Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Clinical Imaging 85 (2022) 118–119

Contents lists available at ScienceDirect

Clinical Imaging

journal homepage: www.elsevier.com/locate/clinimag

Letter to the editor

Pneumocystis pneumonia: An important consideration when investigating artificial intelligence-based methods in the radiological diagnosis of COVID-19

ARTICLE INFO

Keywords
Pneumocystis
SARS-CoV-2
Covid
Imaging
Artificial intelligence
Deep learning

To the Editor,

I read with interest the article by Benameur et al. reviewing the radiological features of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection by various imaging modalities and describing the artificial intelligence (AI) approaches developed for SARS-CoV-2 infection diagnosis and its differentiation from other infections [1]. In their article, the differential diagnosis of SARS-CoV-2 infection focuses on viral and bacterial pneumonia, in particular viral infections, as the authors state that the main challenge for radiologists is how to differentiate between SARS-CoV-2 infection and other viral infections with the same clinical features. The authors also state that to address this issue future works are needed to identify the most relevant features to differentiate between different viruses. I agree that this is an important issue, however the fungal respiratory illness, Pneumocystis pneumonia, also known as PCP (caused by *Pneumocystis jirovecii*) is not mentioned in their article. Moreover, their article summarises 13 studies of existing artificial intelligence approaches for the detection of SARS-CoV-2 infection using chest x-ray and computed tomography (CT) images. These 13 studies had control groups (typically with a range of bacterial and non-SARS-CoV-2 viral respiratory infections) and SARS-CoV-2 infection groups, however, only 1 of the 13 studies specifically mentioned including patients with Pneumocystis pneumonia in their control group [2]. Even this one study that mentioned Pneumocystis pneumonia only included 2/1396 patients with Pneumocystis pneumonia in the control group used for AI training and included 0/156 patients with Pneumocystis pneumonia in the control group used for AI testing.

One of the key areas where benefit could come from using AI is in the differentiation of SARS-CoV-2 infection from Pneumocystis pneumonia. Clinically, patients with SARS-CoV-2 infection and Pneumocystis pneumonia may both present with a fever, dry cough and breathlessness. Radiologically, both SARS-CoV-2 and *Pneumocystis jirovecii* infections can progress to bilateral ground-glass opacities amongst other findings. Although the distribution of lung involvement is often described as more peripheral in SARS-CoV-2 infection compared to in *Pneumocystis jirovecii* infection [3] differentiating between the two infections radiologically can be a challenge. This is supported by the fact that during the coronavirus disease 2019 (COVID-19) pandemic there have been multiple reports of patients with a delayed diagnosis of Pneumocystis pneumonia (particularly in patients with previously undiagnosed immunosuppression[both HIV and non-HIV]) due to misdiagnosis as SARS-CoV-2 infection [4–8]. Furthermore, as we know that throat swab sensitivity for SARS-CoV-2 infection is in the region of 70% [9], many patients with a negative SARS-CoV-2 swab result will still be treated as having a SARS-CoV-2 infection based on imaging findings.

I agree that differentiation of SARS-CoV-2 infection from other bacterial or viral infections is important as they are seen more commonly than Pneumocystis pneumonia. However, Pneumocystis pneumonia requires specific treatment unlike many viral infections that often resolve without specific treatment. Additionally, many patients with suspected or confirmed SARS-CoV-2 infection are given antibiotics routinely to cover for a possible bacterial co-infection, but Pneumocystis pneumonia is not covered by first line antibiotics given for a community acquired pneumonia. Also, the fact clinicians/radiologists see Pneumocystis pneumonia far less frequently potentially renders it less likely to be considered and/or recognised on imaging.

Of additional note, significant decreases in the prevalence of other (non-SARS-CoV-2) viral respiratory infections has been observed during the COVID-19 pandemic when compared to pre-pandemic years [10], possibly attributable, at least in part, to public health measures implemented. However, these public health measures may have less of an impact on the prevalence of Pneumocystis pneumonia infections given that reactivation of latent *Pneumocystis jirovecii* infection within an individual is considered to be one mechanism for Pneumocystis pneumonia [11] (unlike with respiratory viral infections which are typically due to de novo infection). Therefore, Pneumocystis pneumonia needs to remain under strong consideration whilst SARS-CoV-2 continues to circulate and needs to be incorporated into AI-focused imaging strategies. The AI challenge is further complicated by the fact that there have been numerous reports of *Pneumocystis jirovecii* and SARS-CoV-2 coinfections [12].

https://doi.org/10.1016/j.clinimag.2021.02.044
Received 8 February 2021; Accepted 23 February 2021
Available online 26 March 2021

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