Aerospace Medicine Clinic

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You're the flight surgeon in a small Canadian community, where you also serve as a Civil Aviation Medical Examiner (CAME). Today's exam is for a 36-yr-old civilian aviator presenting for medical recertification following a recent COVID-19 infection.

1. Which of the following are the most important questions to ask regarding the course of illness?

   A. Length of symptoms.
   B. Vaccination status.
   C. Presence of COVID-19 sequelae.
   D. Complicated course of illness with hospitalization.
   E. C and D.
   F. All of the above.

ANSWER/DISCUSSION

1. **E.** As a CAME, it is typically your discretion to renew a Medical Certificate (MC) for a pilot post-COVID-19 infection, unless the course of illness was complicated (e.g., hospitalization) and/or there is presence of COVID-19 sequelae. In those cases, you must defer the decision to Transport Canada's Civil Aviation Medicine Branch (CAM). Hospital records must also be submitted to CAM for review. For those seeking recertification with a history of asymptomatic infection, or symptomatic infection with no complications or sequelae, medical certification can be renewed by a CAME.

The presence of Post-Acute Sequelae of COVID-19 (PASC) has been seen as a function of severity of an acute COVID-19 infection. One study examined 181,384 U.S. veterans who survived the first 30 d of COVID-19 infection, categorizing patients by disease severity: non-hospitalized (N = 155,987), hospitalized (N = 19,359), and those requiring intensive care unit (ICU) treatment (N = 6038).[19] Results were compared to a control population of 4,397,509 noninfected veterans. It was found that the rate of having at least one sequela in the 6-mo period following acute infection dramatically increased depending on the severity of the acute illness. Those who were non-hospitalized had a rate of 44.51 per 1000 persons. The hospitalized rate of PASC was 217.08 per 1000 persons, and the ICU rate was 360.16 ICU per 1000 persons. Overall, the study found that the burden of PASC beyond the first 30 d of infection was 4.4% in non-hospitalized, 21.7% in hospitalized, and 36.5% in those who required ICU admission.

Two separate longitudinal studies found a high rate of sequelae in COVID-19 patients requiring hospitalization both 3 mo[20] and 6 mo[10] post-discharge from hospital. Of 538 survivors in one study, 49.6% reported general symptoms 3 mo post-discharge, including 28.3% reporting physical decline and fatigue.[20] 39% reported respiratory symptoms, 13% reported cardiovascular symptoms, and 22.7% reported psychosocial symptoms—with the most common being somnipathy (17.7%).[20] Similarly, a cohort study of 1733 patients 6 mo post-discharge found that 63% reported ongoing fatigue or muscle weakness, and 23% reported sleep difficulties.[10] Disease severity was stratified based on patients not requiring supplemental oxygen, patients requiring supplemental oxygen noninvasively, and patients requiring invasive ventilation.[10] Patients with more severe illness had significantly more impaired diffusing capacity of the lungs for carbon monoxide on 6 mo post-infection pulmonary function tests, as well as more abnormal findings on chest CT as compared to patients with less severe acute illness.[10]

The correlation between PASC and severity of illness, as well as the high rate of sequelae in those previously hospitalized for COVID-19, defines the rationale behind a more detailed review of these pilots prior to recertification. Further, many of the sequelae seen in previously hospitalized patients can be particularly dangerous for pilots, including: fatigue, cardiovascular symptoms, respiratory symptoms, weakness, and somnipathy. Impaired pulmonary functioning (as demonstrated with reduced diffusing capacity of the lungs for carbon monoxide) and abnormal imaging findings could represent grounds for disqualification from recertification, depending on the impact to the ability to safely operate in the aerospace environment.

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2. The pilot describes mild COVID-19 symptoms with an uncomplicated course of illness. What are some examples of COVID-19 sequelae that they may report?

   A. Fatigue.
   B. Muscle weakness.
   C. Exercise intolerance.
   D. Somnipathy.
   E. Presyncope/syncope.
   F. Arthralgia.
   G. Depression, anxiety, dysphoria.
   H. Cardiovascular dysfunction.
   I. All of the above.

