

PERANAN ARTIFICIAL
INTELLIGENCE
PADA X-RAY TORAKS
UNTUK PENEGAKAN
DIAGNOSIS DAN
PROGNOSIS COVID 19

Lina Choridah

FKKMK UGM

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Latar belakang

Pneumonia Covid-19 telah menimbulkan banyak kematian baik di dunia maupun di Indonesia

Tes diagnostik awal untuk infeksi COVID-19 adalah RT-PCR, belum dapat menilai tingkat keparahan penyakit

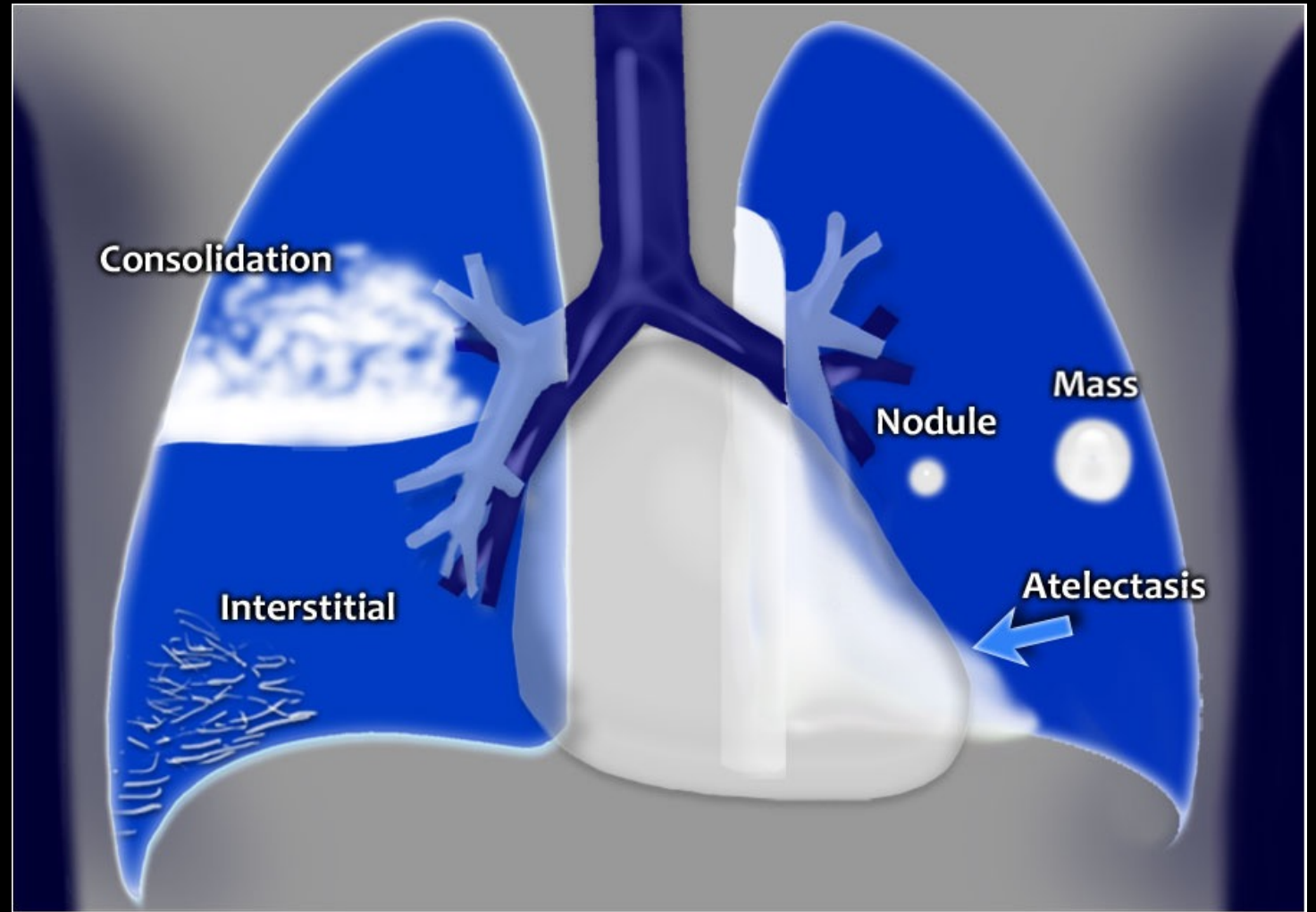
Radiografi toraks tersedia secara luas, dimanfaatkan pada proses penyaringan dan penegakan diagnosis dan penentuan prognosis COVID-19

Diperlukan sistem pembacaan radiografi toraks yang mudah dan objektif untuk penegakan diagnosis

AI memiliki potensi sebagai alat bantu pembacaan radiografi toraks secara objektif

Abnormalitas pada paru Peningkatan densitas/opasitas

- **consolidation** → alveoli terisi cairan, darah, sel radang, dll
- **Interstitial** - abnormalitas pada jaringan penunjang dari parenkim paru → fine /coarse reticular opacities /small nodules.
- **Nodule/** Mass-proses desak ruang tunggal/multiple
- **Atelectasis** - kolaps paru → penurunan udara dalam alveoli → penurunan volume, peningkatan densitas



Pneumonia

Pneumonia is an inflammation of lung tissue. Apart from harmful physical and chemical substances, causes primarily include infections with bacteria, viruses, fungi, and parasites. Amongst infectious diseases, pneumonia is the leading cause of death.

Risk Factors

- For all of the types of risk factors, pneumonia is considered to develop through infection.
- Immune system: weakened by stress, malnutrition, alcoholism, smoking, and other factors.
- Age: elderly and young children.
- Hospitalization: pneumonia is common in hospital inpatients.
- Surgery: pneumonia is common after surgery.
- Chronic diseases: pneumonia is common in patients with chronic diseases.
- Exposure to harmful substances: pneumonia is common in people exposed to harmful substances.
- Exposure to harmful organisms: pneumonia is common in people exposed to harmful organisms.

Inflammation of the air sacs (alveoli) and surrounding tissue in the lung is called pneumonia.

Signs and Symptoms of Pneumonia

The signs and symptoms of pneumonia are generally similar to those of other lung diseases. The most common signs and symptoms are cough, fever, chest pain, and difficulty breathing. The signs and symptoms of pneumonia are generally similar to those of other lung diseases. The most common signs and symptoms are cough, fever, chest pain, and difficulty breathing.

Diagnosis

Pneumonia is diagnosed by a combination of physical examination, chest X-ray, and laboratory tests. The most common physical examination findings are cough, fever, chest pain, and difficulty breathing. The most common chest X-ray findings are consolidation, infiltrate, and effusion. The most common laboratory test findings are elevated white blood cell count, elevated C-reactive protein, and elevated procalcitonin.

