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Highlight

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From The Editor

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Hospitals, field hospitals, community isolation centers, and home isolation

The Editor at his workplace in Southern Thailand interprets chest radiographs from all parts of Thailand through RadioVolunteer project's platform.

Unlike the first and second waves of COVID-19 pandemic in Thailand which were limited among certain populations in certain areas, the third wave starting in April 2021 has spread nationwide. The hospitals and health-care organizations in the outbreak areas responded to the second wave by setting field hospitals to expand their capacity for non-critical infected patients. Trimankha et al. shared their experiences in a field hospital during the second wave in this issue.

The first and second waves occupied the entire 2020 until March 2021 with 28,000 collective infected cases. There have been almost one million cases by far in combination with the cases arising in the third wave [1]. It went from less than 10 new cases a day in 2020, to around 2,000 a day in June and then more than 20,000 new cases a day in August 2021. Among the four doctors who were killed by COVID-19 during this third wave in Thailand, one of them was a very keen and well-respected member at the Royal College of Radiologists of Thailand, Associated Professor Wilaiporn Bhothisuwan. Our memory of her is commemorated in this issue.

When hospitals and field hospitals are currently full, COVID-19 infected patients are cared for in the form of community isolation in public places such as hotels, temples and schools. Home isolation, the latest and probably the final form of health care, was established in August this year.

In whatever form of caring units for COVID-19 patients, a chest radiograph plays a pivotal role in showing the extent of lung involvement. Radiographic units were installed at all field hospitals and some community isolation sites. Six radiographic centers for patients with home isolation were installed in Bangkok, famously known as Rapid X-ray project by Rajavithi Foundation in cooperation with other non-profit organizations [2]. The Royal College of Radiologists of Thailand launched a project called "RadioVolunteer" to interpret and report chest radiographs of COVID-19 patients in prisons, field hospitals where there was a shortage of radiologists, some community isolation centers, and for the Rapid X-ray project. I participated in the RadioVolunteer project early, so did more than 350 radiologists from all parts of Thailand. How the RadioVolunteer project was established and operated has been described in this issue.

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References

1. สถานการณ์ผู้ติดเชื้อ COVID-19 อัพเดทรายวัน [อินเตอร์เน็ต]. นนทบุรี: กระทรวงสาธารณสุข; 2564 [เข้าถึงเมื่อ 18 สิงหาคม 2564]. เข้าถึงได้จาก : https://ddc.moph.go.th/covid19-dashboard

2. โครงการเอกซเรย์ปอด ช่วยโควิด [อินเทอร์เน็ต]. กรุงเทพ: มูลนิธิโรงพยาบาลราชวิถี; 2560 [เข้าถึงเมื่อ 18 สิงหาคม 2564]. เข้าถึงได้จาก: https://www.rajavithifoundation.com/front/activity-details.php?type=1&id=25

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Original Article

Utility of screening chest radiographs in patients with asymptomatic and mildly symptomatic COVID-19 at a field hospital in Samut Sakhon, Thailand

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Abstract

Background: In a new episode of the COVID-19 pandemic in Thailand during the beginning of 2021, cases in Samut Sakhon Province mainly occurred in foreign workers and were mostly asymptomatic or had mild disease. To prevent overwhelming the local hospital, a field hospital was established which used chest radiography as one of screening tools for triaging patients.

Objective: To determine the clinical utility of chest radiographs as a screening tool for COVID-19 patients who were asymptomatic or mildly symptomatic.

Materials and Methods: Six hundred nineteen patients with COVID-19 (confirmed by reverse transcriptase-polymerase chain reaction) were registered at the field hospital at Samut Sakhon provincial sport stadium during 5-8 January 2021 and had chest radiographs taken. The image readings were based on the consensus of two radiologists and a final decision was made by a third radiologist if the first two did not agree. Findings on chest radiographs and clinical outcomes were evaluated.

Results: The study included 619 radiographs; 328/619 (53%) men and 291/619 (47%) women had a mean age of 33.3+/- 9.7 (range, 5-64) years. There was mild disease in 13/619, and asymptomatic infections in 606/619. Chest radiographs were normal in 568 (91.7%) and abnormal in 51 (8.3%) patients; typical findings of COVID-19 were seen in 3 (0.5%) patients. Other abnormal findings were found in 23 (3.8%) patients such as active tuberculosis in 6 (1.0%). Four patients were transferred to the hospital, one of whom required supplemental oxygen.

Conclusion: Combined chest radiographic and clinical information allows better decisions regarding hospital transfers of asymptomatic and mildly symptomatic COVID-19 patients at a field hospital.

Keywords: COVID–19, Chest radiographs, Field hospital.

Introduction

The coronavirus disease 2019 (COVID – 19) caused by the novel severe acute respiratory syndrome coronavirus-2 (SARS-COV-2) emerged in Wuhan, China, in December 2019 [1]. It was declared a global pandemic by the World Health Organization (WHO) at 10:00 AM (Central European Time) on 10 February 2021, with 106,321,987 confirmed cases, including 2,325,282 deaths [2]. About 81% of persons with COVID-19 have a mild clinical course, while about 14% have severe and 5% critical clinical courses [3]. Importantly, 40-45% of asymptomatic cases can transmit virus for longer than 14 days [4]. The incubation period lasts approximately 4-5 days, generally within 14 days of exposure [5,6]. The standard method to make a definite diagnosis of SAR-COV-2 infection is the reverse transcription-polymerase chain reaction assay (RT-PCR) [7].

Radiological imaging plays a crucial role in the evaluation of disease severity during the course of COVID-19, leading to proper management [8]. Chest X-ray is generally considered to lack sensitivity in identifying pulmonary abnormalities during the early stage of disease [9]. The sensitivity of chest radiography increases from 55 % at less than 2 days, to 79 % at more than 11 days after symptom onset [10]. The Fleischner Society recently released a consensus statement with imaging recommendations for three COVID-19 scenarios; for asymptomatic and mild disease without risk of disease progression, imaging is not recommended [11]. Similarly, the American College of Radiology recommends consideration of use of chest radiography in ambulatory settings only when medically necessary [12].

On 17 December 2020, there was a new patient from a seafood cannery in Samut Sakhon Province, Thailand, infected with COVID-19. There followed a new episode of the pandemic in which the number of infected people increased exponentially, especially among foreign workers. Most infected people were asymptomatic or had mild disease. To prevent overwhelming the local hospital, suspected patients were triaged to a field hospital set up at the Samut Sakhon provincial sport stadium. The triage strategy included medical assessment and screening chest radiographs. This study aimed to evaluate the utility of chest radiographs in COVID-19 patients with asymptomatic and mild disease in the field hospital.

Materials and methods

This retrospective study was approved by the institutional review board of Samut Sakhon Provincial Hospital and written consent from subjects was waived.

Subjects

The study included 620 patients registered at the field hospital in Samut Sakhon provincial sport stadium during 5-8 January 2021. All patients were moved from the seafood cannery where the initial COVID-19 RT–PCR testing was done using nasopharyngeal swabs 29-31 December 2020. The admission criteria for the field hospital included: COVID-19 infection confirmed by RT-PCR; none or mild symptoms; no limitation in ordinary daily physical activity; no co-morbidity that required in-hospital care.

Definitions

'Asymptomatic infection' referred to a person with COVID-19 who did not develop symptoms [13].

'Mild disease' referred to a person who had any of the various signs and symptoms of COVID-19 (e.g., fever, cough, fatigue, anorexia, myalgia, sore throat, nasal congestion, headache, gastrointestinal symptom, loss of smell or taste) and was without evidence of hypoxia [14].

Field hospital workflow

The workflow began with passport identification and registration of each patient. Then the medical staff asked whether the patient met the criteria for admission. Chest radiographs were taken 1-2 days after admission (about one week after positive COVID-19 RT-PCR). The field hospital had: self-monitoring stations for vital parameters including temperature, oxygen saturation and blood pressure; 24-hour camera monitoring; telecommunication when required. Foreign patients were divided into small groups, each of which was observed by a representative or volunteer who had good ability to communicate with the medical and support staff. If there was a high risk of clinical deterioration, based on abnormal follow-up chest radiographs or developing symptoms, the volunteer placed a yellow flag at the patient's bed to allow for closer monitoring.

Patients were discharged if no symptoms developed during 10 days of observation in the field hospital.

Chest radiographic process and image analysis

All patients admitted to the field hospital had chest radiographs except one (without an identified cause), resulting in 619 initial radiographs. All chest radiographs were digital, in the postero-anterior projection, and obtained using a mobile X-ray machine (Quest HF series, Quantum Medical Imaging) in a bus. The final reports of chest radiographs were based on readings by two radiologists (4 and 7 years post-board certification). If there was any discordance, the final decision would be made by a third radiologist (19 years post-board certification).

Chest radiograph reports were classified as 'normal' if there was no abnormality and as 'abnormal' if there was any abnormality. Abnormal chest radiographic findings were categorized as i) typical of COVID-19 pneumonia, ii) indeterminate, or iii) other findings.

'Typical' findings of COVID-19 pneumonia were defined as bilateral multi-focal round opacities with lower lobe predominance [15].

'Indeterminate' findings of COVID-19 pneumonia were defined as unilateral, central or upper lung opacities [15].

'Other' findings were defined as findings which raised alternative diagnoses such as tuberculosis (active or non-active), bronchiectasis, lung fibrosis [15].

To simplify for clinical management, radiologists decided to have suggestions in each abnormal report categorized as i) medical attention was required, ii) follow-up chest radiograph was recommended, or iii) no further management was needed. Final decision for transfer of patients to the hospital was determined by the managing clinical team, based on evidence of clinical deterioration and abnormal chest radiography.

Measure of primary outcome

- Patient transferred to regular hospital or remained in field hospital.

Data collection and statistic analysis

Demographic variables including age, sex, and ethnicity were collected at the time of registration at the field hospital. Symptoms, co-morbidities, body weight, height, medical treatment and clinical outcome were collected and recorded in the electronic hospital information system of Samut Sakhon Hospital.

Demographic variables were statistically analyzed and described as mean, dispersion and proportion. Chest radiograph reports were also analyzed as proportions. Correlations between chest radiograph report, symptoms, co-morbidities and clinical outcome were analyzed using Pearson Chi-square and Fisher's exact tests.

Results

Clinical characteristics of COVID-19 patients (Table 1)

In patients who had chest radiographs (n = 619), there were 328 (53%) men and 291(47%) women. The average age was 33.3 +/- 9.7 (ranging between 5 and 64) years old. There were three national origins: 616 from Myanmar (99.5%), two Thai (0.3 %), and one Cambodian (0.2%). There were only 13 patients with symptoms and these were mild; the most common presenting symptom was cough (7/13). There were 30 patients with co-morbidities; the most common was hypertension (13/30).

Table 1. *Clinical characteristic for COVID-19 patients.*

Parameter	Number/Total (%)
Sex	
Male	328/619 (53%)
Female	291/619 (47%)
Age	
< 15 years	5/619 (0.8%)
15-59 years	612/619 (98.9%)
> 60 years	2/619 (0.3%)
Mean age years ± SD	33.3±9.7
(Min-max)	(5-64 years)
Ethnicity	
Myanmar	616/619 (99.5%)
Thai	2/619 (0.3%)
Cambodia	1/619 (0.2%)
Body mass index (BMI, kg/m2)	
< 18.5	21/619 (3.4%)
18.5- 22.9	109/619 (17.6%)
>23.0	144/619 (23.3%)
Mean ± SD	23.94±4.4
(Min-max)	(15.67- 43.28)
No data	345/619 (55.7%)
Symptoms	
Cough	7/619 (1.1%)
Sore throat	3/619 (0.5%)
Chest discomfort	3/619 (0.5%)
Headache	1/619 (0.2%)
Dyspnea	1/619 (0.2%)
Co –morbidities	
Hypertension	13/619 (2.1%)
Old tuberculosis (TB)	8/619 (1.3%)
Diabetes	6/619 (1.0%)
Cerebrovascular disease	3/619 (0.5%)
Allergy	1/619 (0.2%)

Chest radiographic findings (Table 2)

Normal chest radiographs accounted for 91.7% (568 /619), whereas the other 8.3% (51/619) were abnormal. Abnormal chest radiographs were typical of COVID-19 in 0.5% (3/619), indeterminate in 4% (25/619) and had other findings in 3.8% (23/619). Active tuberculosis was found in 26.2% (6/23) of those with 'other' findings.

Table 2. *Chest radiograph findings in COVID-19 patients.*

Chest radiographic findings	Number/Total (%)
Normal	568 /619 (91.7%)
Abnormal	51/619 (8.3%)
- Typical COVID -19 pattern	3/619 (0.5%)
- Indeterminate	25/619 (4%)
- Other findings	23/619 (3.8%)
- Old TB	7/23 (30.5%)
- Active TB	6/23 (26.2%)
- Lung nodules	2/23 (8.7%)
- Lung fibrosis	2/23 (8.7%)
- Cardiomegaly	2/23 (8.7%)
- Bronchiectasis	1/23 (4.3%)
- Calcified lymph nodes	1/23 (4.3%)
- Enlarged hilar nodes	1/23 (4.3%)
- Situs inversus	1/23 (4.3%)
Total	619/619 (100%)

Chest radiographic findings related to having asymptomatic or mild disease (Table 3)

Of the asymptomatic patients, there were abnormal chest radiographs in 8.3% (50/606) with typical findings of COVID-19 pneumonia in 0.5% (3/606), intermediate in 4% (24/606), and other findings in 3.8% (23/606). Of the 13 patients with mild disease, chest radiographs were normal in 12 and indeterminate in one. There were no significant differences between the abnormal chest radiographic findings of asymptomatic and mildly symptomatic patients.

Table 3. *Chest radiograph findings for COVID-19 patients as related to having asymptomatic or mild disease.*

	Asymptomatic	Mild disease	Total	P-value	95% CI
Normal CXR, number/total (%)	556/606 (91.7%)	12/13 (92.3%)	568/619 (91.7%)	0.88	88.5-93.1%
Abnormal CXR, number/total (%)	50/606 (8.3%)	1/13 (7.7%)	51/619 (8.3%)	0.68	6.9-11.5%
Typical pattern, number/total (%)	3/606 (0.5%)	0/13 (0%)	3/619 (0.5%)	0.81	
Indeterminate, number/total (%)	24/606 (4%)	1/13 (7.7%)	25/619 (4%)	0.27	
Other findings, number/total (%)	23/606 (3.8%)	0/13 (0%)	23/619 (3.8%)	0.39	

Correlations between outcomes and co-morbidities, symptoms, chest radiographs (Table 4)

A correlation between co-morbidities, symptoms, chest radiographs and the necessity to transfer a patient to the hospital was found to be statistically significant ($p < 0.05$) only for abnormal chest radiographs. No mortality occurred.

