anosmia, rash....others	Mild + Significant shortness of breath / respiratory distress / chest pain / mental status change.	
Testing	+ PCR / Rapid Ag testing	+ PCR / Clinical Epi-link		
Imaging	None	+/- CXR – no acute findings	CXR or CT with acute findings which may include consolidation, fibrosis, ground glass opacities, cavitations, bleb, bullae.	
Treatment	None	+/- Clinic visit; Uneventful self-isolation at home; <b>no</b> supplemental oxygen requirement, <b>no</b> suspected cardiac (myocarditis / pericarditis) involvement.	Likely ER consult; Outpatient treatment or short hospital stay for O2; No intubation.	Inpatient course required; Any ICU level care or intubation;

## **REQUIRED INVESTIGATIONS BASED ON CATEGORY OF SEVERITY DURING FITNESS DETERMINATION**

8. Table 2 describes the minimum actions required for return to diving for each category. Members having persistent symptoms will have a case by case assessment depending of the symptomatology. Tests ordered have to be normal or at baseline to allow for return to diving without further review.

**TABLE 2 - Recommended minimal actions for return to CAF diving fitness after COVID-19 illness**

	<b>Asymptomatic</b>	<b>Mild &amp; Fully recovered</b>	<b>Mild &amp; ongoing or lasting more than 2 weeks</b>	<b>Moderate to severe</b>
<b>Refrain from strenuous physical activity</b>	2 weeks from diagnosis	2 weeks from symptom resolution	Case by case	Case by case
<b>Unfit Diving period after resolution of symptoms</b>	1 month (after date of positive test)	1 month	6 weeks (*from disease onset)	2 months
<b>Clinical</b>	Full Diver S/O exam - to include Cardiac, Resp and Neurological physical exam			
	Back to Full Strenuous PT without noted limitation from pre-illness.			
		Rest O2 Sat 95% or above		
			Exercise O2 Sat as per Table 4	
<b>Lab</b>	None	Only if indicated	Case by case with CDSM input	
<b>Investigations</b>	None	Dive (3 view) CXR	Case by case with CDSM input (Likely chest CT)	
		Resting ECG		
		Normal (baseline) office Spirometry	Full Pulmonary function test with lung volumes, diffusion capacity (+/- Resp Challenge testing)	
<b>Consultations</b>	CDSM for info / tracking	CDSM for review	CDSM +/- Specialist	CDSM +/- Appropriate specialist + US-AUMB
<b>MEL on resumption</b>	None	Consider if oxygen enriched / deep diver.	Discuss with CDSM	Discuss with CDSM

## SPECIAL CONSIDERATIONS

9. Additional review is required if any of the following were present during the course of infection or recovery:

- (1) If there is history of persistent SOBOE after initial illness resolved, shunting is of concern. Formal cardiopulmonary exercise testing (CPET) may be considered, although difficult to arrange at present. As a minimum, oxygen saturation monitoring with maximum effort exercise testing should be arranged to assess for an excessive drop in saturation with exercise.
- (2) **Pneumothorax/ empyema (with or without a chest tube):** Member will require a US-AUMB review.
- (3) **Abnormal chest imaging:** member must be re-screened with CT chest (high-resolution CT) in order to rule out permanent scarring, bleb or cavitation. Even small amounts of scarring or new bleb/cavitation can predispose to pulmonary overinflation syndrome (POS) and arterial gas embolism (AGE). Review of lung imaging in COVID-19 patients (with severe enough disease to warrant CT) shows changes peaking at 10 day post-symptom onset (ref. B). In another study from China (ref. G), only 8% of 149 hospitalized patients had normal CT on discharge, this went up to 53% at 3 weeks post discharge.
- (4) **Coagulopathy:** CBC, INR, PTT, D-Dimer should be reviewed for all patients hospitalized and/or any thrombotic red flags. Some 20-55% of patients hospitalized for COVID-19 have lab evidence of coagulopathy which seems prothrombotic in nature.(Ref. H) This prothrombotic state seems to confer a worse prognosis during hospitalization, but it is unclear if it is a consequence of the virus or a reaction to the infective process. Association of DCI and coagulopathy is another controversial issue, but may be a predisposing factor and/or confer worse prognosis. Coagulopathy should normalize during the unfit diving period following illness (1-3-mo), but for some patients, a CBC, INR, PTT should be considered before return to diving occurs. In addition, depending on the specific presentation, consideration of hematology or internal medicine consult should be considered. “COVID toes” may be an indicator of such thrombotic complication and should trigger appropriate investigations before return to CAF diving.
- (5) **Cardiac involvement:** Some COVID-19 patients have experienced cardiac complications, such as myocardial injury with increased troponins. Pathophysiology is heterogeneous, but mainly acute coronary syndrome type 2 (supply-demand) as well as myocarditis and cardiomyopathy occurring in severely ill patients and those with pre-existing conditions. Scientific reports also suggest ~16% of patients may experience arrhythmia (Ref. I). These complications in hospitalized patients with COVID-19 are reported to occur at a rate much higher than other viral infections (22% vs 1%) (Ref. F). JAMA has also published its guideline for resumption of sports and exercise after COVID-19 (Ref. F) which recommend a period of rest/no exercise for 2 weeks for all who tested positive for COVID-19 (even those never symptomatic). In the event of cardiac involvement, CDSM consultation and referral to Cardiology/Internal Medicine is required, with consideration of the following investigation:

- i. Hs-troponin
- ii. Echocardiography
- iii. Stress testing
- iv. Holter monitoring

(6) **Neurological manifestations:** Anosmia is a relatively common reported symptom. (Ref. K) Although in itself anosmia has very little pertinence to diver fitness, it may indicate neural invasion of the virus. Careful attention to the peripheral and vestibular components of the neurological exam should be undertaken (2-point discrimination / Cold sensation / Vibration / Modified Romberg). Any anomalies should be discussed with CDSM in interpreting fitness to dive.

## CONSIDERATION FOR MEL

10. **Lung:** The Belgian Society of Diving and Hyperbaric Medicine (Ref. D) suggests that the physiologic bubble filtration capability of the lung may be compromised by COVID-19-induced inflammatory changes. They recommend that consideration is given to restrict decompression diving in order to avoid any bubbles forming, escaping the lung filter, and therefore increasing risk of DCS. A known PFO could theoretically add to this shunting, however, there currently exists no scientific data on this issue. This potential concern will be addressed on a case-by-case basis with specialist consultation, when considering return to diving.

11. **Pulmonary Oxygen toxicity:** Both Dr Hartig's article and Belgian report discuss the possibility of enhanced pulmonary oxygen toxicity. This conclusion is largely theoretical. There are currently no reports describing enhanced pulmonary oxygen toxicity in ICU COVID-19 patients, however it is a concern for hyperbaric treatment in which ppO<sub>2</sub> can reach 2.8 ATA. Nonetheless, until this theory is further elucidated, we recommend that divers using enriched oxygen mixtures should be warned of this theoretical complication, and any diver who suffered a moderate to severe COVID-19 illness progress through an incremental return to diving. As such, it is recommended DMO considers MEL's for no decompression diving or exceeding an oxygen partial pressure of 1.4 ATA for the first 30 days of diving. Divers who suffered only mild symptoms do not absolutely require this restriction, but should be counselled about this possibility and to abort dive safely (slow ascent) if unusual chest symptoms present during a dive.

## CONCLUSION

12. At this point in time, there is still no validated national or international standard for fitness to dive determination after COVID-19, however we have reviewed the currently available evidence as well as other international guidance based on expert opinion and applied it to CAF diving to produce this communique.

13. DMO & DPA need to involve CDSM for all cases (see table 2). Mild & asymptomatic cases can be managed by ADMO if no ambiguity, but CDSM should be made aware of case.

14. We expect this advice to evolve as new scientific evidence becomes available. Any questions may be directed to appropriate regional CDSMs.

**TABLE 3: Examining, Reviewing and Approval Clinician Requirements**

<b>COVID-19 Severity</b>	<b>Examining Clinician</b>	<b>Reviewing MO</b>	<b>Approval</b>
Asymptomatic	DMO (note 1)	ADMO	ADMO
Mild (resolved)	DMO (note 1)	ADMO	CDSM (note 2)
Mild with persisting symptoms or Moderate/Severe	DMO	CDSM	CDSM/AUMB

Notes:

1: May be a specific, experienced ADMT (ADPA) as delegated by a CDSM.

2: Approval may be granted by the reviewing MO if said review is completed by a CDSM or an ADMO as delegated by CDSM (i.e., Fleet Support MO)

**TABLE 4 - Exercise Saturation challenge**

<b>Criteria for testing</b>	Subjectively back at pre-illness physical fitness Resting SpO2 of 95% or more Minimum 2 weeks from resumption of illness Cardiology review if had significant cardiac involvement
<b>Testing procedure</b>	CAF member to exercise on treadmill, elliptical or exercise bike to a HR of 120-130. Continuously monitor SpO2 while maintaining HR for 10 minutes. (*Treadmill testing may be difficult given movement of sat probe)
<b>Interpretation</b>	Any saturation of <90% or desaturation of more than 5 % will trigger review from CFEME.