Prevention

- Avoiding contact with people who have pneumonia.
- Avoiding contact with people who have other respiratory infections.
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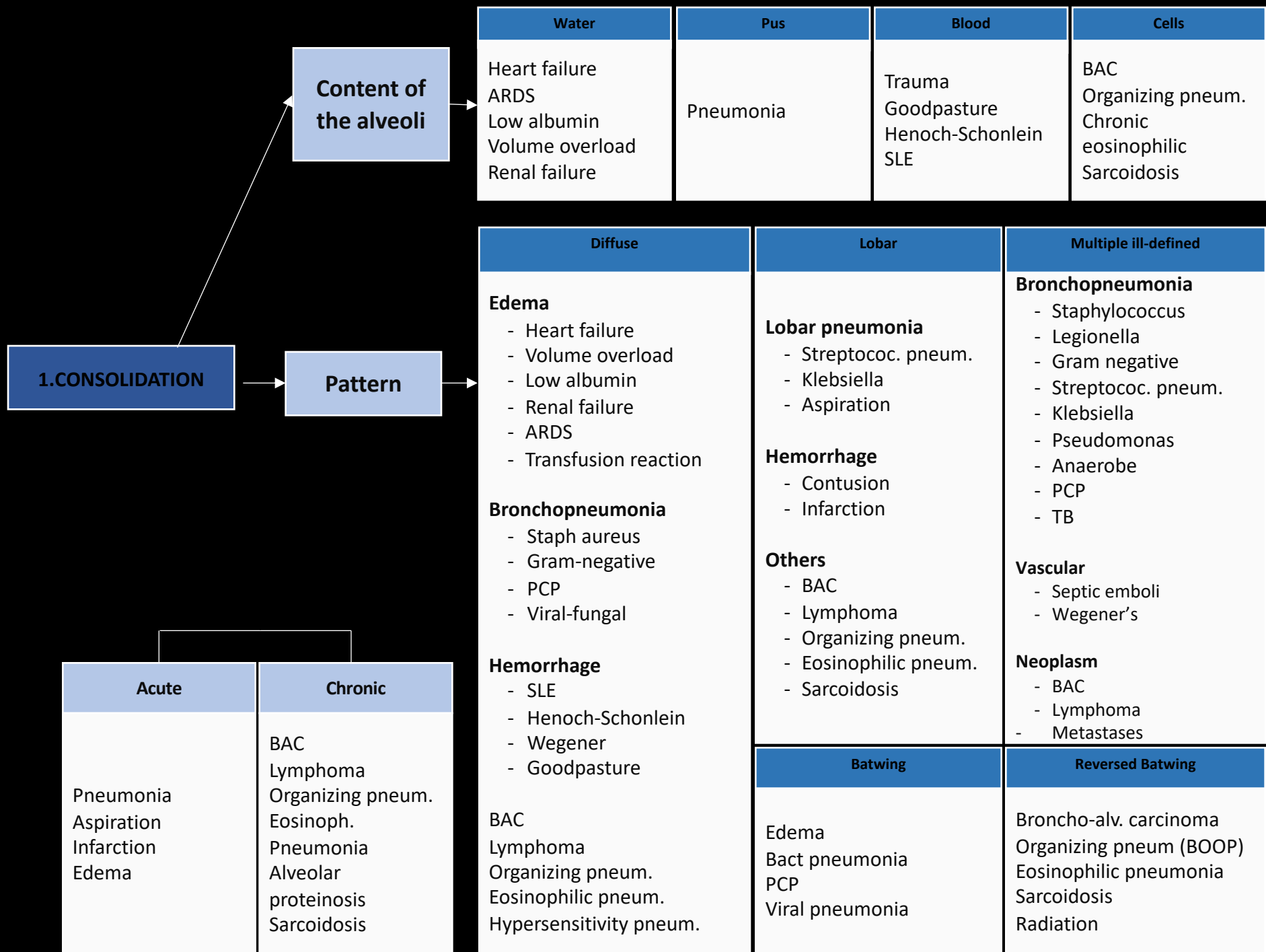
Long-term treatment of the lung

- Long-term treatment of the lung is generally similar to that of other lung diseases.
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Inflammation of the walls separating the air sacs with inflammatory reactions leading to fluid accumulation.

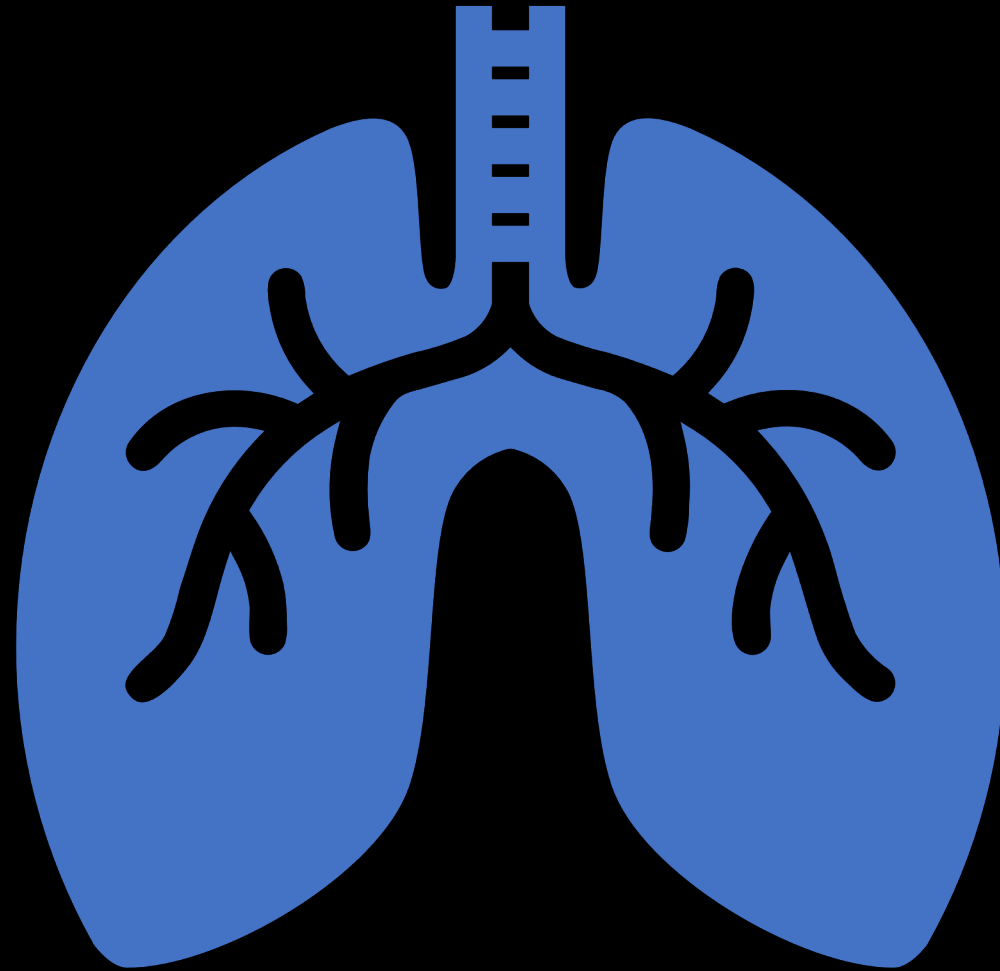
Pneumonia

Pneumonia is an inflammation of the lung tissue. It is caused by infection with bacteria, viruses, fungi, and parasites. The most common cause of pneumonia is infection with bacteria. The most common symptoms of pneumonia are cough, fever, chest pain, and difficulty breathing.