Table 4. *Correlations between outcomes and co-morbidities, symptoms, chest radiographs.*

	Total	Remain in field hospital	Transferred to hospital	Mortality	P-value
Comorbidities					
-Yes	30	29	1	0	0.18
- No	589	586	3		
Symptoms					
- Asymptomatic	606	602	4	0	1.00
- Mild disease	13	13	0		
Chest report					
- Normal	568	566	2	0	0.036
- Abnormal	51	49	2		

Follow-up of transferred patients

There were four patients transferred to the hospital. Two of them were transferred due to typical radiographic findings of COVID-19 and were given favipiravir due to their abnormal chest radiographs (Figure 1). One of them had a history of old pulmonary TB. Both patients had no symptoms during admission and no need of oxygen treatment. After complete treatment, there was resolution of pulmonary opacities on the chest x-rays.

One patient who was asymptomatic and had a normal chest radiograph on the first day of admission, developed sudden acute dyspnea in the second day and was transferred to the hospital. The follow-up chest radiograph after transfer to the hospital showed unilateral patchy ground glass opacity (Figure 1). This patient was given favipiravir and oxygen therapy due to acute dyspnea. Finally, this patient was found to be immunocompromised based on a low CD-4 count.

The fourth patient was transferred to the hospital due to acute psychosis from drug withdrawal and was not given favipiravir since there was no indication.

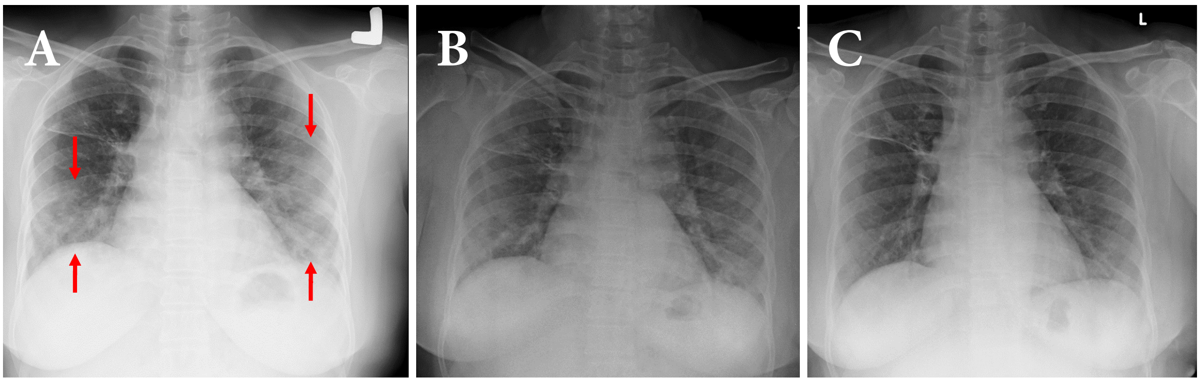

Figure 1. *Chest radiographs with typical pattern of COVID-19 pneumonia. Patient was asymptomatic and had previous pulmonary tuberculous infection. (A) The first chest radiograph taken at the field hospital revealed multifocal bilateral opacities in mid to lower lung zones. Fibrosis in right upper lobe was also noted. (B) The follow-up chest radiograph, 5 days after the first one and on the day after completion of favipiravir treatment, revealed partial resolution of the pulmonary opacities. (C) The chest radiograph before discharge reveals resolution of pulmonary opacities.*

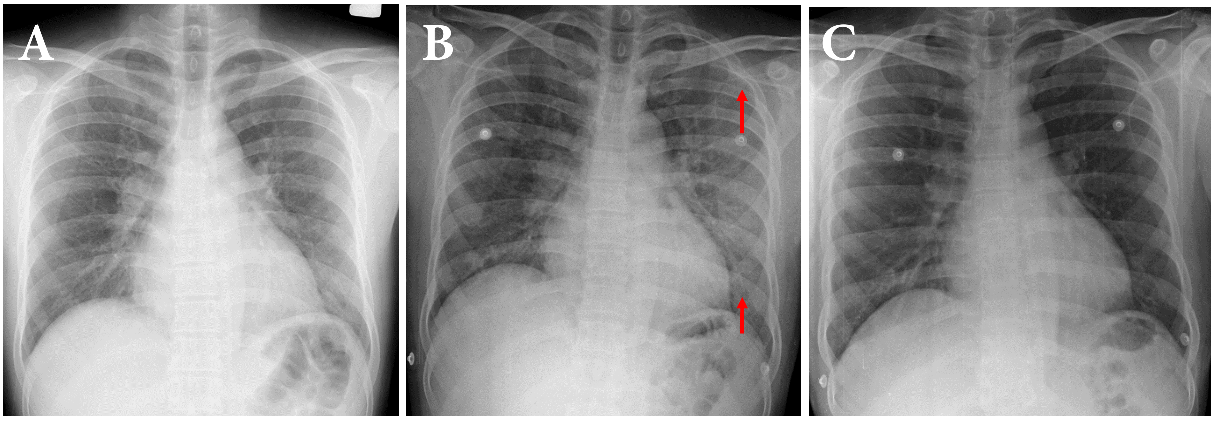

Figure 2. *Radiographs of a 37-year-old male who developed acute dyspnea and was transferred to the hospital. (A) The initial chest radiograph reveals no pulmonary infiltration. (B) The follow-up chest radiograph, which was taken after he had dyspnea and oxygen saturation of 94%, reveals unilateral patchy ground glass opacities in mid to lower left lung zones. (C) Chest radiograph 4 days after starting favipiravir treatment reveals resolution of the pulmonary opacities.*

Discussion

The ongoing COVID-19 pandemic caused a large burden to national health systems. A good triage system was needed to prioritize patients and prevent overwhelming hospitals. For asymptomatic and mild COVID-19-infected cases, the Fleischer Society recommends that chest radiography is not indicated unless there is a risk of clinical deterioration [11]. In moderate to severe COVID-19, there is no doubt that chest radiographs help monitor disease progression and predict outcomes [16,17].

In this study, the 619 chest x-rays of asymptomatic and mild COVID-19 patients revealed normal findings in 91.7%. This result was consistent with other reports that most asymptomatic and mildly symptomatic patients have normal chest radiographs. Kuo, et al. [18] reported that screening chest radiographs in asymptomatic and mild disease in Singapore were normal in 98.0% (1,925/1,964) and showed findings of pulmonary infection in 2.0%.

Of the abnormal chest radiographs, there were chest findings typical of COVID-19 in 0.5% (3/619), indeterminate in 4% (25/619) and other findings in 3.8% (23/619). In the 'other' findings, active tuberculosis was diagnosed in 1% (6/619). Of the 4 patients who were transferred to the hospital, abnormal chest radiograph was the only parameter which was significantly correlated ($P < 0.05$). This was likely due to the agreement of clinical management team that abnormal chest radiographs reflected a high risk of disease progression.

Two patients transferred because of typical chest radiographic findings of COVID-19 pneumonia were asymptomatic during the whole length of hospital stay. They were treated with favipiravir and their follow-up chest radiographs showed complete resolution (Figure 1). One patient with typical chest radiographic findings of COVID-19 pneumonia remained in the field hospital and was discharged after a 10-day asymptomatic course. Initially, the chest radiograph of the last patient was reported as showing indeterminate findings and the clinical management team decided not to transfer the patient to the hospital. However, retrospective review led to a consensus among radiologists that the x-ray findings were typical of a COVID-19 pattern.
The 'typical' COVID-19 pattern should be differentiated from that of other infections, organizing pneumonias or results from lung insults due to etiologies such as medications and recreational drugs [14]. Yet the typical chest radiographic findings in asymptomatic patients might not be a definite indication for transfer of patients to the hospital and might not predict the course of disease. Parry, et al. [19] reported that asymptomatic infection could have a variable clinical-radiological course, spanning resolution, progression and no change. However, in the progression group, patients also had high levels of C-reactive protein and L-delactohydrogenase, as well as lower lymphocyte counts. This implied that other factors are needed to properly triage asymptomatic patients beyond chest radiographs.

One transferred patient was initially asymptomatic with a normal chest radiograph. However, the day after admission he developed sudden dyspnea requiring in-hospital supplemental oxygen and his follow-up chest radiograph demonstrated abnormal lung opacifications (Figure 2). This could be explained by either an initial false negative chest radiograph or rapid progression of disease. However, there was no comparative computed tomography which is known to be superior to chest radiograph in demonstrating early findings [20].

The fourth patient was transferred to hospital because of acute psychosis due to drug withdrawal. It should be kept in mind that etiologies non-related COVID-19 continue to occur in such critical periods. An additional benefit of the chest x-ray screening program was the detection of active pulmonary tuberculosis, which allowed personal isolation and safety of others in the field hospital.

There were some limitations in this study. First, there were indeterminate findings in nearly 50% of the abnormal chest radiographs which could not be resolved with computed tomography. They might be due to subtle disease, overlying breast tissue, or other processes. Second, the small number of transferred patients limited the power of the statistical analysis. Third, the lack of available data about the date of symptom onset in each patient impaired the calculation of sensitivity of chest radiography. Finally, the outcomes of discharged patients were not tracked and so late complications were not detected.

Conclusion

Combined chest radiograph and clinical information make better decision for transferred-in hospital in asymptomatic and mild symptomatic COVID-19 patients at filed hospital.

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Declaration of competing interests: The authors declare that they have no competing financial interests nor personal relationships that could have appeared to influence the work reported in this paper.

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. doi: 10.1016/S0140-6736(20)30183-5.

2. World Health Organization [Internet].Geneva: The Organization; 2021 [cited 2021 Jul 1]. Coronavirus Disease 2019 (COVID-19) Dashboard; [about 7 screens]. Available from: https:// www. Covidi2.who.int

3. Wu Z, Mcgoogan GM. Characteristics of and important lessons from the Coronavirus Disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA 2020;323:1239-42. doi: 10.1001/jama.2020.2648.

4. Oran DP, Topol EJ. Prevalence of asymptomatic SARS-CoV-2 infection. Ann InternMed 2020;173:362-7. doi: 10.7326/M20-3012.

5. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of Novel Coronavirus-I-infected pneumonia. N Engl J Med 2020;382:1199-207. doi: 10.1056/NEJMoa2001316.

6. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of Coronavirus Disease 2019 in China. N Engl J Med 2020;382:1708-20. doi: 10.1056/NEJMoa2002032.

7. Chinese Society of Radiology, Chinese Medical Association. Radiological diagnosis of New Corona Virus infected pneumonitis: expert recommendation from Chinese Society of Radiology (First Edition). Chin J Radiol [Internet] 2020 [cited 2021 Jul 1];4:279-85. Chinese. Available from: http://rs.yiigle.com/CN112149202004/1187937.htm

8. Zu ZY, Jiang MD, Xu PP, Chen W, Ni QQ, Lu GM, et al. Coronavirus Disease 2019 (COVID-19): a perspective from China. Radiology 2020;296:E15-25. doi: 10.1148/radiol.2020200490.

9. Ng MY, Lee EYP, Yang J, Yang F, Li X, Wang H, et al. Imaging profile of the COVID-19 infection: radiologic findings and literature review. Radiol Cardiothorac Imaging 2020;2:e200034. doi: 10.1148/ryct.2020200034.

10. Stephanie S, Shum ST, Cleveland H, Challa SR, Herring A, Jacobson FL,et al. Determinants of chest X-Ray sensitivity for COVID-19: a multi-institutional study in the United States. Radiol Cardiothorac Imaging 2020;2: e200337. doi: 10.1148/ryct.2020200337

11. Rubin GD, Ryerson CJ, Haramati LB, Sverzellati N, Kanne JP, Raoof S, et al. The role of chest imaging in patient management during the COVID-19 pandemic: a multinational consensus statement from the Fleischner Society. Radiology 2020;296:172-80. doi: 10.1148/radiol.2020201365.

12. ACR American College of Radiology [Internet]. Reston(VA): ACR; 2020 Mar 11 [updated 2020 Mar 22; cited 2021 Jul 1]. ACR recommendations for the use of chest radiography and Computed Tomography (CT) for suspected COVID-19 infection. Available from: https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection.

13. World Health Organization [Internet]. Geneva: WHO; 2020 Apr 2 [cited 2021 Jul 1]. Coronavirus Disease 2019 (COVID-19) situation report -73. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200402-sitrep-73-covid-19.pdf?sfvrsn=5ae25bc7_6.

14. World Health Organization [Internet]. Geneva: WHO; 2020 [cited 2021 Jul 1].Use of chest imaging in COVID-19: a rapid advice guide 11 June 2020. Available from: https://apps.who.int/iris/handle/10665/332336

15. Litmanovich DE, Chung M, Kirkbride RR,, Kicska G, Kanne JP. Review of chest radiograph findings of COVID-19 pneumonia and suggested reporting language. J Thorac Imaging 2020;35:354-60. doi: 10.1097/RTI.0000000000000541.

16. Borghesi A, Maroldi R. COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. Radiol Med 2020;125:509-13. doi: 10.1007/s11547-020-01200-3.

17. Hui TCH, Khoo HW, Young BE, Haja Mohideen SM, Lee YS, Lim CJ, et al. Clinical utility of chest radiography for severe COVID-19. Quant Imaging Med Surg 2020;10:1540-50. doi: 10.21037/qims-20-642.

18. Kuo BJ, Lai YK, Tan MLM, Goh XC. Utility of screening chest radiographs in patients with asymptomatic or minimally symptomatic COVID-19 in Singapore. Radiology 2021;298:E131-40. doi: 10.1148/radiol.2020203496.

19. Parry AH, Wani AH, Yaseen M, Shah NN, Dar KA. Clinicoradiological course in coronavirus disease-19 (COVID-19) patients who are asymptomatic at admission. BJR Open 2020;2:20200033.doi: 10.1259/bjro.20200033.

20. Wong HYF, Lam HYS, Fong AH, Leung ST, Chin TW, Lo CSY, et al. Frequency and distribution of chest radiographic findings in patients positive for COVID-19. Radiology. 2020;296:E72-8. doi: 10.1148/radiol.2020201160.

Case Report

Kinked coronary saphenous vein graft after aortic dissection surgery: An unusual differential diagnosis of cardiac tamponade

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Abstract

A 73-year-old female patient presented with cardiac tamponade following Stanford type A aortic dissection required immediate pericardiocentesis and followed by root replacement with coronary artery bypass grafting. The patient's postoperative course was eventful and coronary graft kinking contributed to myocardial ischemia, but the presentation was confused with cardiac tamponade.