ANSWER/DISCUSSION

2. **I.** PASC have been reported in almost all bodily systems. Examples of cardiac PASC include chest pain, palpitations, and myocarditis.[13,14,17] Some respiratory PASC include pleurisy, pulmonary fibrosis, and dyspnea.[14,15] Neural deficits including anosmia and sensorineural hearing loss have also been reported.[3,8,11] With regards to the musculoskeletal system, previous studies report patients experiencing symptoms such as myalgias, arthralgias, and weakness.[12,14,15] Mental health PASC include depression, anxiety, and cognitive impairment, among others.[6,7,16] Renal injury, erectile dysfunction, and urinary dysfunction are all examples of genitourinary PASC.[5,7,15] Lastly, numerous gastrointestinal PASC have been reported such as diarrhea, nausea, and abdominal pain.[4,5,14] A summary of PASC (grouped by body system) is presented in **Table I**. Potential findings that may be uncovered during review of systems and examination procedures, as outlined in the CAME handbook, are also listed.[18]

Although some sequelae may have more pertinence to pilot medical recertification than others, current regulations state that the presence of any sequelae warrants deferral to CAM for review and decision. It should be noted that Table I is not an exhaustive list of all possible PASC. In the event that other explanations for the presence of PASC are likely, further investigations may be warranted prior to decision. However, the presence of these symptoms must still be communicated to CAM with decision for recertification being deferred at the time of examination.

3. Which PASC may result in a decision to deem the pilot unfit for recertification, according to the CAME handbook?

   A. Myalgia.
   B. Guillain-Barré syndrome.
   C. Severe migraines.
   D. Irritable bowel syndrome.

Table I. PASC with Potential Examination/Testing Findings.

SYSTEM	SEQUELAE	POTENTIAL FINDINGS ON REVIEW OF SYSTEMS	POTENTIAL EXAMINATION/ TESTING FINDINGS
Cardiopulmonary[7,14,15,17,20]	Myocarditis; pericarditis; myopericarditis; right ventricular dysfunction; myocardial infarction; vasculitis; venous thrombosis; postural tachycardia syndrome; arrythmias; Pulmonary fibrosis; pneumonitis; pleurisy; secondary bacterial infection; pulmonary emboli	Chest pain; palpitations; dyspnea; cough; fever; sore throat; pre- syncope/syncope; dizziness	Tachycardia; dyspnea; poor perfusion; hypertension; labile heart rate and blood pressure with orthostatic and activity changes; ECG abnormalities*; murmurs; extra heart sounds; unilateral leg swelling; carotid bruit; focal neurological deficits; crackles, decreased breath sounds, and/or adventitious sounds on lung auscultation.
ENT[3,7,8,14,15]	Sensorineural hearing loss; anosmia	Loss of smell/taste; difficulty hearing	Failed whisper test; audiology abnormalities†
MSK[7,12,14]	Sarcopenia; myopathy; myositis; arthritis	Post-exertional malaise; joint pain; weakness; disturbed balance/gait	Muscle weakness; muscle/joint stiffness; abnormal balance/gait
Nervous[6,7,11,14-16]	Encephalitis; ischemic stroke; cerebral hemorrhage; Guillain- Barré syndrome; anxiety, depression, PTSD; cognitive impairment; migraines; seizures; somnipathy	Profound fatigue; problems concentrating; brain fog; low mood; anxiety; dysthymia; headaches; seizure-like symptoms	Mental status changes; focal neurological deficits; abnormal gait; abnormal reflex test
Genitourinary[5,7,14,15]	Urinary dysfunction; post-inflammatory glomerulonephritis; orchitis; epididymitis; embolic renal infarction	Involuntary voids; difficulty voiding; testicular pain; hematuria; oliguria; erectile dysfunction	Hematuria and/or proteinuria on urine dipstick‡
Gastrointestinal[4,5,7,14,15]	Pancreatitis; hepatitis; gastroenteritis; irritable bowel syndrome; ischemic colitis	Diarrhea; nausea; overall changes in bowel habits; hematochezia; abdominal pain; bloating; anorexia	Pruritis; jaundice; hepatomegaly; tenderness; guarding

*ECG only required at first examinations for class 1 and 2 medical categories, and then incrementally depending on age. For those seeking class 3 or 4 medical categories, ECG requirement is dependent on age.
†Audiogram only required for first examinations for class 1 and 2 medical categories and then at 55 yr old. For classes 3 and 4, it is only required if clinically indicated.
‡Generally, urine dipstick is performed to examine for presence of glucose; however, the presence of proteinuria/hematuria can also be examined using most dipsticks.

ANSWER/DISCUSSION

3. **C.** Widely, any condition which may compromise a pilot's ability to safely operate an aircraft can be determined to be grounds for disqualification for medical certification. Within the CAME handbook,[18] migraines are classified into 'without aura' and 'with aura'. Pilots who experience migraines without aura can generally be considered fit. Migraines with aura are further categorized into three groups: 1) migraines with aura which do not interfere with flight safety and for which the same aura has been consistent over several years; 2) migraines with auras which are slow onset, occur infrequently, are not associated with any cognitive impairment and/or cause only minor sensory difficulties which do not impair performance, and for which the same aura has been consistent over several years; and 3) migraines with significant auras that could affect flight safety and do not fit into Group 2 with regards to onset, frequency and effect on cognition. Most pilots who suffer from migraines and fall into the first two categories can be considered fit for certification. Due to the safety risk associated with those who fall into Group 3, such pilots are considered unfit; however, they may be considered for restricted medical certification if they fall into Group 2 after a 3-yr period of stability.[18] Other COVID-19 sequelae that can deem a pilot unfit for certification are demonstrated in **Fig. 1**.