KEY FINDINGS OF CONSOLIDATION

- Opasitas homogen yang menutupi pembuluh darah.
- Silhouette sign: tepi paru menghilang/ superposisi dengan jaringan lunak.
- Air-bronchogram
- Perluasan ke pleura
- Tidak terdapat pengurangan volume



RALE

cocok untuk menilai
gambaran X-Ray →
inflamasi paru
→ konsolidasi paru
→ sistem penilaian RALE.

Beberapa kuadran dengan
batas vertikal oleh kolom
vertebral dan secara
horizontal oleh cabang
pertama bronkus utama
kiri.

Setiap kuadran diberi skor konsolidasi dari 0–4 untuk mengukur tingkat luasan kekeruhan alveolar, berdasarkan persentase luasan kekeruhan yang telah ditentukan.

Selain itu, terdapat juga skor densitas dari 1-3 untuk mengukur kepadatan/opasitas alveolar.

Setelah kedua skor ditemukan pada masing-masing kuadran, kedua skor dalam kuadran yang sama dikalikan. Hasil itu bisa disebut sebagai skor kuadran.

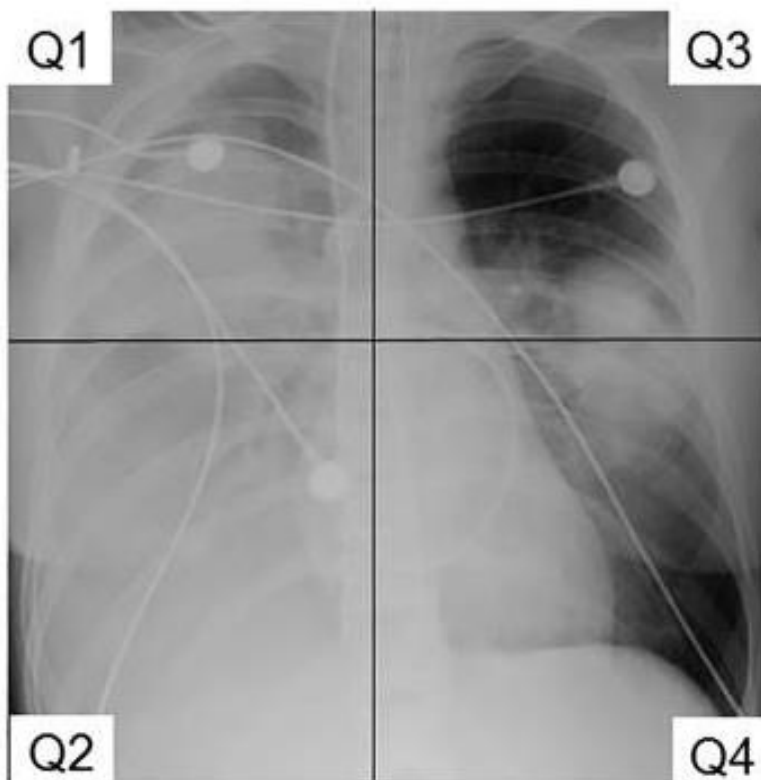
Kemudian, cara untuk mendapatkan skor akhir RALE adalah dengan menjumlahkan keempat skor kuadran yang nanti skor akhirnya memiliki rentang dari 0 (tidak ada infiltrasi) hingga 48 (konsolidasi padat di >75% dari setiap kuadran) (Warren *et al.*, 2018).

Consolidation ^a	
Consolidation Score	Extent of alveolar opacities
0	None
1	<25%
2	25-50%
3	50-75%
4	>75%
Density ^b	
Density Score	Density of alveolar opacities
1	Hazy
2	Moderate
3	Dense
Final RALE Score ^c	
Right Lung	Left Lung
Upper Quadrant	Upper Quadrant
Cons x Den = Q1 score	Cons x Den = Q3 score
Lower Quadrant	Lower Quadrant
Cons x Den = Q2 score	Cons x Den = Q4 score
Total RALE = Q1+ Q2 + Q3 + Q4	

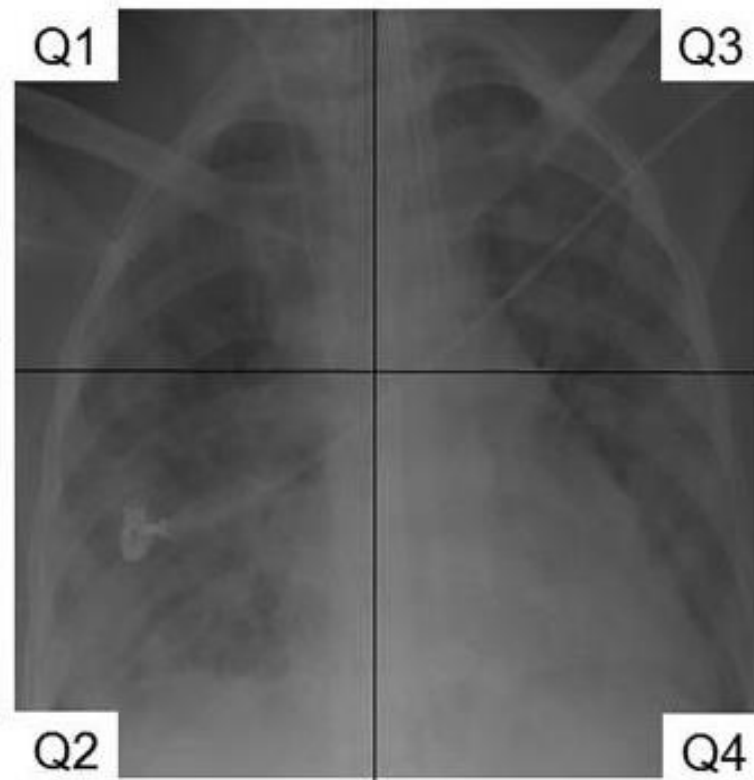
Consolidation is scored for each quadrant

Density is scored for each quadrant that has a consolidation score ≥ 1

If Quadrant consolidation score is – then Quadrant score is 0



Calculation of the RALE Score for Left Radiograph					
Score	Q1	Q2	Q3	Q4	Total
Consolidation	4	4	1	2	
Density	3	3	3	3	
Quadrant Score	4 x 3 = 12	4 x 3 = 12	1 x 3 = 3	2 x 3 = 6	33



Calculation of the RALE Score for Right Radiograph					
Score	Q1	Q2	Q3	Q4	Total
Consolidation	4	4	4	4	
Density	1	2	1	2	
Quadrant Score	4 x 1 = 4	4 x 2 = 8	4 x 1 = 4	4 x 2 = 8	24