Keywords: Angina, Shock, Coronary artery disease.

Introduction

Long-term outcomes of aortic root replacement using coronary ostial buttons have been stated with good results and there are no concerns emerging in the follow-up process regarding coronary button anastomosis [1]. However, post-operative ischemic issues related to the coronary buttons, especially in the high-risk patients of type A aortic dissection involving aortic root have been well-reported, and still pose challenging clinical circumstances.

Case summary

A 73-year-old female was presented with cardiogenic shock which was followed by cardiac arrest in the emergency department, and it was managed with a brief period of cardiopulmonary resuscitation. The patient's cardiac output returned and immediate bedside Transthoracic Echocardiogram (ECHO) revealed large haemorrhagic pericardial collection with the features of cardiac tamponade which was drained percutaneously using an 8.3 F catheter under guidance. Cardiac gated contrast Computed Tomography (CT scan) displayed Stanford type A aortic dissection extending from the aortic root proximally and a ruptured Penetrating Aortic Ulcer (PAU) posteriorly near the coronary ostia (Figure 1A, 1B and 2A). Intra-operative Trans Oesophageal Echocardiogram (TEE) showed a tri-leaflet aortic valve with severe regurgitation. Aortic root replacement with replacement of the ascending aorta including hemiarch using deep circulatory arrest was performed (23 Magna ease, Edward life science, USA, and 26 mm Gelweave Dacron tube graft, Terumo, USA) and coronary ostia were implanted as buttons over the Gelweave graft. Dissection flap was extending well beyond RCA button, and it led to severe bleeding after coming off cardiopulmonary bypass. Eventually, reverse Saphenous Vein (SVG) graft over mid RCA in end to side manner and the proximal end was grafted on the Gelweave graft, while proximal native RCA was disconnected and ligated.

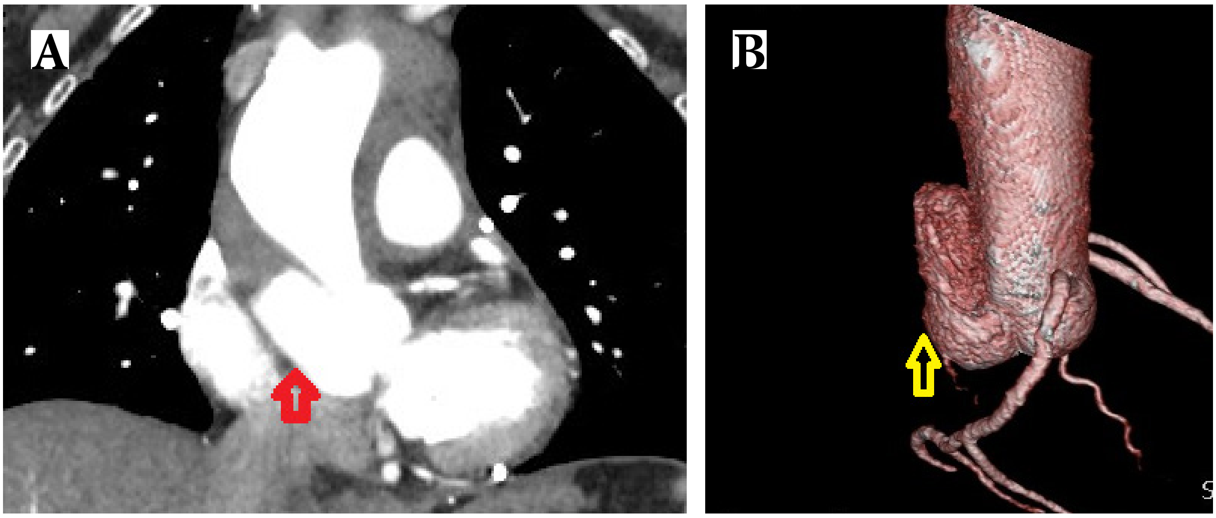

Figure 1. *(A) Contrast CT scan: Arrow showing penetrating aortic ulcer (PAU) and dissection extending to the root. (B) 3-Dimensional volume rendered view of contrast CT scan: arrow showing penetrating aortic ulcer (PAU).*

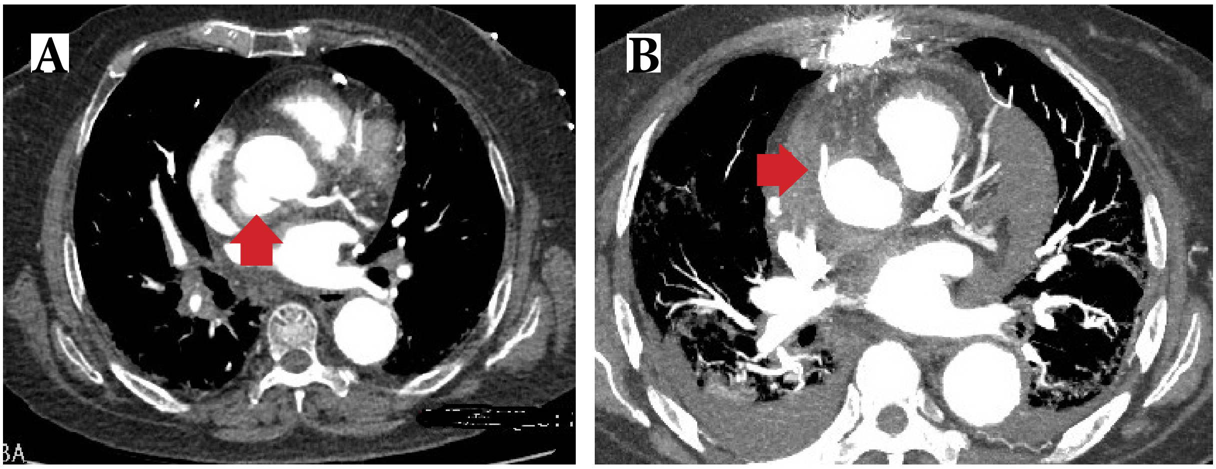

Figure 2. *(A) Contrast coronary angiogram (axial view) arrow showing aortic dissection in proximity with the root and left coronary ostia. (B) Post-operative contrast coronary angiogram (axial view) arrow showing saphenous vein graft surrounded by the pericardial fluid collection.*

Imaging findings

Post-operative follow-up contrast CT chest showed good patency of the vein graft with moderate pericardial collection, which was assumed to be reactionary fluid from Gelweave graft and managed conservatively (Figure 2B). The patient developed hypotension and bradycardia ten days after the operation and underwent urgent surgical pericardial drainage with a working diagnosis of cardiac tamponade, although intra-operative TEE showed no features of cardiac tamponade. The patient was discharged to rehabilitate but represented after three weeks with acute onset angina at rest with very high Troponin I level (15000 nanogram/litre) and diagnosed with inferior ST elevation Myocardial Infarction (STEMI). Trans-Thoracic Echocardiogram (TTE) showed severe Right Ventricular (RV) dysfunction with inferior wall hypokinesia, and the patient was referred for urgent coronary angiogram (CAG). CAG showed kinking of the SVG ostia (Figure 3A), which was opened by deploying two Promus PREMIER Drug Eluting Stents (Boston scientific, USA) (Figure 3B). The follow-up contrast CT aortogram confirmed patency of the stent in the proximal SVG with patent distal vein graft (Figure 4). The patient recovered after the coronary intervention and TTE prior to the discharge revealed improving RV systolic functions.

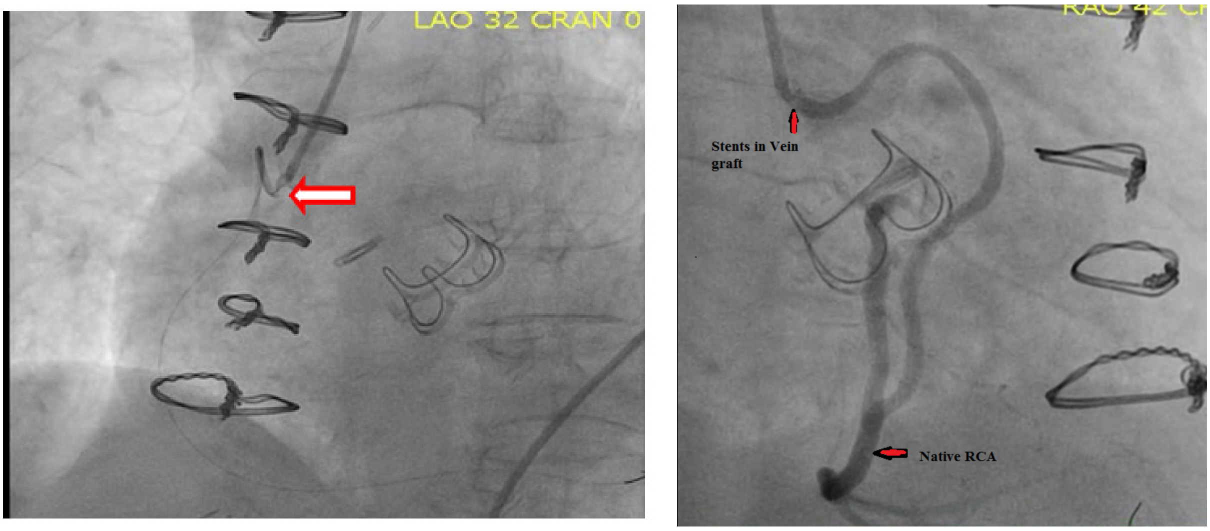

Figure 3. *(A) Coronary angiogram: arrow showing SVG ostia stenosis with guidewire in-situ in the SVG lumen. (B) Coronary Angiogram: arrow showing SVG after the stent deployment.*

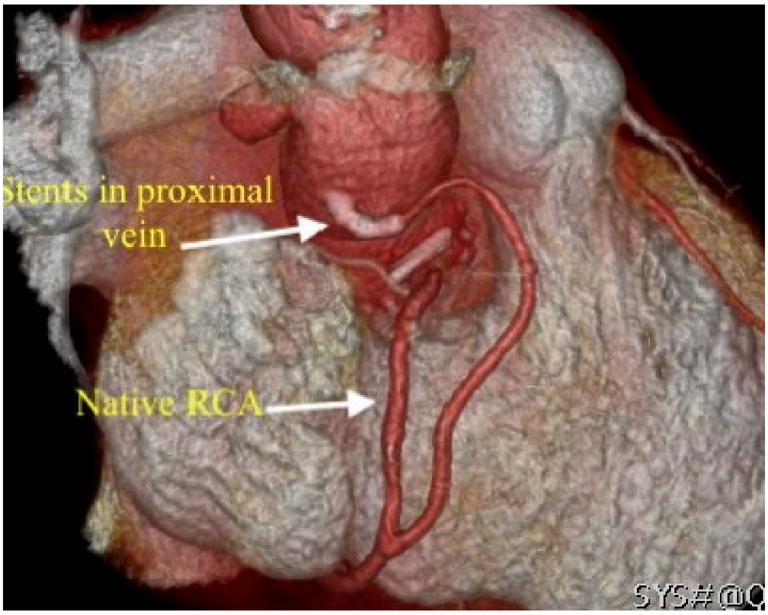

Figure 4. *Post-operative contrast CT scan: volume rendered image showing coronary stents in the SVG.*

Discussion

Even with continuous improvement in the operative techniques, all-inclusive surgical morbidity, and mortality of acute Type A Aortic Dissection (TAAD) remained high (17%-26%) and the overall prognosis of a TAAD patient is determined by the patient's comorbidities and dissection-related complications, like unstable patients with circulatory malperfusion and the extent of surgical repair [1]. Malperfusion secondary to the TAAD is well known (20-35%) and it can involve coronary arteries, arch vessels, visceral arteries, or distal femoral arteries [2]. Acute myocardial infarction after TAAD surgery is reported between 5.6-5.9% in a systemic review and continues to be a major life-threatening situation [2].

Patients with TAAD can have retrograde dissection flap extension into the coronary ostia or further distally into the main coronary artery and its branches. Neri et al. had differentiated three main types of coronary lesions, coronary ostial dissection, and dissection with a coronary false channel and circumferential detachment with an inner cylinder intussusception [3]. Although various techniques have been described to repair dissected coronary artery during an index aortic repair, because of the good results and simplicity, the most commonly used technique is a coronary bypass graft while ligating native coronary artery [4].

Iatrogenic kinking or stenosis of the vein graft is also well known and most often this issue arises between two weeks to six months after the surgery, as it happened in our case. Various mechanisms have been reported in isolated case reports, namely, mechanical obstruction (compression from the haematoma surrounding the heart, fluid and blood leading to tamponade and bioglue) and dynamic obstruction, for example, low or high positioning of the SVG on the tube graft, ostial obstruction due to the excessive or short length of the graft [5]. Presentation may vary from immediate post-operative cardiogenic shock, rhythm changes and cardiac arrest to late presentation with STEMI and heart failure. Management depends upon the stage of the presentation and mechanism responsible for these changes. Surgery can be an option for the mechanical obstruction and where the patient needs a release of the cardiac tamponade, while the majority of the cases are treated with Per Cutaneous Interventions (PCI) using drug eluting stents [5]. Some benefits of PCI are fast revascularization and limiting ischemic myocardial damage, less invasion and good outcomes.

Our patient had graft flow issues on day ten which leads to a low cardiac output with RV dysfunction in the post-operative period, but it was confused with cardiac tamponade and ended in unfruitful surgical re-exploration and delay in the correct diagnosis. These patients should be further triaged using TTE, blood biochemistry markers (Troponins) and if doubt persists then urgent CT coronary angiogram should be performed as delay in the treatment can be detrimental.

Conclusion

Our case again re-enforces the fact that the acute myocardial infarction after TAAD repair should be diagnosed promptly and managed effectively using either options in surgery or per-cutaneous interventions to avoid possible ischemic complications.

References

1. Mookhoek A, Korteland NM, Arabkhani B, Di Centa I, Lansac E, Bekkers JA, et al. Bentall procedure: a systematic review and meta-analysis. Ann Thorac Surg 2016;101:1684–9. doi: 10.1016/j.athoracsur.2015.10.090.

2. Helder MRK, Schaff HV, Day CN, Pochettino A, Bagameri G, Greason KL, et al. Regional and temporal trends in the outcomes of repairs for acute type a aortic dissections. Ann Thorac Surg 2020;109:26-35. doi: 10.1016/j.athorac sur.2019.06.058.

3. Neri E, Toscano T, Papalia U, Frati G, Massetti M, Capannini G, et al. Proximal aortic dissection with coronary malperfusion: presentation, management, and outcome. J Thorac Cardiovasc Surg 2001;121:552–60. doi: 10.1067/ mtc.2001.112534.