Although not explicitly outlined in the CAME handbook,[18] many other PASC would likely impact the determination of fitness of a pilot for medical certification. For example, fatigue and cognitive impairment are some of the most commonly experienced sequelae as reported in contemporary literature.[6,14,15] The degree of severity of these sequelae and their potential impact on one's ability to safely operate an aircraft have not been well examined and can likely vary notably from pilot to pilot. Nevertheless, the potential dangers of granting medical certification to pilots experiencing any PASC are significant. It is therefore important for CAM to review these pilots on a case-by-case basis to best determine fitness for aircraft operation.

4. How would your approach change for a pilot serving in the Canadian Armed Forces (CAF)?

   A. They would be disqualified from aircrew selection for life.
   B. The degree of severity of acute infection would not factor into my decision.
   C. They would require a brain MRI to look for evidence of ischemic damage.
   D. The approach is the same as for civil aviation.
   E. They would require exertional testing either by 6-min walk test and/or 1-min sit-to-stand test.

ANSWER/DISCUSSION

4. **E.** CAF has released a Flight Surgeon guideline outlining procedures to determine aircrew medical fitness post-COVID-19.[2] Similar to CAM, military post-COVID-19 fitness certification procedure is stratified based on infection severity and the presence of complications. For mild symptoms with an uncomplicated course of illness (e.g., no hospitalization) as well as full resolution of symptoms, CAF has outlined mandatory history, physical examination, and testing to be completed.[2]

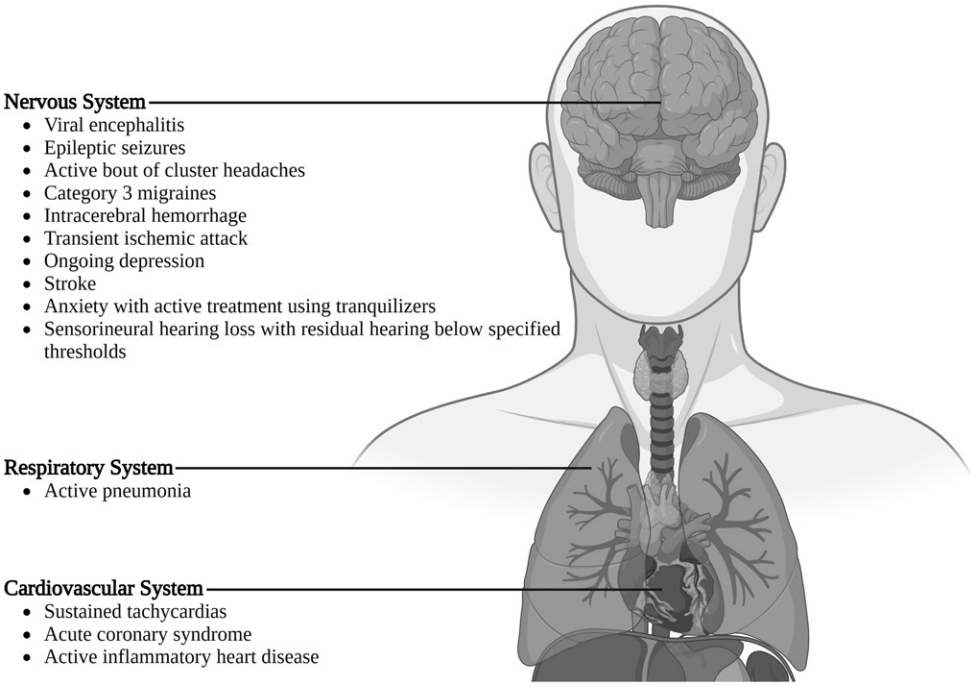

Fig. 1. Pathologies and symptoms which are post-acute COVID-19 sequelae and can make a pilot unfit for medical certification according to the Transport Canada CAME Handbook. Created with BioRender.com.