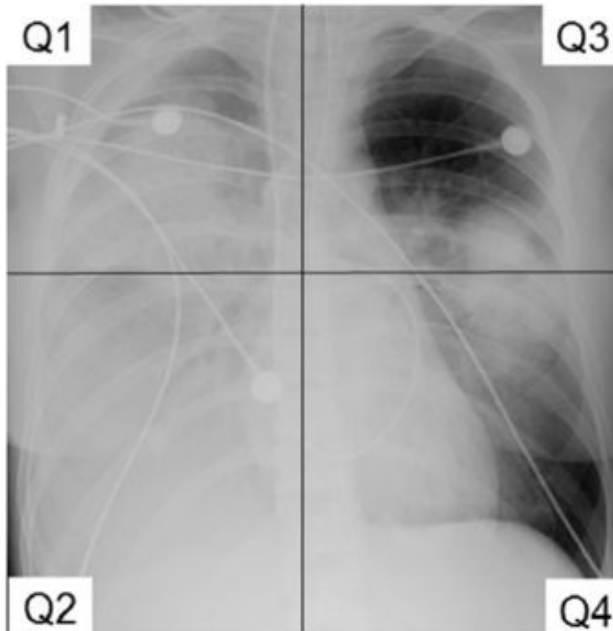
A

Consolidation ^a	
Consolidation Score	Extent of alveolar opacities
0	None
1	<25%
2	25-50%
3	50-75%
4	>75%
Density ^b	
Density Score	Density of alveolar opacities
1	Hazy
2	Moderate
3	Dense
Final RALE Score ^c	
Right Lung	Left Lung
Upper Quadrant	Upper Quadrant
Cons x Den = Q1 score	Cons x Den = Q3 score
Lower Quadrant	Lower Quadrant
Cons x Den = Q2 score	Cons x Den = Q4 score
Total RALE = Q1+ Q2 + Q3 + Q4	

^aConsolidation is scored for each quadrant

^bDensity is scored for each quadrant that has a consolidation score ≥ 1

^cIf Quadrant consolidation score is - then Quadrant score is 0



Calculation of the RALE Score for Left Radiograph					
Score	Q1	Q2	Q3	Q4	Total
Consolidation	4	4	1	2	
Density	3	3	3	3	
Quadrant Score	4 x 3 = 12	4 x 3 = 12	1 x 3 = 3	2 x 3 = 6	33

B

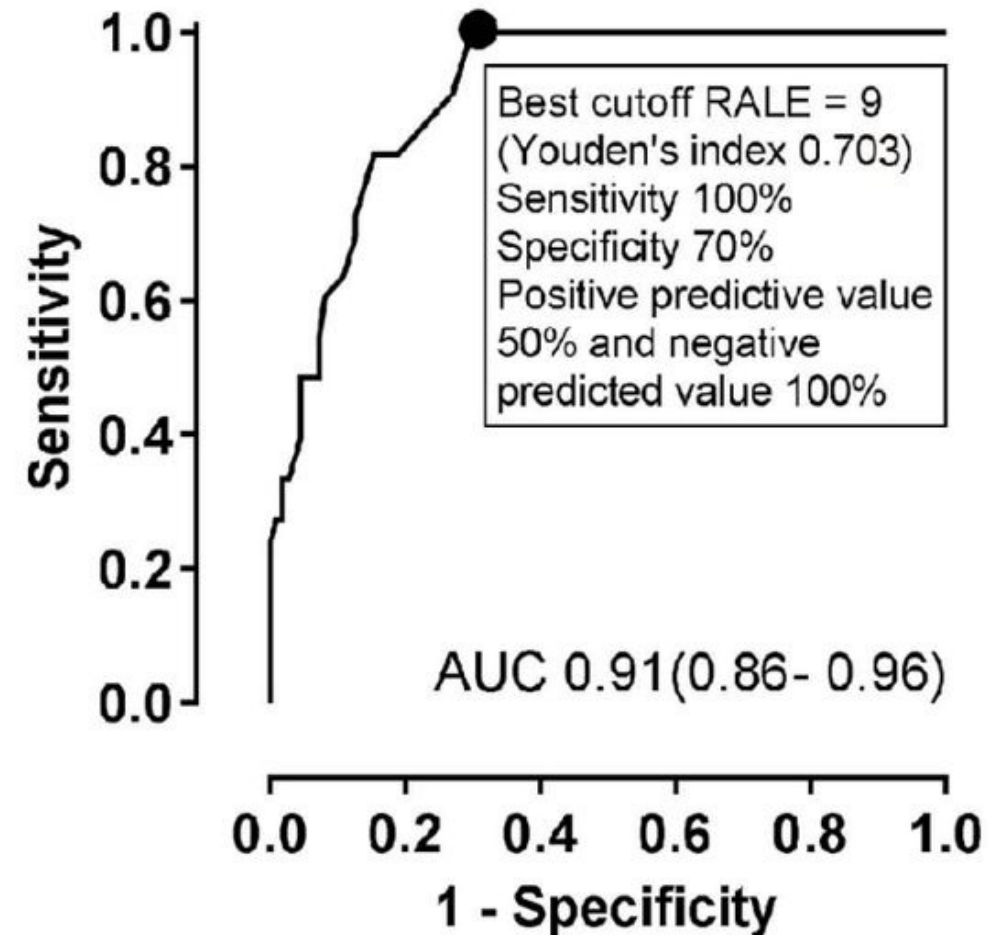
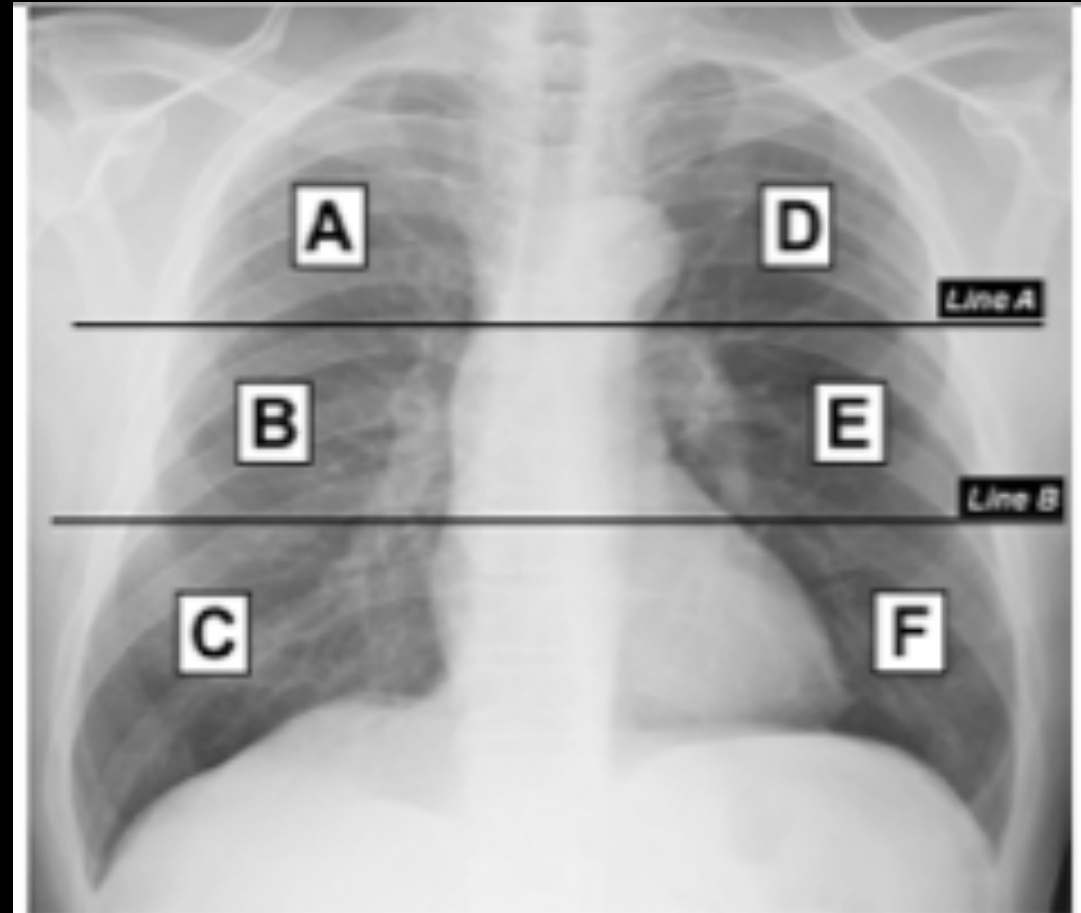