4. Tribble C. To know acute aortic dissection is to know all of cardiovascular surgery. Semin Thoracic Surg 2017; 29:186–7. doi: 10.1053/j.semtcvs.2017.01. 014.

5. Adamson C, Rocchiccioli P, Brogan R, Berry C, Ford TJ. Post-operative myocardial infarction following aortic root surgery with coronary reimplantation: a case series treated with percutaneous coronary intervention. Eur Heart J Case Rep 2019; 3:1-6. doi: 10.1093/ehjcr/ytz181.

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ASEAN Movement in Radiology

Rama Co-RADS: Cutting-edge tool for improved communication in management and treatment of COVID-19 patients in Thailand

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Abstract

In Thailand, the rapid and constant rise in the number of confirmed COVID-19 cases, together with the increasing number of patients requiring respiratory and other medical life support during the third wave of COVID-19, has drastically overwhelmed the existing country's healthcare facilities, physicians, and other healthcare workers. Hence, early identification of vulnerable patients at risk and early COVID-19 pneumonia is crucial for timely management and treatment by antivirals or corticosteroids to prevent them from developing severe COVID-19 pneumonia. A prompt chest X-ray report with clear and concise information at baseline screening in alternative healthcare facilities, especially in resource-constrained conditions, is essential. The article presents the use of Rama

Co-RADS, a categorical assessment scheme for chest X-ray findings for diagnosing pneumonia in patients with confirmed COVID-19, in Ramathibodi hospitels. Its use facilitates a rapid, clear, and concise X-ray report despite the various levels of radiologists' experience. Comprehensible and consistent chest X-ray information successfully reduces the time lapse and communication gap among medical staff and assists on-duty, frontline physicians to make prompt and more accurate decisions regarding the management and treatment of COVID-19 patients in accordance with the current national guideline.

Keywords: SAR-CoV-2, COVID-19, Chest X-ray, Chest radiograph, Report, Alternative healthcare facilities.

Introduction

Despite success in containing the number of patients with coronavirus disease 2019 (COVID-19), an emerging infection caused by a novel Coronavirus strain named SARS-CoV-2 during the first and second waves of infection [1,2], Thailand has faced continuous and exponential growth of newly confirmed COVID-19 cases in the third wave since April 2021 [3]. In late July 2021, a constant rise of more than 15,000 confirmed COVID-19 cases per day, together with a substantial amount of unrecovered and critical patients requiring respiratory and other medical life support, has drastically overwhelmed the existing country's healthcare facilities. As of July 30, 2021, the total number of fatal cases has exceeded 4,600 [3]. Of these, patients with risk factors and pre-existing comorbid diseases (e.g., aged >60 years, obesity (>90 kg or BMI >30 kg/m^2), chronic obstructive pulmonary disease and other chronic lung diseases, chronic kidney disease, uncontrolled diabetes, cardiovascular disease, and cirrhosis) tended to develop severe pneumonia [3]. Early identification of vulnerable patients at risk and with pulmonary involvement in COVID-19 are crucial for addressing timely management and treatment by antivirals or corticosteroids, which prevent patients from developing severe COVID-19 and improve patient outcomes [2,4,5]. Moreover, it helps reduce unnecessary drug prescriptions, which may lead to drug resistance, serious side effects, or other complications [6].

Management and treatment of COVID-19 in Thailand

In response to the COVID-19 crisis in the third wave, the Department of Disease Control and the Department of Medical Services of the Ministry of Public Health have implemented various case-management strategies and guidelines [7-11]. One of the ongoing case-management strategies is the setting up of alternative healthcare facilities for accommodation, surveillance, and management of confirmed COVID-19 cases identified for positive SARS-CoV-2 using reverse transcription-polymerase chain reaction (RT-PCR). The procedure has been implemented by converting hotels and other feasible facilities to "hospitels" and mobile field medical units, respectively [8-11].

The Department of Medical Services of the Ministry of Public Health has provided several guidelines for managing and treating patients based on the severity of clinical symptoms and pulmonary involvement in COVID-19 in various situations [12]. Table 1 summarizes the current guidelines on clinical practice, diagnosis, treatment, and prevention of healthcare-associated infection for COVID-19 (hereinafter referred to as "the national guideline"), last updated on July 21, 2021 [12].

As shown in Table 1 [12], antiviral drugs are not recommended for asymptomatic COVID-19 patients. Instead, prescribing *Andrographis paniculata* (Fa Talai Jone) capsule may be considered an alternative remedy. To date, favipiravir is an antiviral drug recommended for treating patients with risk factors to develop a severe disease, regardless of the severity of symptoms or the presence of pneumonia. Nevertheless, favipiravir may be considered in patients having mild symptoms or no risk factor to develop a severe disease.

Table 1. *The guidelines on clinical practice, diagnosis, treatment, and prevention of healthcare-associated infection for COVID-19 by the Department of Medical Services, the Ministry of Public Health, last updated on July 21, 2021 [12].*

Group	Clinical Symptoms and Severity	Recommendations for Management and Treatment
1	Asymptomatic cases	• Recommend admitting the patients in a hospital or an alternative government-supported healthcare facility for at least 14 days from the day the patients are tested positive • Provide supportive care without prescribing antivirals • Consider prescribing *Andrographis paniculata* (Fa Talai Jone) capsule
2	Cases with mild symptoms, without pneumonia and any risk factors for a severe disease[1]	• Recommend admitting the patients in a hospital or an alternative government-supported healthcare facility for at least 14 days from the day the patients are tested positive, or until symptoms improve for at least 24-48 hours • Provide supportive care • Consider prescribing favipiravir
3	Asymptomatic or symptomatic cases • With a risk factor for a severe disease or major comorbidities[1] OR • With mild pneumonia that does not meet the criteria below	• Recommend hospitalization for at least 14 days from the onset of symptoms or until symptoms improve • Prescribe favipiravir for 5 days or more, depending on clinical symptoms • May consider administering corticosteroids plus favipiravir in patients with worsening lung symptoms[2] and chest X-ray findings
4	Confirmed pneumonia with hypoxia (resting SpO_2 at room air ≤96%), or with SpO_2 at room air drops ≥3% from the first measured value during exertion (exercise-induced hypoxia), or with progression of pulmonary abnormalities on a chest X-ray	• Prescribe favipiravir for 5-10 days depending on clinical symptoms • Administer corticosteroids • May consider concomitant prescription of lopinavir/ritonavir for 5-10 days

[1]*Age >60 years, chronic obstructive pulmonary disease and other chronic lung diseases, chronic kidney disease, cardiovascular disease including congenital heart disease, stroke, uncontrolled diabetes, obesity (>90 kg or BMI >30 kg/m²), cirrhosis, immunosuppression, and lymphocyte <1,000 cells/mm³ or patients without risk factors but more likely to have more severe disease*

[2]*Resting SpO_2 at room air ≤96%), or with SpO_2 at room air drops ≥3% from the first measured value during exertion (exercise-induced hypoxia)*

Ramathibodi hospitels as alternative healthcare facilities for COVID-19

In mid-April 2021, the Faculty of Medicine Ramathibodi Hospital, Mahidol University, in collaboration with partner hotels, established alternative healthcare facilities (hereinafter referred to as "Ramathibodi Hospitels"). Physicians and healthcare staff working in the hospitels are allocated from different departments, under close supervision of infectious disease (ID) physicians.

The rapid rise in COVID-19 cases, which has eventually overwhelmed the hospitals, led to a substantial increase in patients with moderate severity and multiple comorbidities admitted to the hospitels. Due to shortage of infectious disease (ID) specialists, on-duty, frontline physicians allocated from different departments to the hospitels are responsible not only for initial screening for risk factors and pulmonary involvement but also for determining the onsite management and treatment by following the workflow for management and treatment of COVID-19 patients in the hospitels (hereinafter referred to as the workflow). The current workflow chart (Figure 1) provided by the Division of Infectious Disease, Department of Medicine, Faculty of Medicine Ramathibodi Hospital is consistent with the national guideline (Table 1).

Since COVID-19 patients can remain asymptomatic despite having pulmonary involvement or have rapid change in the clinical course, chest imaging becomes essential in COVID-19 pandemic [5,13-17]. Although chest computed tomography (CT) appears to be associated with higher sensitivity, specificity, and accuracy than chest X-ray [15-17], there is no evidence to support CT screening for pulmonary involvement in asymptomatic patients or when the pulmonary involvement is readily visible on the chest radiography. In the limited or constrained resources, chest CT is not recommended as a screening and monitoring tool. It should instead be performed to answer specific clinical problems contributing to the patient's management [15-17]. Considering the cost-effectiveness, low radiation exposure, rapid execution, and low risk of infection transmission to the radiology staff and uninfected patients [5,15-18], multiple countries are still using chest X-ray, particularly portable chest X-ray, as a first-line triage tool for diagnosis, assessing the severity of the COVID-19 infection, and excluding an alternative diagnosis. It is also helpful for disease monitoring and detecting complications, especially in critical care settings [5,15,19,20].

To facilitate timely diagnosis, management, and treatment, all patients admitted to the Ramathobodi Hospitels are required to undergo chest X-ray examinations using a mobile or portable X-ray unit at admission and during hospitel admission, scheduled for illness days 5-7 and 10-12 after the symptom onset.

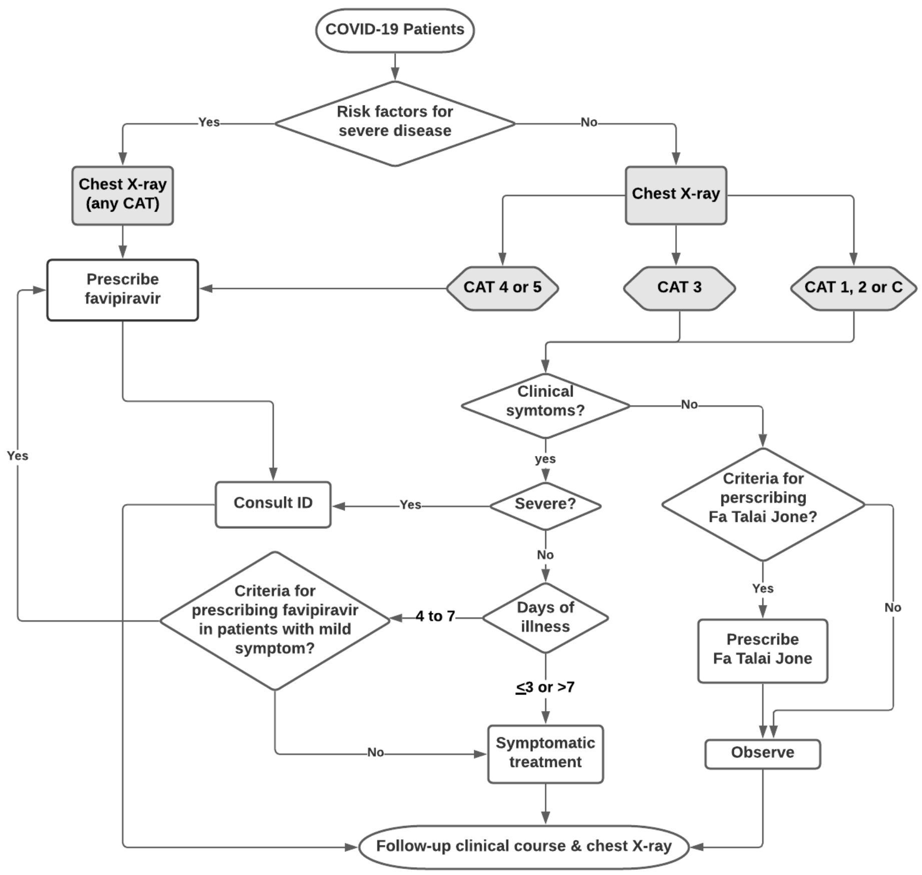

Figure 1. *The workflow chart for the management and treatment of COVID-19 patients in Ramathibodi hospitels.*

Radiology movement in COVID-19

The role of the Department of Diagnostic and Therapeutic Radiology, Faculty of Medicine Ramathibodi Hospital is to set up a portable X-ray unit and allocate radiology technicians to work with frontline physicians in each hospitel. Since a chest X-ray report is essential for further management and treatment, all chest X-rays must be reported as fast as possible. Hence, radiologists are assigned from all subspecialties of Radiology for film interpretation daily. However, the increasing number of chest X-rays performed, time restraint, and the different levels of radiologists' experience contributed to the diversity and ambiguity of the chest X-ray reports in the early phase. The time lapse and communication gap in chest X-ray reporting among on-duty, frontline physicians at baseline screening led to unnecessary consultations with the supervising ID specialists and delayed treatment.

In this context, a standardized reporting system can mitigate the problems by reducing variations and turnaround time for chest X-ray reporting [21-23]. However, the readily available standardized reporting systems for chest CT and chest X-ray of pulmonary involvement in COVID-19 published in the literature [15,24-27] are unfit for management of the current COVID-19 situation of Thailand.

First of all, it is unsuitable to use the expert consensus statement on chest CT findings related to COVID-19, endorsed by the Radiological Society of North American, the Society of Thoracic Radiology, and American College of Radiology [24], and COVID-19 Reporting and Data System (CO-RADS) proposed by the COVID-19 Standardized Reporting Working Group of the Dutch Radiological Society [25] for chest X-ray reporting. It is because some CT findings, for example, the crazy-paving appearance and thickened vessels, cannot be readily depicted on a chest X-ray [24,25]. Moreover, both the expert consensus statement on chest CT findings and CO-RADS are intended to enable the diagnosis of COVID-19 in a patient suspected of having COVID-19 before getting an RT-PCR result [25], not in a confirmed COVID-19 case as in our clinical setting.

Secondly, the suggested reporting language of chest radiographic findings proposed by Litmanovich et al. [15] and the structured reporting template for portable chest X-rays presented by Yates et al. [26] are also used for early evaluation of a patient suspected of having COVID-19 [15,26]. Therefore, it is not appropriate to use them for triage of confirmed COVID-19 patients in our clinical situation.

Thirdly, the CO X-RADS proposed by De Sanctis et al. [27] is intended to evaluate the clinical and radiological severity of COVID-19 in symptomatic patients with confirmed COVID-19 admitted to main hospitals. Accordingly, it does not fit the current clinical setting in Thailand. Moreover, CO X-RADS (0-IV) using a sum of radiological severity score (range, 0-10) of various pulmonary abnormalities on chest X-rays [27] is a complicated and time-consuming task, precluding fast reporting for prompt decision, timely management, and treatment in alternative healthcare facilities.