Additionally, a history of COVID-19 infection within the past 3 mo is automatically disqualifying for aircrew selection, and a remote history can be considered only on a case-by-case basis.[1] Current aircrew members are deemed temporarily unfit with a confirmed diagnosis and must undergo the same testing as new pilots in order to return to service.[1] Another key difference between military and civilian guidelines is unto whom discretion to issue medical certification falls. Largely, discretion falls to CAME's within civil aviation.[18] Only in the cases of hospitalization or with evidence of sequelae must decisions be deferred to CAM. Within CAF, multiple regulatory bodies review each complex case.[2] Unsurprisingly, military guidelines call for more specific and extensive examination of pilots as compared to those for civil aviation.[1,2,18] The higher demands and increased danger of military aircraft operation necessitate more comprehensive review of pilots after an acute COVID-19 infection, in order to determine medical fitness. The Federal Aviation Administration (FAA) has also amended their own guidelines for aviation medical examiners to include guidance for examination of pilots with previous COVID-19 infection.[9] These guidelines are similar to their CAM counterparts, with the main difference being that, according to the FAA, hospitalization does not necessitate deferral of decision to the regulatory body.[9] Only in cases where ICU care is required, and/or post-acute-COVID-19 sequelae are apparent, is deferral mandated.[9] A comparison between CAM, CAF, and FAA guidelines in illustrated in **Fig. 2**.

Much remains unknown with regards to the effects of COVID-19 infection on a pilot's ability to safely operate an aircraft. Potential sequelae of the disease are numerous and varied. It is therefore important for aviation medicine practitioners to carefully examine cases of pilots seeking recertification following acute infection. Aviation regulatory bodies have differing procedures and requirements for recertification, depending on disease severity and the presence of sequelae. In Canadian civil aviation, there should be a low threshold for deferral of decision to the CAM if doubts arise. Furthermore, the process and requirements for recertification following COVID-19 infection are likely to evolve as the disease process and post-disease state is further understood. It is the responsibility of the aviation practitioner to remain up to date with these changes to best serve their aircrew. As the aviation industry re-emerges in the post-pandemic world, aviation medicine serves a critical role in maintaining flight safety.

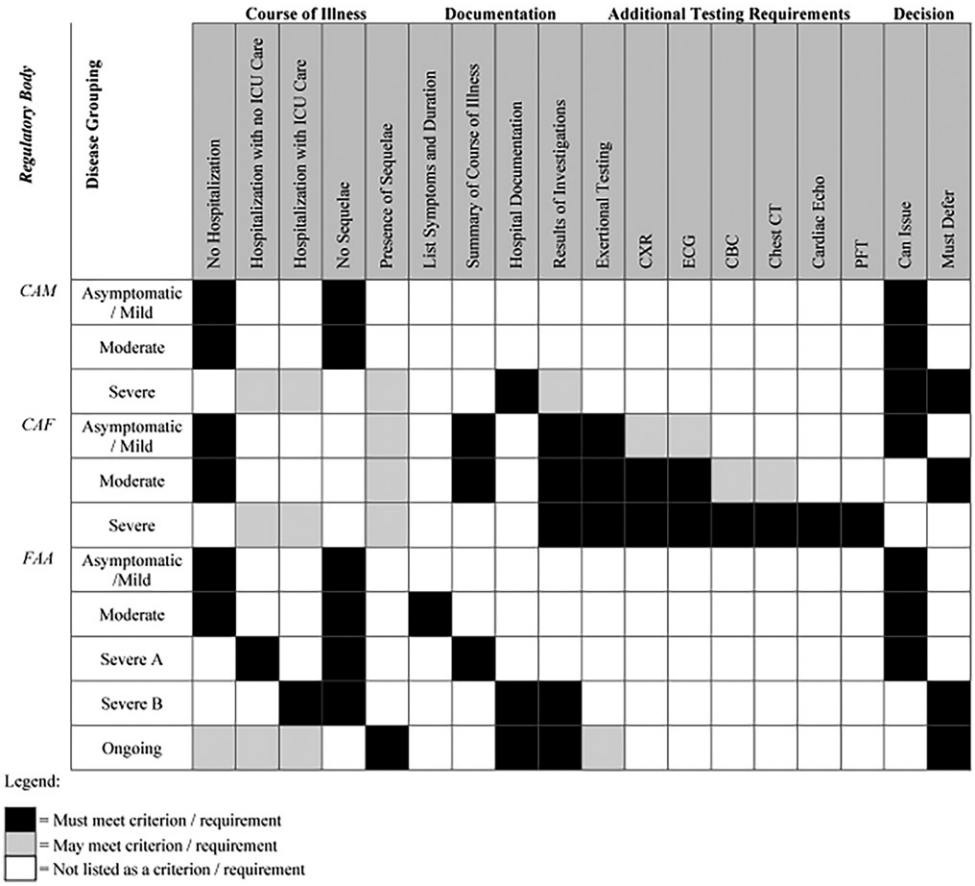

Fig. 2. CAM vs. CAF vs. FAA post-acute COVID-19 Medical Certification comparison chart. CAM = Transport Canada's Civil Aviation Medicine Branch; FAA = Federal Aviation Administration; and CAME = Civil Aviation Medical Examiner.

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