Figure1.

BRIXIA SCORE

by Borghesi and Maroldi in March 2020

Pembagian paru-paru menjadi enam zona pada foto toraks frontal. Garis A digambar setinggi dinding inferior lengkung aorta. Garis B digambar setinggi dinding inferior vena pulmonalis inferior kanan. Zona atas A dan D; Zona tengah B dan E; C dan F zona bawah



SECOND STEP

- Tahap 2 menentukan skore masing-masing zona berdasar abnormaliats yang dijumpai
- Skor 0 tidak ada kelainan paru •
- Skor 1 infiltrat interstisial •
- Skor 2 infiltrat interstisial dan alveolar (interstisial
- dominan) •
- Skor 3 infiltrat interstitial dan alveolar (pra-alveolar
- dominasi)
- Total skore 0-18

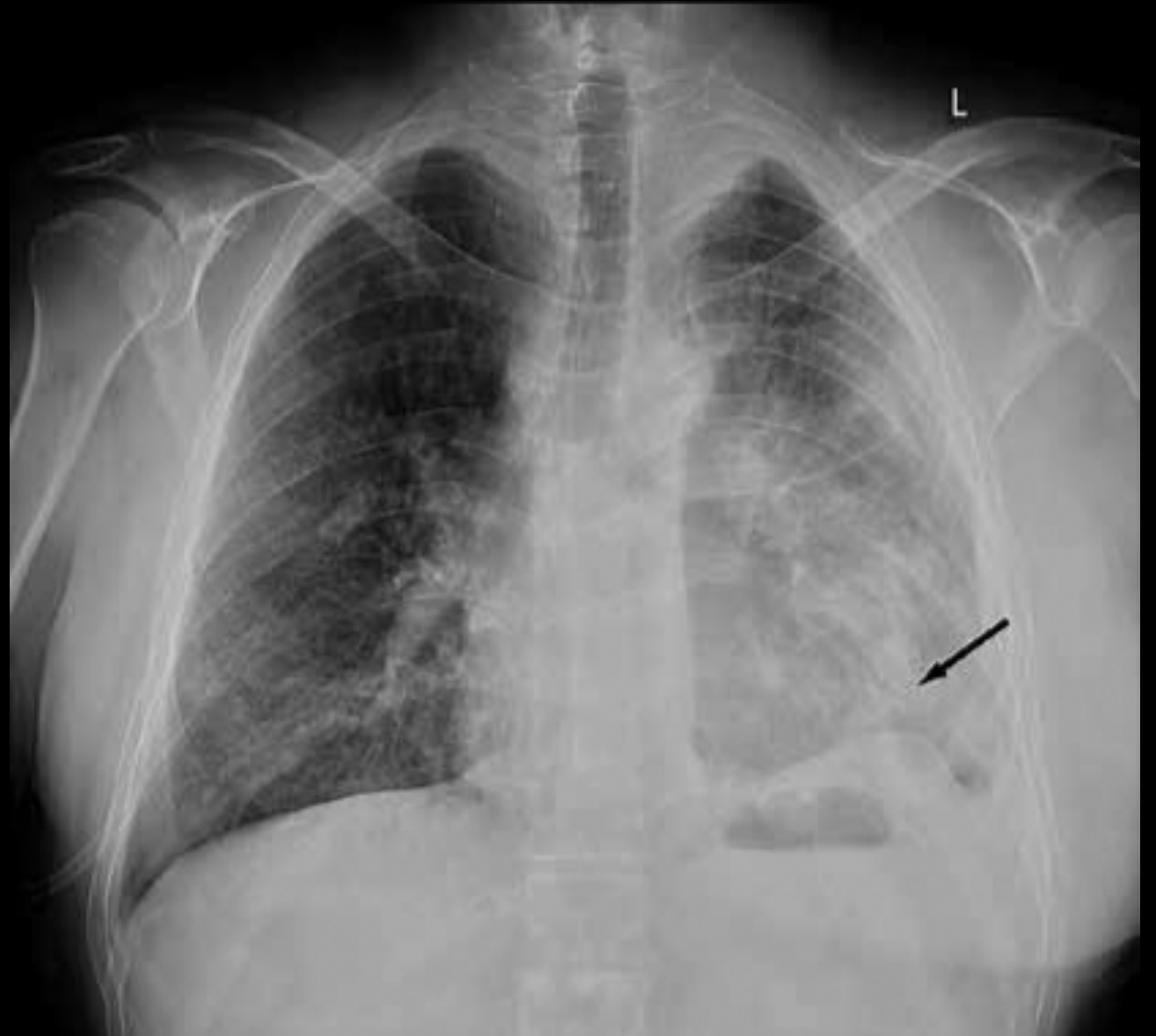
SARI chest X-ray severity scoring system

- Disusun oleh Taylor *et al.* in “BMC Medical Imaging” in 2015
- Dibuat saat era pre Covid, untuk menyederhanakan tingkatan klinis dari laporan CXR menjadi 5 derajat keparahan pada pasien rapat inap trekonfirmasi infeksi respirasi akut

SARI CXR categorised

1. normal;
 2. patchy atelectasis and/or hyperinflation and/or bronchial wall thickening;
 3. focal consolidation;
 4. multifocal consolidation; and
 5. diffuse alveolar changes
- Terdapat satu laporan penggunaan SARI oleh Yoon dari Southern Korea → kuantifikasi keterlibatan paru pada pasien Covid-19

SKORE SARI 5



RALE VS BRIXIA

Covid-19. Sistem penilaian RALE ini terbilang cukup mudah dilakukan oleh dokter karena hanya melihat seberapa luas konsolidasi dan densitas di paru-paru sesuai parameter yang telah ditentukan.