Rama Co-RADS

To respond to the ongoing and pressing challenges on patient triage in hospitels, Suwatanapongched et al. [28] proposed an alternative categorical assessment scheme of chest X-ray findings for the diagnosis of pneumonia in patients with confirmed COVID-19 (hereinafter referred to as "Rama Co-RADS") (Table 2). Rama Co-RADS was designed based on Ramathibodi's experiences in the first and second waves of COVID-19 in Thailand and previously published studies [14,15,29,30] using the standardized reporting systems for chest CT and chest X-ray COVID-19 published in the literature [15,24-26] as the framework.

As shown in the previous studies, COVID-19 pneumonia shares similar chest X-ray and chest CT findings [14,15,18,29,30]. The presence of poorly defined patchy opacities or consolidations in a peripheral distribution or rounded morphology on chest X-rays raises the likelihood of being COVID-19 pneumonia in the pandemic setting, especially in the confirmed cases (Figures 2B,3-5).

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Rama Co-RADS provides six categories, i.e., categories 1-5 and additional category C (Table 2) [28]. As shown in Table 2, the categories in Rama Co-RADS refer to six likelihood levels of COVID-19 pneumonia on chest X-rays in confirmed COVID-19 cases. The likelihood level increases from negative or very low in Rama Co-RADS category 1 to very high in Rama Co-RADS category 5.

Rama Co-RADS category 1 indicates a normal chest X-ray [28] and implies a negative or very low likelihood of having pulmonary involvement in COVID-19.

Rama Co-RADS category 2 denotes minor abnormalities unrelated to COVID-19 pneumonia on a chest X-ray and also implies a negative or very low likelihood of having pulmonary involvement in COVID-19. Examples are anatomical variants (e.g., breast implants, scoliosis, and old bony fractures), features favoring minor technical issues (e.g., rotation, suboptimal inspiration, inadequate exposure) not affecting film interpretation, and irrelevant abnormalities (e.g., old tuberculosis (TB), mild cardiomegaly, aortic atherosclerosis) requiring no treatment [28].

Rama Co-RADS category C (Figure 2A) indicates atypical chest X-ray findings inconsistent with COVID-19 pneumonia and suggests other clinically significant diseases. Examples are bacterial pneumonia, active TB, congestive heart failure, pneumothorax, pleural effusion, and malignancy. This category implies a low likelihood of COVID-19 pneumonia. Unlike minor abnormalities listed in category 2, these abnormalities are clinically significant and warrant further proper management and treatment. Rama Co-RADS category C also includes the severe technical artifacts impeding accurate film interpretation for COVID-19 pneumonia. A repeated chest X-ray on the following day is recommended [28].

Rama Co-RADS category 3 (Figure 3) indicates the presence of equivocal/unsure/indeterminate findings on a chest X-ray. Since early/mild/atypical pulmonary involvement in COVID-19 can manifest as subtle, poorly defined opacities indistinguishable from other causes (e.g., pseudolesions, other diseases) [29], Rama Co-RADS category 3 implies a moderate likelihood of COVID-19 pneumonia. Hence, a patient should receive a clinical evaluation for respiratory symptoms and undergo a follow-up chest X-ray within the next 1-2 days [28].

Rama Co-RADS category 4 (Figures 2B and 4A) requires the presence of single or multifocal poorly defined ground-glass opacities, consolidations, or both in the unilateral lung. These findings are considered suspicious for early/mild COVID-19 pneumonia [15,19,26,28,29] and, therefore, implies a high likelihood of COVID-19 pneumonia.

Rama Co-RADS category 5 (Figure 5) requires the presence of typical findings for COVID-19 pneumonia, i.e., multifocal, peripheral opacities (ground-glass opacities, consolidations, or both), including those with rounded morphology, in bilateral lungs. This category implies a very high likelihood of COVID-19 pneumonia [15,19,26,28,29]. Timely treatment with antivirals (± corticosteroids if indicated) and close follow-up, especially in a high-risk patient, are mandatory [4,12].

Rama Co-RADS category 5 generally reflects a greater extent of pulmonary involvement, implying more severe COVID-19 pneumonia than Rama Co-RADS category 4. Nevertheless, it is essential to note that categories 4 and 5 do not reflect the overall disease extent or severity of pneumonia, which may vary differ among patients. As the disease progresses or regresses, a dynamic or temporal change is inevitable (Figures 2, 4, and 5) [13-15,19,20].

When chest X-ray findings fit more than one category, the chest X-ray should be designated with the higher Rama Co-RADS category [28]. For example, a chest X-ray shows subtle equivocal opacities in one lung (Rama Co-RADS category 3) and multifocal, poorly defined ground-glass opacities in another lung (Rama Co-RADS 4), the chest X-ray should be assigned to Rama Co-RADS category 4. When another clinically significant disease coincides with a single poorly defined ground-glass opacity or consolidation, the chest X-ray should be assigned to Rama Co-RADS category 4 (Figure 2B).

The standardized description and interpretation of Rama Co-RADS facilitate radiologists to provide a rapid, precise, and concise chest X-ray report regarding the presence or absence of pneumonia in patients with confirmed COVID-19, despite the different levels of experiences.

Since applying Rama Co-RADS for chest X-ray reporting in Ramathibodi Hospitels on 26 April 2021, there has been a reduction in the median turnaround X-ray reporting time, the time lapse, and the communication gap among healthcare staff. As of 31 May 2021, the median turnaround X-ray reporting time reduced by 24%, compared with the time spent before using Rama Co-RADS [28].

At present, Rama Co-RADS has been adopted by other alternative healthcare facilities provided by different government agencies, for example, the Regional Health 8 Office of the Ministry of Public Health and the RadioVolunteer project [28,31,32]. The RadioVolunteer project is the collaboration of the Royal College of Radiologists of Thailand, the JF AdvanceMed Co.,LTD, and 328 Thai radiologists to help provide chest X-ray reporting of COVID-19 patients in the Medical Correctional Institution in Bangkok and prisons in all parts of Thailand.

Table 2. *Rama Co-RADS: categorical assessment scheme of chest X-ray findings for diagnosing pneumonia in patients with confirmed COVID-19.*

Rama Co-RADS	Likelihood of COVID-19 Pneumonia	Impression	Chest X-ray Findings
Category 1	Negative or very low	Normal chest X-ray	• No abnormality detected
Category 2	Negative or very low	Minor abnormalities unrelated to COVID-19 pneumonia	• Anatomical variants (e.g., breast implants, scoliosis, and old bony fractures) • Features favoring minor technical issues (e.g., suboptimal inspiration, inadequate exposure) but not affecting film interpretation • Irrelevant abnormalities (e.g., old tuberculosis (TB), mild cardiomegaly, aortic atherosclerosis)
Category C	Low	Low probability or atypical for COVID-19 pneumonia, but with other clinically significant diseases requiring clinical correlation and further management	• Other clinically significant diseases (e.g., bacterial pneumonia, active TB, congestive heart failure, pneumothorax, pleural effusion, malignancy) • Presence of severe technical artifacts affecting film interpretation and requiring a repeated or follow-up chest X-ray
Category 3	Moderate	Equivocal/unsure/indeterminate for COVID-19 pneumonia	• Some features (e.g., subtle, poorly defined opacities) that may represent early/mild/atypical COVID-19 pneumonia or other causes (e.g., pseudolesions, other diseases) requiring clinical correlation and follow-up chest X-ray
Category 4	High	Suspicious for early/mild COVID-19 pneumonia	• Single or multifocal poorly defined ground-glass opacities or consolidations in the unilateral lung
Category 5	Very high	Typical for COVID-19 pneumonia	• Multifocal peripheral opacities (ground-glass opacities and/or consolidations), including those with rounded morphology, in bilateral lungs

**Adapted from Suwatanapongched T, et al. Rama Med J 2021;44(2):50-62 [28].*

Rama Co-RADS for communication, management, and treatment of COVID-19

A chest X-ray report denoting Rama Co-RADS category 1 and 2 or C implies a negative/very low or low likelihood of COVID-19 pneumonia. Therefore, on-duty physicians can follow the workflow without consulting ID specialists (Figure 1). Since a negative chest X-ray may result from a lack of pulmonary involvement, an early course of infection, or subtle pulmonary involvement beyond the resolution of plain radiography, follow-up chest X-ray is required for disease monitoring, especially in high-risk or symptomatic patients [19].

A chest X-ray denoting Rama Co-RADS category 4 or 5 implies, respectively, a high or very high likelihood of COVID-19 pneumonia (Figure 2B, 4, 5). Regardless of symptoms and risk factors, on-duty physicians can bypass a consultation with ID specialists and prescribe antivirals (± corticosteroids, if indicated) to these patients (Figure 1).

A chest X-ray report denoting Rama Co-RADS category 3 (Figure 3) implies a moderate likelihood of COVID-19 pneumonia. In this regard, the on-duty physician needs to consult the supervising ID specialists for further opinion, management, and treatment (Figure 1).

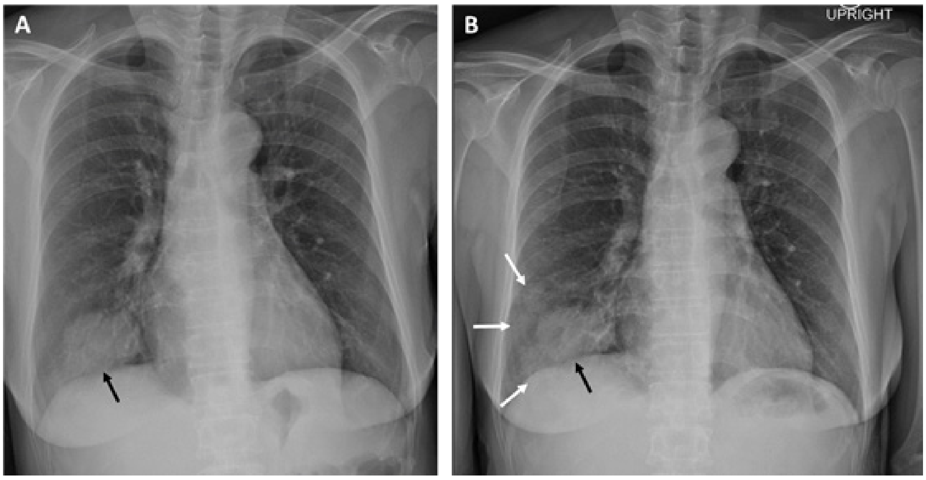

Figure 2. *A 55-year-old woman with positive RT-PCR.*
(A) The admission chest X-ray was obtained 7 days after the symptom onset. It shows a sizeable pulmonary mass (black arrow) in the right lower zone. The finding is atypical for COVID-19 pneumonia but raises the concern regarding lung cancer. This important finding should be categorized as Rama Co-RADS category C and warrants further workup. (B) The follow-up chest X-ray was obtained 2 days later. It shows newly developed opacities (white arrows) with rounded morphology around the pre-existing right lower lung mass (black arrow). The remaining lungs are clear. The new findings should now be categorized as Rama Co-RADS category 4, which raises the high likelihood of COVID-19 pneumonia.

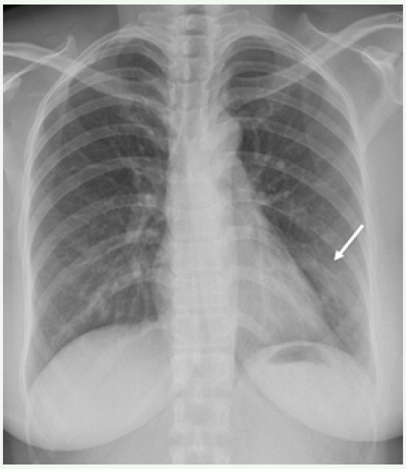

Figure 3. *A 39-year-old woman with positive RT-PCR.*
The admission chest X-ray obtained 10 days after the symptom onset shows subtle, poorly defined opacities (arrow) in the left lower zone, which might represent early COVID-19 pneumonia or pseudolesions caused by the overlapping ribs and pulmonary vessels. The findings are considered Rama Co-RADS category 3. However, due to late presentation and lack of clinical symptoms or risk factors, the ID specialist decided to discharge the patient the following day for monitoring as a home isolation case, without requesting chest X-ray follow-up and prescribing antiviral treatment.

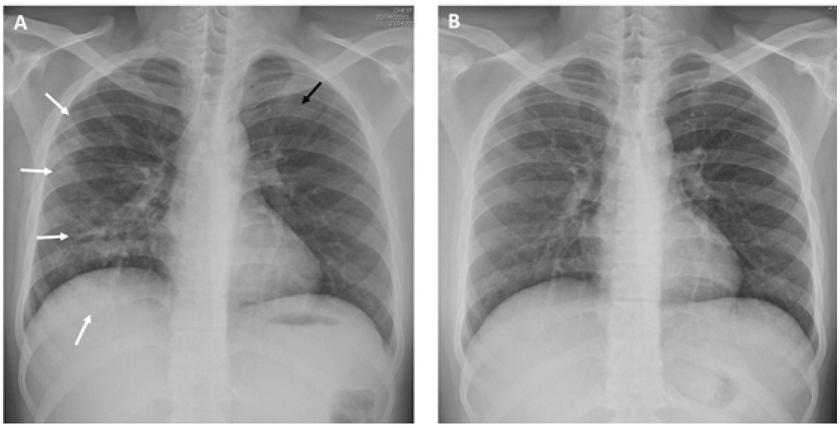

Figure 4. *A 20-year-old man with fever, cough, dyspnea, anosmia, and positive RT-PCR.*
(A) The admission chest X-ray was obtained 15 days after the symptom onset. It reveals multifocal, poorly defined opacities (white arrows) in all zones of the right lung (most pronounced in the lower zone); findings are suspicious for COVID-19 pneumonia. Also, subtle, poorly defined opacities in the left upper zone (black arrow) are noted, representing either early pneumonia or pseudolesions caused by the overlapping structures. Since the opacities in the left upper zone are considered equivocal, the chest X-ray findings should be categorized as Rama Co-RADS category 4. (B) The follow-up chest X-ray was obtained 23 days after the symptom onset and 8 days of favipiravir and prednisolone treatment. It shows marked radiographic improvement along with remission of all clinical symptoms.