Sementara itu, sistem penilaian Brixia dirancang untuk ahli radiologi (Mitchel L. Zoler, 2020; Setiawati *et al.*, 2021).

Table 1. Comparison between CXR scoring systems mentioned in the review

	CXR scoring systems		
	SARI CXR severity scoring system [10]	RALE clasification [12]	CXR score [7]
Lung regions to consider	No specified region	2 lungs	6 zones
Number of intervals	5	5	4
Level of involved organ assessment	No	Yes	Yes
Character of abnormalities assessment	Yes	No	Yes
Clear treshhold for severe COVID-19	No	No	Yes

Penelitian CAD Pneumonia Covid-19 di Yogyakarta

- GAMA CAD dikembangkan oleh Fakultas Teknik, UGM
 - Sebagai *second reader* dalam mendiagnosis pneumonia pada pasien Covid-19
 - Dapat mempercepat kerja dokter spesialis radiologi dalam membuat keputusan
 - Meningkatkan kecepatan, ketepatan, dan akurasi dalam menentukan interpretasi penyakit

TUJUAN

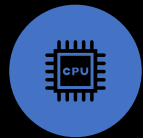
- Mengetahui kesepakatan Dokter Spesialis Radiologi dalam Mendiagnosis pneumonia COVID-19 melalui foto toraks Menggunakan Brixia dan RALE skor dengan baku emas PCR Swab
- Mengetahui Kesesuaian GAMA CAD dalam mendiagnosis pneumonia COVID-19 melalui foto toraks dengan menggunakan hasil PCR swab Sebagai baku emasnya

JALAN PENELITIAN



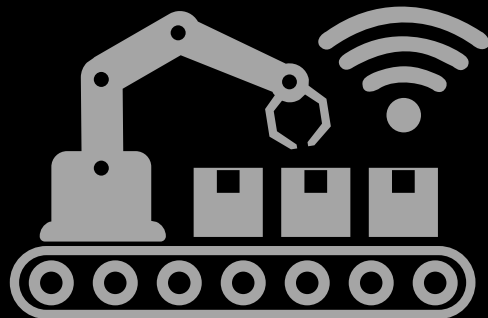
Desain Penelitian

Retrospektif → kesesuaian radiologis dan AI
→ diagnosis COVID-19 berdasar PCR swab



Waktu & Tempat Penelitian

Selama 6 bulan di RSUP Dr. Sardjito, Yogyakarta



I & E



Inklusi & Eksklusi

Semua pasien COVID-19 (Mei 2020-Jan 2021) → tanpa ada riwayat keganasan pada paru (Ca oaru, metastasis paru, dan emboli paru)



Subjek Penelitian

Hasil CXR pasien COVID-19 di RSUP Dr. Sardjito (Mei 2020-Januari 2021)





Foto X-ray Toraks Normal

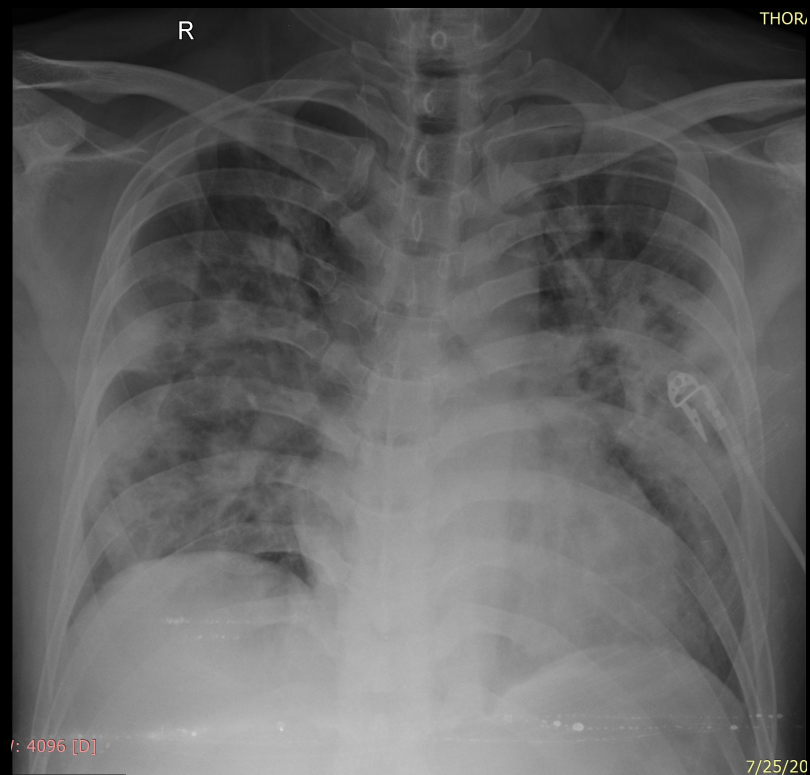


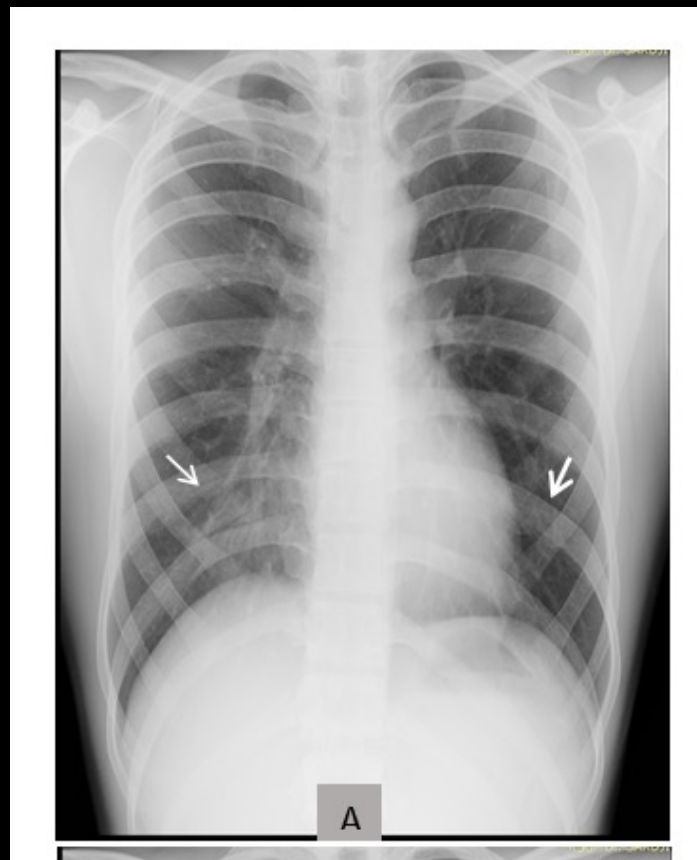
Foto X-ray Toraks Dengan
Pneumonia Covid-19

Prediction: COVID-19 - Probability: 1.00

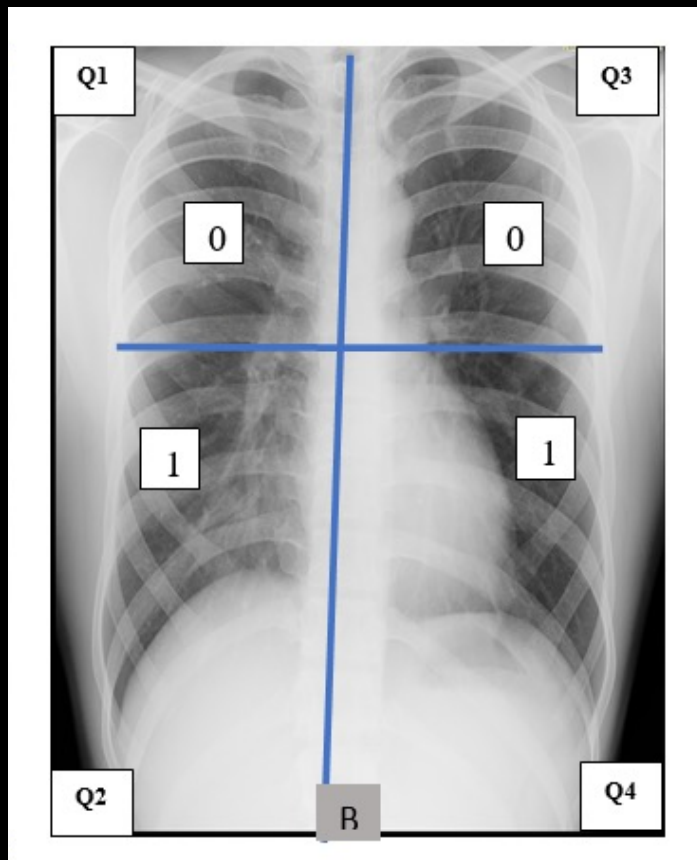


Foto X-ray Toraks Dengan Pneumonia
Covid-19 dan sudah dianalisis
menggunakan CAD AI

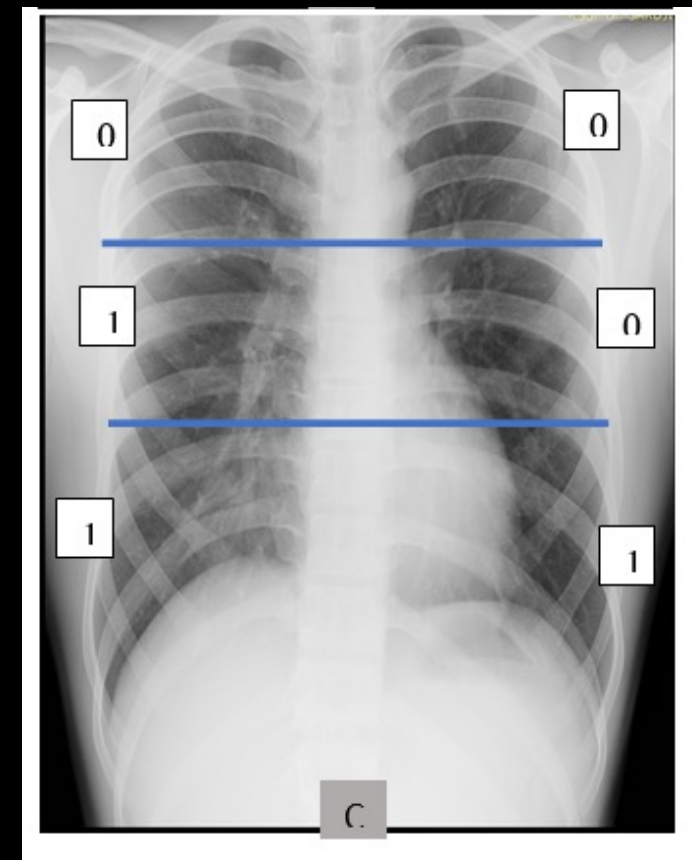
Chest X-ray Evaluation Using Brixia and RALE Score