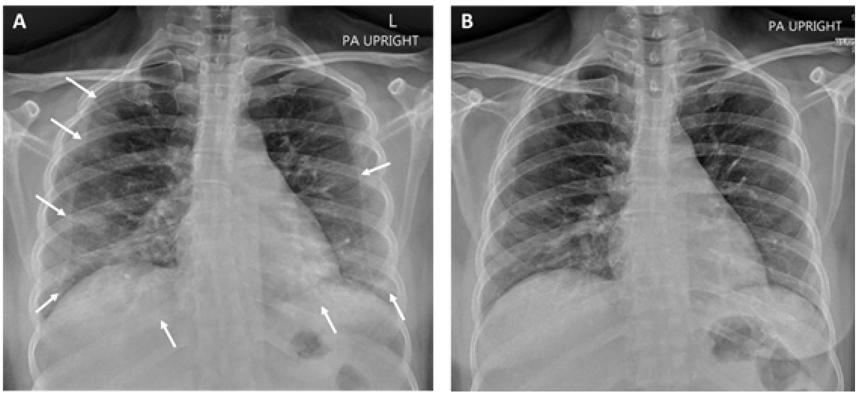

Figure 5. *A 44-year-old woman with cough and positive RT-PCR.*
(A) The admission chest X-ray was obtained 7 days after the symptom onset. It shows multifocal, bilateral, poorly defined opacities (arrows), more pronounced on the right lung and the lower zones. The findings are typical for COVID-19 pneumonia corresponding to Rama Co-RADS category 5.
(B) The follow-up chest X-ray was obtained 12 days after the symptom onset and 5 days of favipiravir and dexamethasone treatment. Significant radiographic improvement is evident along with clinical remission.

Conclusion

In the current and unprecedented COVID-19 situation which overwhelms the country's existing healthcare facilities, physicians, and other healthcare staff in Thailand, early identification of vulnerable patients at risk and early COVID-19 pneumonia on chest X-ray is crucial for addressing timely management and treatment by antivirals or corticosteroids to prevent them from developing severe COVID-19 pneumonia. Incorporating a categorical assessment scheme in Rama Co-RADS into the radiology workflow helps facilitate rapid, clear, and concise chest X-ray reports, and reduces the time lapse and communication gap among healthcare staff. Its use successfully assists on-duty, frontline physicians in the alternative healthcare facilities to make prompt and more accurate decisions regarding the management and treatment of COVID-19 patients following the current national guideline.

Author contributions

The authors have made a substantial, direct and intellectual contribution to the work and approved it for publication.

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References

1. Nittayasoot N, Suphanchaimat R, Namwat C, Dejburum P, Tangcharoensathien V. Public health policies and health-care workers' response to the COVID-19 pandemic, Thailand. Bull World Health Organ 2021;99:312-8. doi: 10.2471/BLT.20.275818.

2. Beyrampour-Basmenj H, Milani M, Ebrahimi-Kalan A, Ben Taleb Z, Ward KD, Dargahi Abbasabad G, et al. An overview of the epidemiologic, diagnostic and treatment approaches of COVID-19: What do we know? Public Health Rev 2021;42:1604061. doi: 10.3389/phrs.2021.1604061.

3. Department of Disease Control, Ministry of Public Health [Internet]. Nonthaburi: MOPH; c2021 [cited 2021 July 31]. [Coronavirus Disease (COVID-19): Thailand situation]. Available from: https://ddc.moph.go.th/viralpneumonia/index.php. Thai.

4. Booth A, Reed AB, Ponzo S, Yassaee A, Aral M, Plans D, et al. Population risk factors for severe disease and mortality in COVID-19: a global systematic review and meta-analysis. PLoS ONE 2021;16:e0247461. doi.org/10.1371/journal.pone.0247461. doi: 10.1371/journal.pone.0247461.

5. Kaleemi R, Hilal K, Arshad A, Martins RS, Nankani A, Tu H, et al. The association of chest radiographic findings and severity scoring with clinical outcomes in patients with COVID-19 presenting to the emergency department of a tertiary care hospital in Pakistan. PLoS One 2021;16:e0244886. doi: 10.1371/journal.pone.0244886.

6. Angus DC, Derde L, Al-Beidh F, Annane D, Arabi Y, Beane A, et al. Effect of hydrocortisone on mortality and organ support in patients with severe COVID-19: the REMAP-CAP COVID-19 corticosteroid domain randomized clinical trial. JAMA 2020;324:1317-29. doi:10.1001/jama.2020.17022.

7. Department of Medical Services, Ministry of Public Health [Internet]. Nonthaburi: MOPH; c2019 [cited 2021 July 31]. [COVID-19]. Available from: https://covid19.dms.go.th. Thai.

8. Department of Medical Services, Ministry of Public Health. [Guidelines on the management of hospitels for COVID-19 patients with mild disease and no or controlled co morbidities] [Internet]. Nonthaburi: MOPH; 2021 July 20 [cited 2021 July 30]. Available from: https://bit.ly/3icP0yx. Thai.

9. Department of Medical Services, Ministry of Public Health. [Guidelines on the establishment of hospitels for COVID-19 [Internet]. Nonthaburi: MOPH; 2020 March 3 [cited 2021 July 30]. Available from: https://bit.ly/3rLOr26. Thai.

10. Department of Disease Control, Ministry of Public Health. [Guidelines on the establishment of field hospitals in case of COVID-19 widespread] [Internet]. Nonthaburi: MOPH; 2021 January 7 [cited 2021 July 2]. Available from: https://covid19.dms.go.th/backend/Content/Content_File/Covid_Health/Attach/25640111082302AM_Field%20Hospital%20GL_V_5_08012021.pdf. Thai.

11. Prutipinyo C. COVID-19 field hospital: alternative state quarantine hospital and hospitel. Public Health Policy & Laws Journal 2021;7(1):195-213.

12. Department of Medical Services, Ministry of Public Health. [Guidelines on clinical practice, diagnosis, treatment, and prevention of healthcare-associated infection for COVID-19] [Internet]. Nonthaburi; MOPH; [updated 2021 July 21; cited 2021 July 29]. Available from: https://covid19.dms.go.th/backend/Content/Content_File/Covid_Health/Attach/25640721115923AM_CPG_COVID_v.16.4.n.pdf. Thai.

13. Meng H, Xiong R, He R, Lin W, Hao B, Zhang L, et al. CT imaging and clinical course of asymptomatic cases with COVID-19 pneumonia at admission in Wuhan, China. J Infect 2020;81:e33-9. doi: 10.1016/j.jinf.2020.04.004.

14. Wang Y, Dong C, Hu Y, Li C, Ren Q, Zhang X, et al. Temporal changes of CT findings in 90 patients with COVID-19 pneumonia: a longitudinal study. Radiology 2020;296:E55-64. doi: 10.1148/radiol.2020200843.

15. Litmanovich DE, Chung M, Kirkbride RR, Kicska G, Kanne JP. Review of chest radiograph findings of COVID-19 pneumonia and suggested reporting language. J Thorac Imaging 2020;35:354-60. doi: 10.1097/RTI.0000000000000541.

16. Rodrigues JCL, Hare SS, Edey A, Devaraj A, Jacob J, Johnstone A, et al. An update on COVID-19 for the radiologist - A British society of Thoracic Imaging statement. Clin Radiol 2020;75:323-5. doi: 10.1016/j.crad.2020.03.003.

17. Rubin GD, Ryerson CJ, Haramati LB, Sverzellati N, Kanne JP, Raoof S, et al. The role of chest imaging in patient management during the COVID-19 pandemic: a multinational consensus statement from the Fleischner Society. Radiology 2020;296:172-80. doi: 10.1148/radiol.2020201365.

18. Kwee TC, Kwee RM. Chest CT in COVID-19: What the radiologist needs to know. Radiographics 2020;40:1848-65. doi:10.1148/rg.2020200159.

19. Kohli A, Hande PC, Chugh S. Role of chest radiography in the management of COVID-19 pneumonia: An overview and correlation with pathophysiologic changes. Indian J Radiol Imaging 2021;31(Suppl 1):S70-9. doi: 10.4103/ijri.IJRI_967_20.

20. Goyal A, Tiwari R, Bagarhatta M, Ashwini B, Rathi B, Bhandari S. Role of portable chest radiography in management of COVID-19: Experience of 422 patients from a tertiary care center in India. Indian J Radiol Imaging 2021;31(Suppl 1):S94-100. doi: 10.4103/ijri.IJRI_480_20.

21. Gross A, Heine G, Schwarz M, Thiemig D, Gläser S, Albrecht T. Structured reporting of chest CT provides high sensitivity and specificity for early diagnosis of COVID-19 in a clinical routine setting. Br J Radiol 2021;94: 20200574. doi: 10.1259/bjr.20200574.

22. Stanzione A, Ponsiglione A, Cuocolo R, Rumolo M, Santarsiere M, Scotto R, et al. Chest CT in COVID-19 patients: structured vs conventional reporting. Eur J Radiol 2021;138:109621. doi: 10.1016/j.ejrad.2021.109621.

23. Kwee RM, Adams HJA, Kwee TC. Diagnostic Performance of CO-RADS and the RSNA classification system in evaluating COVID-19 at Chest CT: A Meta-Analysis. Radiol Cardiothorac Imaging 2021;3:e200510. doi: 10.1148/ryct.2021200510.

24. Simpson S, Kay FU, Abbara S, Bhalla S, Chung JH, Chung M, et al. Radiological Society of North America Expert Consensus Statement on reporting chest CT findings related to COVID-19. Endorsed by the Society of Thoracic Radiology, the American College of Radiology, and RSNA - Secondary Publication. J Thorac Imaging 2020;35:219-27. doi: 10.1097/RTI.00000000000 00524.

25. Prokop M, van Everdingen W, van Rees Vellinga T, Quarles van Ufford H, Stöger L, et al. COVID-19 standardized reporting working group of the Dutch Radiological Society. CO-RADS: a categorical CT assessment scheme for patients suspected of having COVID-19-definition and evaluation. Radiology 2020;296:E97-104. doi: 10.1148/radiol.2020201473.

26. Yates A, Dempsey PJ, Vencken S, MacMahon PJ, Hutchinson BD. Structured reporting in portable chest radiographs: An essential tool in the diagnosis of COVID-19. Eur J Radiol 2021;134:109414. doi:10.1016/j.ejrad.2020.109414.

27. De Sanctis V, Bedair EMA, Soliman AT, Nair AP, Al Masalamani MA, Yassin M. Proposed scoring system for evaluating clinico-radiological severity of COVID-19 using plain chest X-ray (CXR) changes (CO X-RADS): preliminary results. Acta Biomed 2020;91:e2020172. doi:10.23750/abm.v91i4.10664.

28. Suwatanapongched T, Nitiwarangkul C, Sukkasem W, Phongkitkarun S. Rama Co-RADS: categorical assessment scheme of chest radiographic findings for diagnosing pneumonia in patients with confirmed COVID-19. Rama Med J 2021;44(2):50-62. doi.org/10.33165/rmj.2021.44.2.251259. Thai.

29. Yoon SH, Lee KH, Kim JY, Lee YK, Ko H, Kim KH, et al. Chest radiographic and CT findings of the 2019 novel coronavirus disease (COVID-19): analysis of nine patients treated in Korea. Korean J Radiol 2020;21:494-500. doi:10.3348/kjr.2020.0132.

30. Wong HYF, Lam HYS, Fong AH, Leung ST, Chin TW, Lo CSY, et al. Frequency and distribution of chest radiogaphic findings in patients positive for COVID-19. Radiology 2020;296(2):E72-8. doi: 10.1148/radiol.2020201160.

31. R8way, Ministry of Public Health [Internet]. Nonthaburi: MOPH; 2021 [cited 2021 July 30].Case management COVID-19. Available from: https://r8way.moph.go.th/r8way/covid-19. Thai.

32. Tanomkiat W, Taprig A, Piyavisetpat N. RadioVolunteer, the novel combination of social, management and technological innovations of the Royal College of Radiologists of Thailand during COVID-19 pandermic. ASEAN J Radiol. In press 2021.

Perspectives

MRI used for non-invasive description of new octopus species

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Keywords: MRI, Octopus.

In the North Pacific Ocean, the Emperor Seamounts are named for Japanese emperors. A new species of dumbo octopus ('dumbo' because its paired fins remind one of the ears of Disney's flying elephant; National Geographic video of dumbo octopus: www.youtube.com/watch?v=pl4pqu5FTaI&ab_channel=NationalGeographic) found there is proposed to have the English name 'Emperor dumbo'. In the language of the German scientists who describe this new octopus, the name would be 'Kaiserdumbo'.

On 5 July 2016, the German deep ocean research vessel SONNE was pulling rocks and sediments, animals and plants from one of the Emperor seamounts, from a depth of more than 4000 meters. On that day, one of the steel nets included a pink octopus, 29 cm in length [1]. It happened that the zoologist on the research team, Dr. Alexander Ziegler from University of Bonn, had a special interest in digital three-dimensional (3D) imaging of invertebrates. He recognized the dead animal as a dumbo octopus, likely an unknown species. The octopus was placed in a tub of cold seawater; external features were photographed and measured, including a close up of the suckers which averaged 71 per arm (Figures 1-3), and a bit of tissue was collected from a damaged arm for DNA sequence analysis. Rather than follow the traditional taxonomic practice of dissecting the internal organs, he planned to fully visualize the animal non-invasively. Thus, this rare species would be intact and without any tissue staining (including contrast agents) for potential future studies.

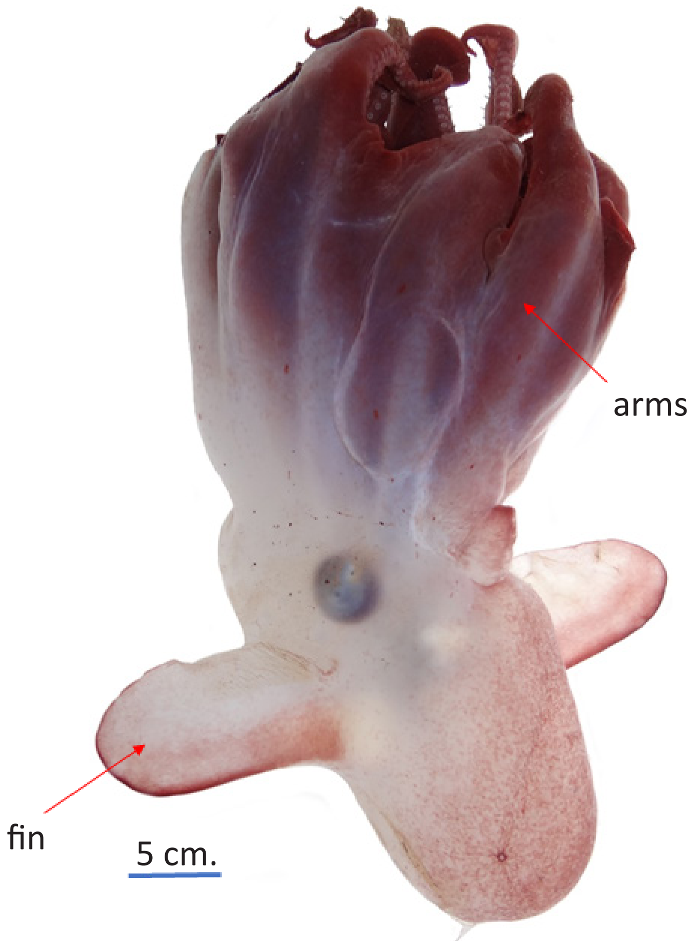

Figure 1. *Emperor dumbo octopus. Dorsal view of specimen before fixation showing one eye and two fins with arms pointing upward. (Photo by Alexander Ziegler; uploaded from MorphoBank.) [2]*

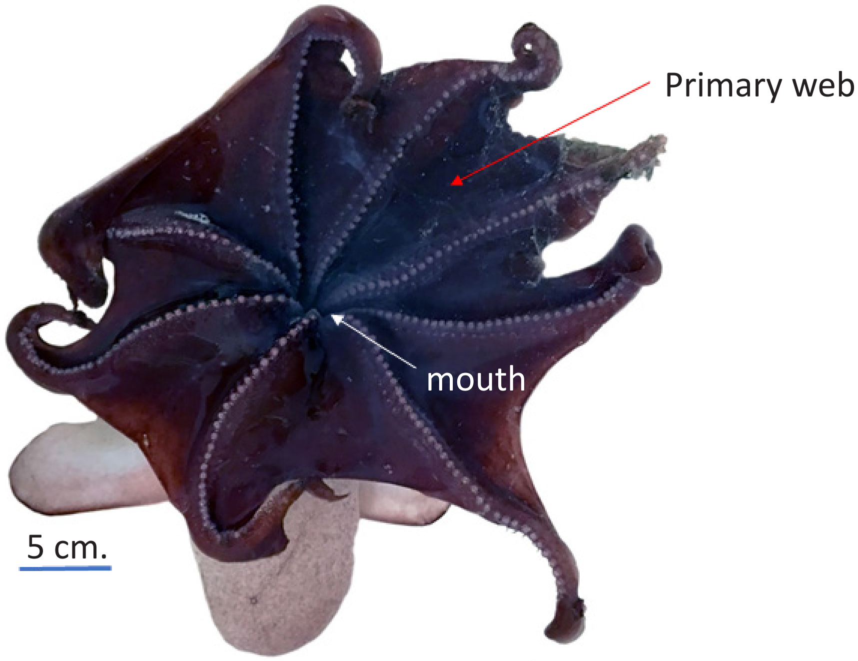

Figure 2. *Emperor dumbo octopus. Ventral view of specimen before fixation showing open webbed arms around central mouth. (Photo by Alexander Ziegler; uploaded from MorphoBank.) [2]*

Figure 3. *Emperor dumbo octopus. Lateral view of section of arm showing the suckers. (Photo by Alexander Ziegler; uploaded from MorphoBank.) [2]*

In April of 2021, Ziegler and Christina Sagorny (a former graduate student) published their holistic description of this previously unknown species [2]. As octopi are mostly soft tissue, magnetic resonance imaging (MRI) was the key technology they utilized. But the animal also has a beak and rasping tongue (radula) made of chitin, and so they also utilized computerized tomography (CT). Datasets acquired from these two methods allowed generation of 3D models of internal organs and systems.

The animal was fixed in formalin (10%) for MRI. Scanning was done at the German Center for Neurodegenerative Diseases in Bonn with a 7-T high-field Magnetom clinical MR system with a 600-mn magnet bore, with acquisition over 17 hours. Data reconstruction used the software syngo MR B17 (Siemens). We believe this to be the first MRI study which images all of the viscera of a deep-sea octopus.

For micro-CT, the specimen was transferred to an ethanol (70%) solution. Scanning was done by the paleontologists at the University of Bonn with a Phoenix v/tome/x s 180/240 CT system, with an acquisition time of about 1.5 hours. Reconstruction of the 16-bit images was done with Phoenix datos/x 2.7 software.

The MRI showed the reproductive system to be that of an adult male. A virtual section through the 3D MRI database is shown (Figure 4). The large eyes at top and bottom, and pair of fin cartilage/muscle toward the left, are helpful for orientation. The internal organs are shown in a volume rendering view, emphasizing the gastrointestinal and cardiovascular systems (Figure 5; oblique posterior).

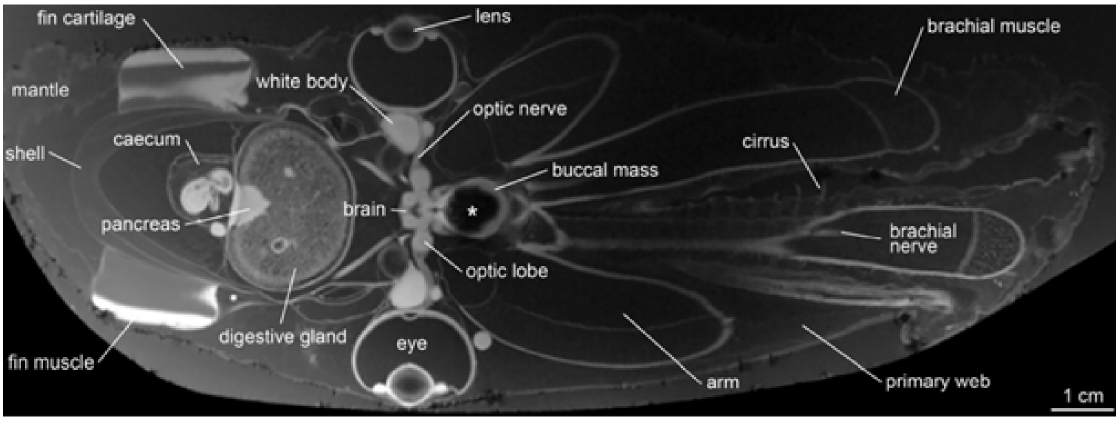

Figure 4. *Virtual section of Emperor dumbo octopus through the 3D MRI dataset with anterior facing right. (Credit: Ziegler and Sagorny, BMC Biology, 2021) [2]*

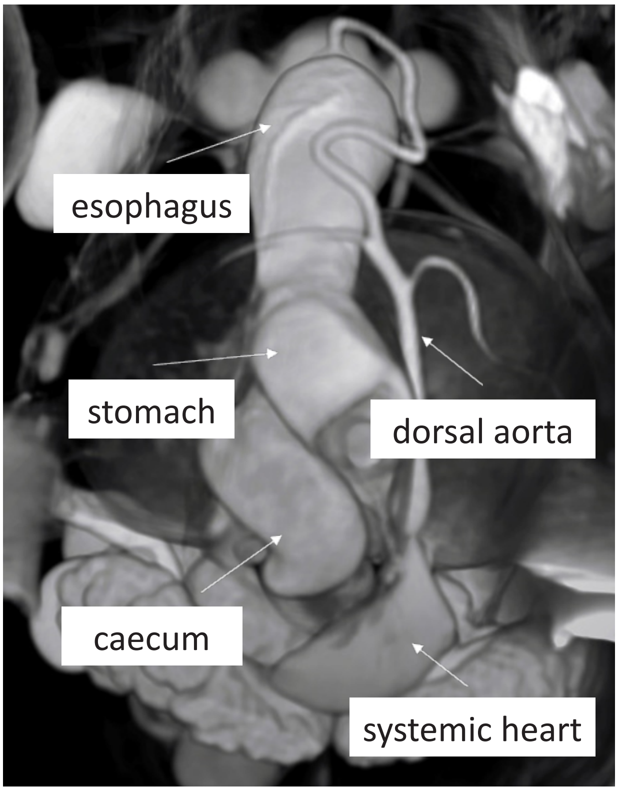

Figure 5. *Volume rendering of Emperor dumbo octopus viscera, ventral view, with anterior facing up. (Credit: Ziegler and Sagorny, BMC Biology, 2021) [2]*

The work of Ziegler and Sagorny demonstrate the power of current and complementary imaging techniques to fully characterize deep sea animals in a non-destructive manner. Since these animals are so rare, yet likely so diverse, maintaining their physical integrity for future study is a major advantage of these MRI and CT technologies.

The paper was published as open access, with data deposited in, and made publicly available through, the MorphoBank and GenBank projects.

References

1. DeWeerdt S. Seeing inside the newly discovered Emperor Dumbo Octopus. Hakai Magazine: coastal sciences and societies [Internet]. 2021 April 22[cited 2021 Aug 11]: [about 4 minutes]. Available from: https://www.hakaimagazine.com/news/seeing-inside-the-newly-discovered-emperor-dumbo-octopus/

2. Ziegler A, Sagorny C. Holistic description of new deep sea megafauna (Cephalopoda: Cirrata) using a minimally invasive approach. BMC Biol 2021;19:81. doi: 10.1186/s12915-021-01000-9.

Initiative/ Innovation

RadioVolunteer, a novel combination of social, management and technological innovations by the Royal College of Radiologists of Thailand in response to the COVID-19 pandemic

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Abstract

RadioVolunteer, a project launched by the Royal College of Radiologists of Thailand, combined social, technological and management innovation, and integrated government, private and non-profit sectors, to overcome a complex task that only one sector could not seamlessly complete. Working on a digital platform which allowed radiologist volunteers from any part of Thailand to promptly read and report chest radiographs of patients with corona virus disease 2019 (COVID-19) who resided in prisons across the country. Its digitized reporting format helped triage patients with COVID-19 pneumonia, and also screen for tuberculosis.

Keywords: Digital intervention, Artificial intelligence, Chest radiograph, Corona virus disease 2019, Tuberculosis, Prison.

Background

Associated Professor Nitipatana Chierakul, as the President of Thoracic Society of Thailand under Royal Patronage [1] telephoned one of us (WT), as the President of the Royal College of Radiologists of Thailand (RCRT) [2], on May 15, 2021, to share his great concern regarding the third wave of the COVID-19 pandemic spreading through Thailand. He predicted that superclusters would arise at any time, with prisons as a particularly high-risk location. He suggested that all societies of health professionals in the country should recruit resources, especially human, to be ready to assist. On that day, an author (NP) was asked to run a project under the name of the RCRT which would consist of chest radiology experts, radiologist volunteers, and private sectors which had corporate social responsibility policies. The J.F. Advance Med Co., a radiological digital technology supplier, was chosen to create a digital platform where more than 5,000 chest radiographs a day could be displayed, interpreted, reported, and recorded. This project was named “RadioVolunteer” (Figure 1a) by the author (NP).

Description

Chest radiology experts were asked to choose a reporting format which would clearly guide caring physicians to the type and intensity of pulmonary involvement, be friendly to the volunteers interpreting radiologists, and understandable to the assisting medical staff and patients. Ramathibodi Hospital’s Co-RADS [3] was adapted, simplified and digitized to use in the RadioVolunteer project.

This project was inspired by a prior project, “RT Hero” (Figure 1b), run by the Thai Society of Radiological Technologists to recruit radiological technologist volunteers for COVID-19 field hospitals. However, that project had a few drawbacks, mainly because it used face-to-face operation and volunteers needed to stay near the site. Learning from those lessons, RadioVolunteer strove to allow volunteers to join from any place at their most convenient times. To cover at least the daytime hours, the number of volunteers must be sufficient that even by entering into the system randomly, there would be at least 4-5 volunteers in each hour.

Figure 1. *Digital posters for (A) "RadioVolunteer" and (B) "RT Hero" which were disseminated via social media to recruit volunteers.*

In addition to the speed of the digital platform system, a friendly and joyful reporting system was also essential. Two authors (NP and AT) designed and created the digital reporting system (Figure 2a) that allowed a normal chest radiograph (CXR) with a good image quality to be displayed, interpreted and reported with 3 clicks. Together with the motto "every click helps save a life", recruitment drew more than 350 board-certified Thai radiologists into the project (Figure 3).

The volunteers interpreted the original CXR image side-by-side with a computer -assisted image assessed by an artificial intelligence (AI) technology provided by the platform (Figure 2b). In this way, the RCRT used RadioVolunteer as a 'sandbox' where members could experience AI, and technology suppliers could introduce AI products to the radiologists. Moreover, the accuracy of AI compared to the volunteer radiologists, and the usefulness of AI to the radiologists or to the diagnostic work flow could all potentially be assessed by the RCRT.

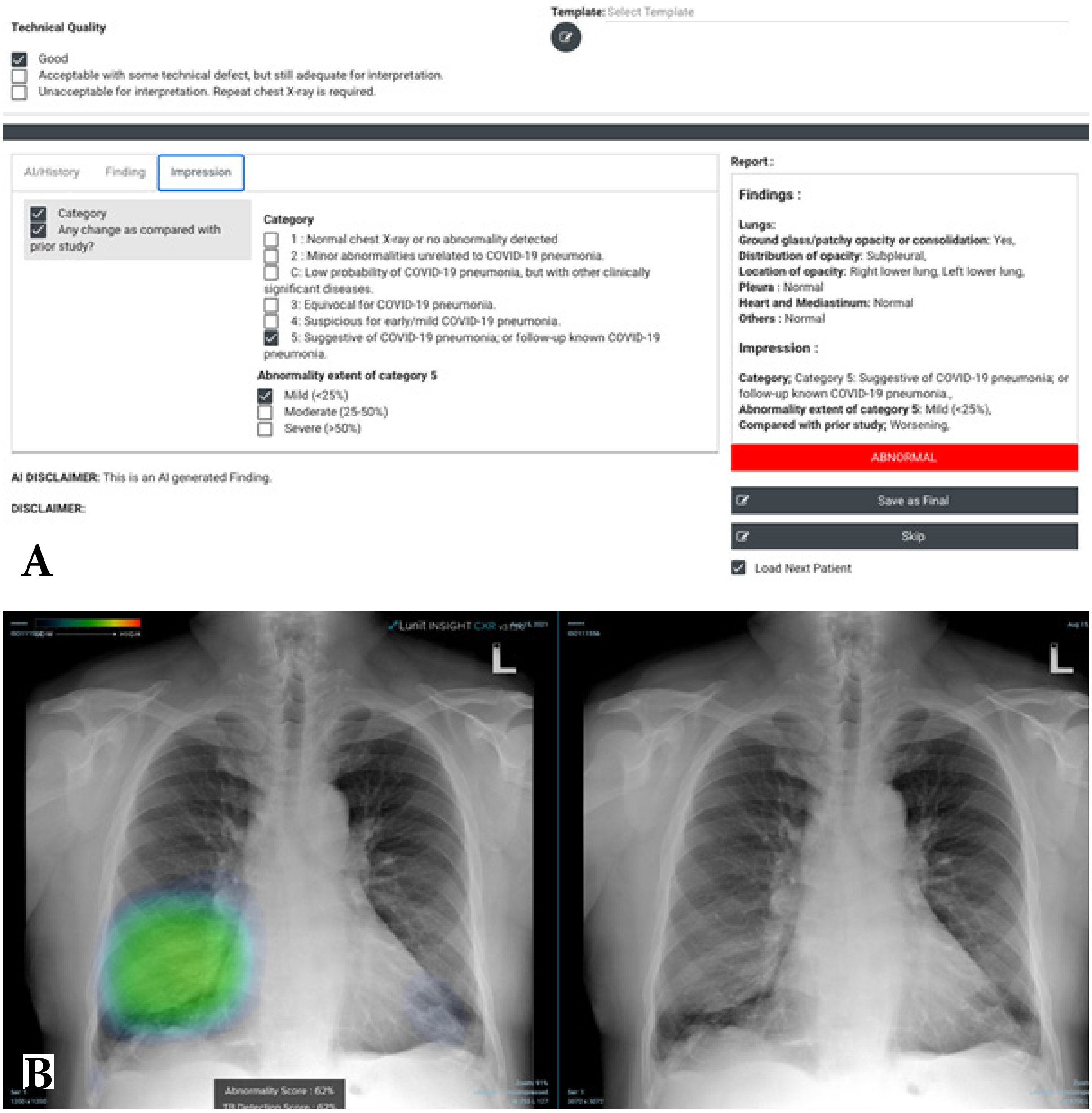

Figure 2. *The digital reporting system (A) captures image quality, findings, diagnostic categories, extent of COVID-19 pneumonia, and comparison with prior images. (B) The original chest radiograph is displayed side-by-side with the computer-assisted (AI) one.*

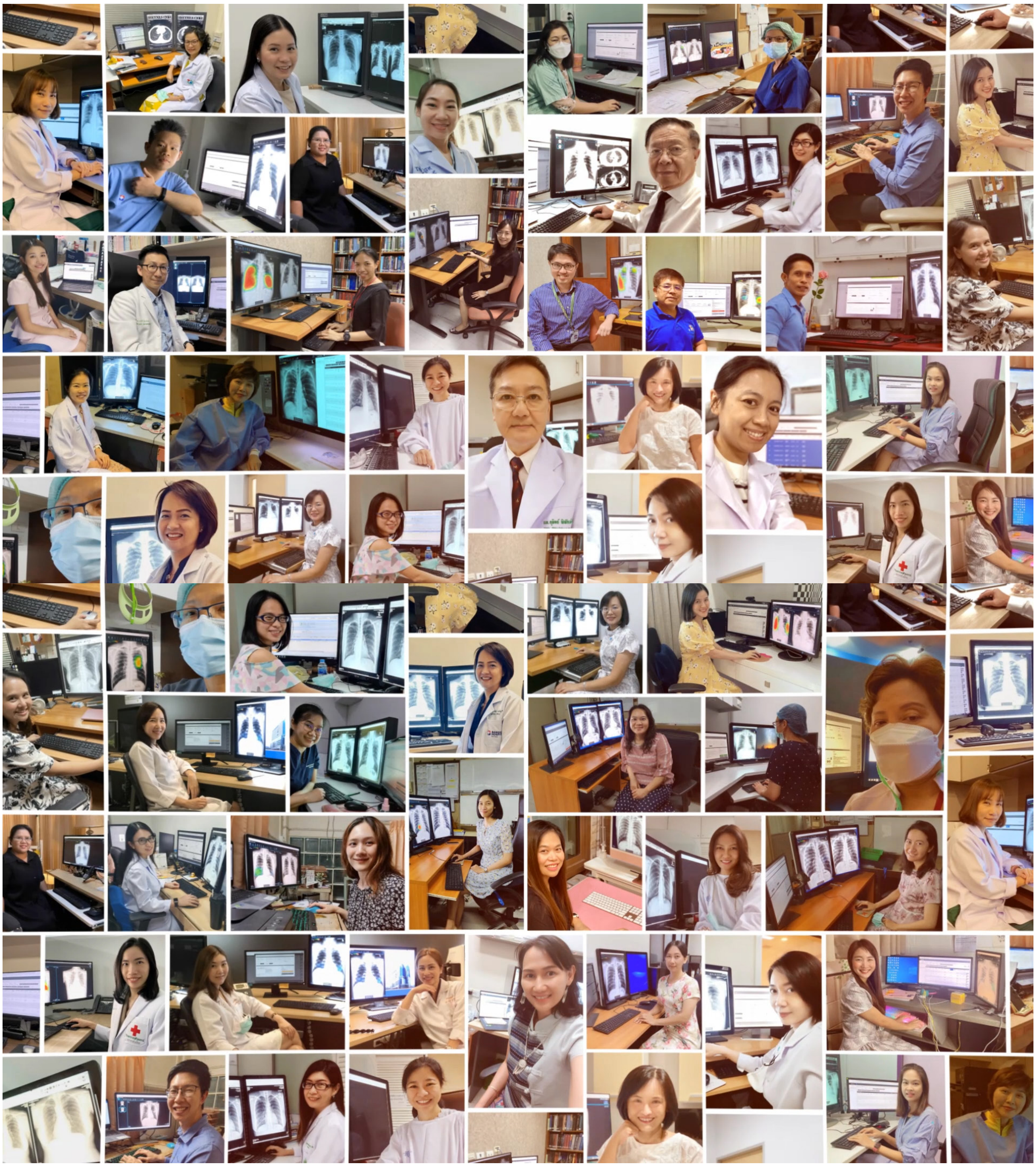

Figure 3. *Some of the 350 volunteer radiologists who joined from home and work locations.*

RadioVolunteer was launched on June 2, 2021, and the first volunteers were the authors and other chest radiology experts. The operation was set up in response to a request from the Department of Corrections of Thailand where there was a shortage of radiologists in its hospitals. Reports from radiologists were used for triaging the level of medical care, including anti-viral medication, among infected prisoners (Figure 4). During June-July 2021, 77,037 chest radiographs of infected prisoners in 34 prisons in all parts of Thailand were interpreted by RadioVolunteer. The surprisingly low mortality rate of 0.1% in the infected prisoners, compared with 0.8% in the infected general Thai population (though the prisoners may tend to be younger) during the same period of time [4] was thought to be due to the effectiveness of the caring system, including the timely chest radiograph reports from RadioVolunteer.

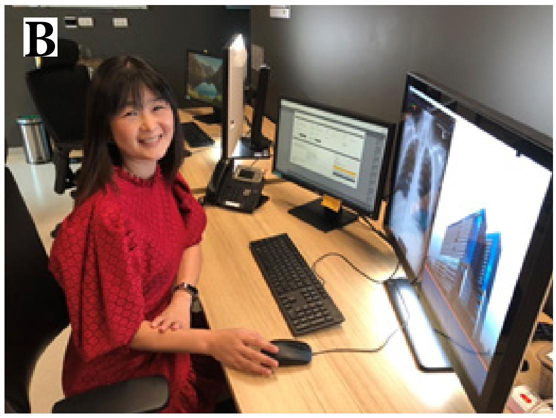

Figure 4. *(A) Mrs. Nipha Ngamtrairai, the director of prisons in Songkla, a province in the deep south of Thailand (left) and two of the authors (WT, middle; AT, right) at one of the participating prisons, representing government, non-profit and private sectors, respectively. (B) One author (NP) is interpreting and making a report through RadioVolunteer from her office in Bangkok, more than 1,000 kilometers from the site.*

With an estimated incidence of 153 new cases of tuberculosis (TB) per 100,000 population in 2018, Thailand is among the 12 countries with the highest TB burdens [5]. It is the national policy to end tuberculosis by 2030 to meet the Sustainable Development Goal (SDG), according to the United Nation (UN) [6] and the World Health Organization (WHO) End TB Strategy [7]. One of the five strategies to reduce TB incidence to 88 cases per 100,000 population per year within 2021was to use chest radiography as a screening tool in all people within 7 high-risk groups [8]. Having the highest incidence, prisoners are the first group to be screened. The plan to screen all prisoners with chest radiographs was to begin in March 2021, but was completely stopped in April due to the third wave of COVID-19 which spread to all parts of Thailand, including in prisons. RadioVolunteer, even though initiated to assess COVID-19 pneumonias, also allowed part of the screening TB plan to be implemented because TB, either of active or indeterminate activity, was included in the report format.

From prisons, RadioVolunteer expanded its help to non-prison field hospitals in many parts of Thailand during June-July, 2021. When the COVID-19 infection rate was sky rocking in August, 2021, to over 20,000 new cases per day, forms of medical caring system in addition to field hospitals were initiated. This included community and home isolation for those who were infected and waiting for standard medical care in the hospitals. RadioVolunteer, with an estimated capacity of more than 8,000 CXRs a day and a maximal speed of more than 1,100 CXR images per hour, is ready to plug in with any medical care system which requires chest radiographs to determine extent of pneumonia.

Discussion

RadioVolunteer combined social, management and technological innovations, and allowed cooperation of three sectors of society: government, private and non-profit. These sectors shared and integrated their different strengths to execute a complex task that one sector alone could not seamlessly complete. The technological innovations which bridged geographic and time boundaries, provided opportunities to the radiologist volunteers from all parts of the country to conveniently use their professional skills to help patients from all parts of the country. Digital chest radiographs, AI, and a specially-designed digital reporting system were used for triage and directing medical attention to not only COVID-19 pneumonia but also tuberculosis.

Information and communications technology is one (Goal 9) of the SDGs, with the hope that digital technology will enhance the delivery and analysis of information which is essential to achieve other SDGs, including health promotion [6]. RadioVolunteer was a good example of a digital intervention to enhance patient care, surveillance, and management. It was also a good 'sandbox' for introducing, using and examining an AI product. In the future, the RCRT may add other aspects to RadioVolunteer, such as education and skill development.

Acknowlegement: The authors, on behalf of the Royal College of Radiologists of Thailand and RadioVolunteer project, would like to thank the many radiologists who volunteered their time for this project and the staff of the J. F. Advance Med Company for their helpful support.

References

1. President talk March 2021 [Internet]. Bangkok: Thoracic Society of Thailand under Royal Patronage; 2021 [cited 2021 August 18]. Available from: https://www.thoracicsocietythai.org/2021/03/01/%e0%b8%aa%e0%b8%b2%e0%b8%a3%e0%b8%88%e0%b8%b2%e0%b8%81%e0%b8%99%e0%b8%b2%e0%b8%a2%e0%b8%81%e0%b8%aa%e0%b8%a1%e0%b8%b2%e0%b8%84%e0%b8%a1%e0%b8%ad%e0%b8%b8%e0%b8%a3%e0%b9%80%e0%b8%a7%e0%b8%8a%e0%b8%8a-3/ Thai.

2. Letter from President 20 May 2020 [Internet]. Bangkok: Royal College of Radiologists of Thailand; 2019 [cited 2021 August 18]. Available from: https://www.rcrt.or.th/the-royal-college-of-radiologists-of-thailand/letter-form-president/ Thai.

3. Suwatanapongched T, Nitiwarangkul C, Sukkasem W, Phongkitkarun S. Rama Co-RADS: Categorical Assessment Scheme of Chest Radiographic Findings for Diagnosing Pneumonia in Patients With Confirmed COVID-19. Rama Med J [Internet] 2021 [cited 2021 Aug 18];44:50-62. Available from: https://he02.tci-thaijo.org/index.php/ramajournal/article/view/251259 Thai.

4. สถานการณ์ผู้ติดเชื้อ COVID-19 อัพเดทรายวัน: ข้อมูลเชิงวิเคราะห์รายจังหวัด [อินเตอร์เน็ต]. นนทบุรี:กระทรวงสาธารณสุข; 2564 [เข้าถึงเมื่อ 18 สิงหาคม 2564]. เข้าถึงได้จาก: https://ddc.moph.go.th/covid19-dashboard/?dashboard=analysis-province

5. WHO releases new global lists of high-burden countries for TB, HIV-associated TB and drug-resistant TB [Internet]. Geneva: World Health Organization; 2021 [cited 2021 Aug 18]. Available from: https://www.who.int/news/item/17-06-2021-who-releases-new-global-lists-of-high-burden-countries-for-tb-hiv-associated-tb-and-drug-resistant-tb

6. Sustainable Development Goals [Internet]. 2015. New York: United Nations. Department of Economic and Social Affairs [cited 2021 Aug 18]. Available from: https://sustainabledevelopment.un.org/sdgs

7. Sixty-seventh World Health Assembly. Resolution WHA67.1. Global strategy and targets for tuberculosis prevention, care and control after 2015 [Internet]. 2014 May 21 [cited 2021Aug 18]. Available from: http://apps.who.int/gb/ebwha/pdf_files/WHA67/A67_R1-en.pdf

8. Thailand Operational Plan to End Tuberculosis 2017-2021 [Internet]. Ministry of Public Health; 2017 [cited 2021 Aug 18]. Available from: https://www.tbthailand.org/download/Manual/Thailand%20Operational%20Plan%20To%20End%20%20TB_2017_2021.pdf

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Memorial

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Associated Professor Wilaiporn Bhothisuwan, 1947-2021

Associated Professor Wilaiporn Bhothisuwan died on July 10, 2021 from complications caused by corona virus disease 2019. She was born on July 2, 1947 and grew up in Bangkok, the capital of Thailand. Her father was an architect and lawyer, and her mother was a teacher. She earned an MD degree from the Faculty of Medicine, Siriraj Hospital, Mahidol University in 1971 and subsequently completed radiology residency at the same university. She then moved to London, England where she completed the Diagnostic Radiology Fellowship at Saint Bartholomew's Hospital in 1981.

Dr. Bhothisuwan's academic career in the Faculty of Medicine, Siriraj hospital, Mahidol University was definitely a successful one. She published quite a few articles and wrote several books on ultrasonography and breast imaging. She was an active member of the Royal College of Radiologists of Thailand, the Radiological Society of Thailand, and the Medical Ultrasonic Society of Thailand. She served in the Board of Directors for the Royal College of Radiologists of Thailand during 1995- 2015 as a president for the Medical Ultrasonic Society of Thailand during 2008-2011. Dr. Bhothisuwan loved her family, and developed strong passion for teaching residents, painting and gardening. She married Clinical Professor Kris Bhothisuwan and they were approaching their 47th anniversary just before she died. She was a mother of three sons and a grandmother of a grandson.

We uniformly admired Dr. Bhothisuwan for her clinical expertise, commitment to education, and amiable and pleasant personality. I personally truly enjoyed conversations with her and I learned a great deal from her sincere and kind opinions on various subjects.

Wiwatana Tanomkiat, M.D.
President
Royal College of Radiologists of Thailand

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