CXR of 25 years old man with positive COVID-19 by RT-PCR

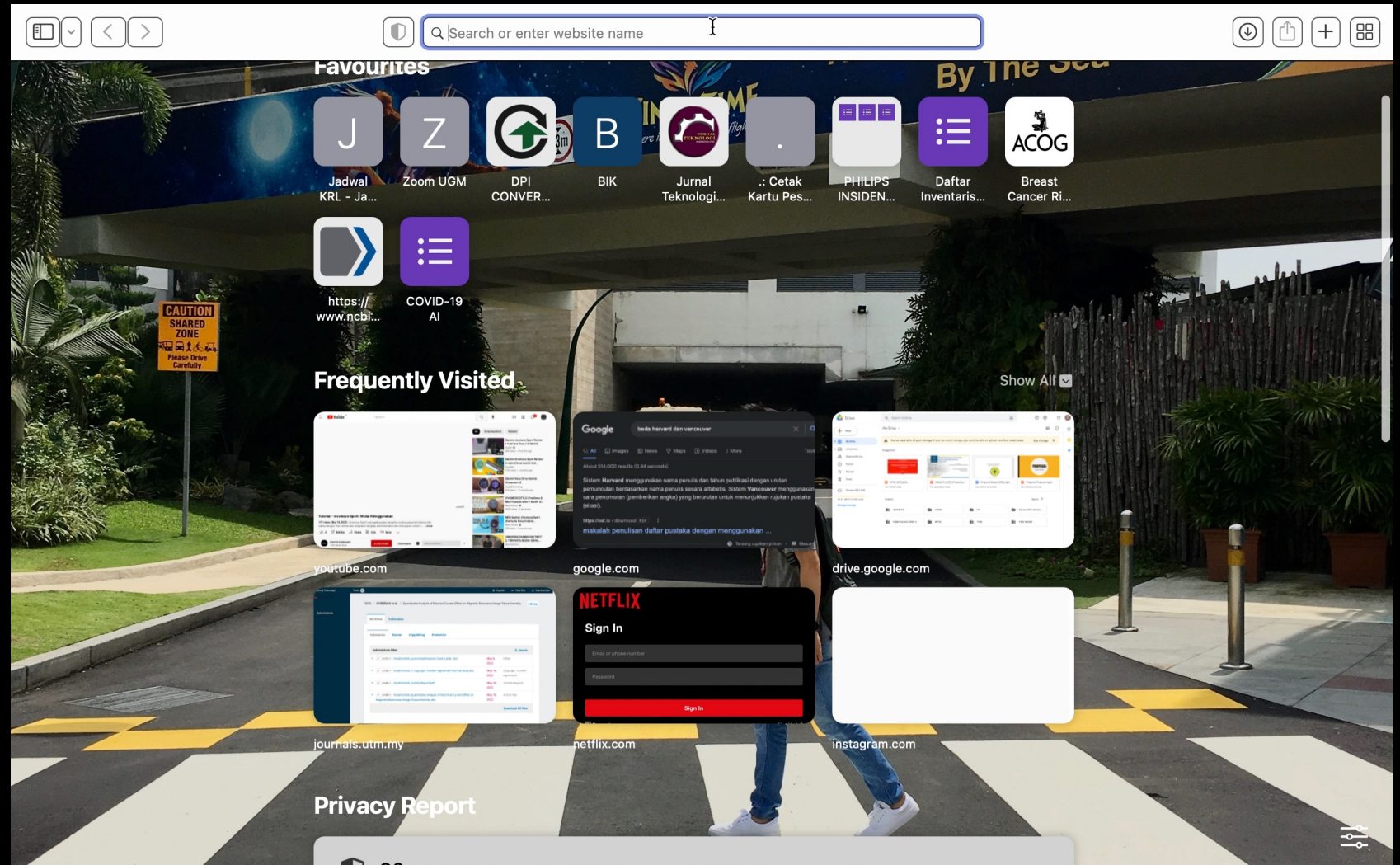


Assessment of RALE score, at Q2 and Q4 radiologist rated as 1, thus the patient has total RALE score of 2



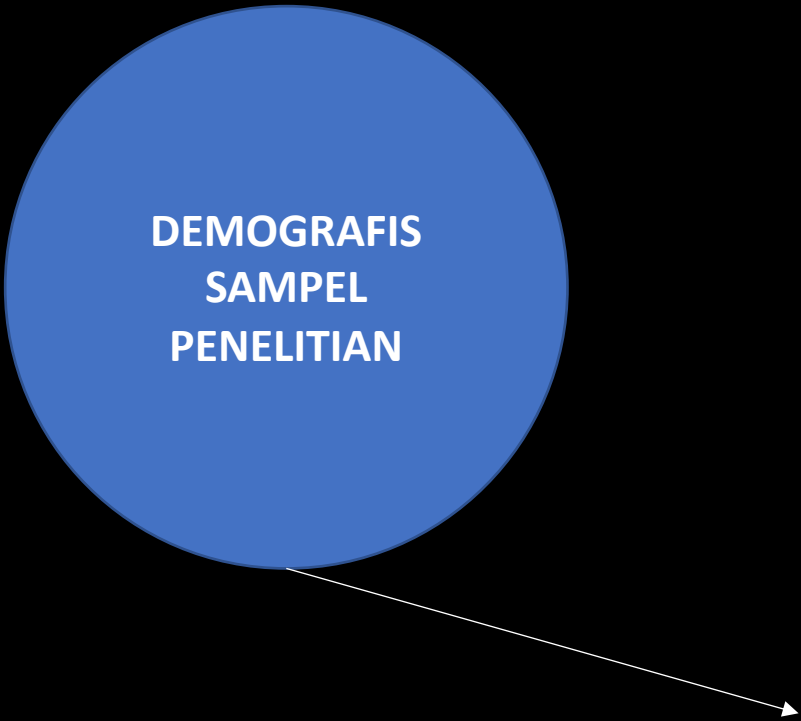
Assessment of Brixia score, divided into 6 regions. The patient has a Brixia score of 3

CARA AKSES CAD-AI



GAMA CAD AI

<http://202.157.176.211:8501>



Variabel	n(%)	Skor Brixia	Skor RALE
Jenis kelamin	332(100)		
Laki-laki	162(48,8)	6,29±4,430	11,56±9,997
Perempuan	170(51,2)	5,84±4,152	10,47±9,032
Usia	332(100)		
42,37 ± 15,22 (2-88)			
< 20	10(3,0)	5,10±5,322	9,60±8.475
20-30	80(24,1)	5,40±4,136	8,26±8,187
30-40	81(24,4)	6,84±4,504	10,19±8,843
40-50	49(14,8)	5,43±3,841	11,41±8.381
50-60	63(19,0)	6,51±4,332	14,08±10,079
>60	49(14,8)	6,08±4,242	13,69±11,582

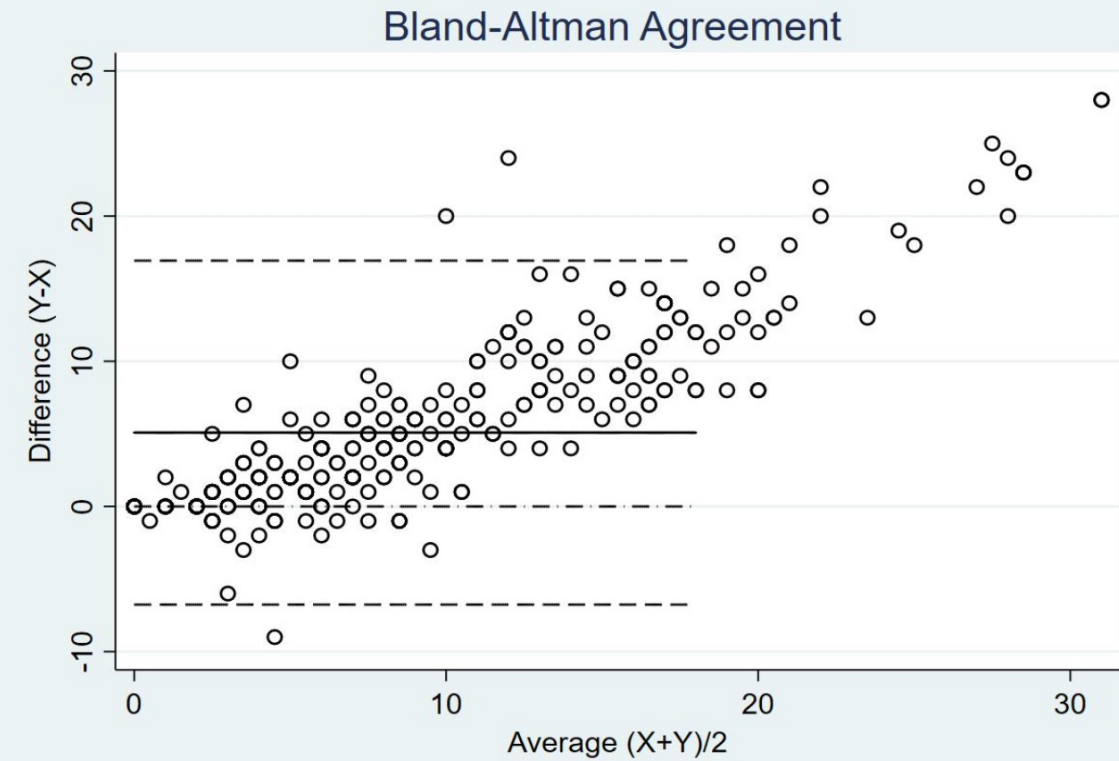
Berdasarkan tabel diatas dapat disimpulkan bahwa jenis kelamin perempuan 170 (51,2%) lebih banyak dibanding jenis kelamin laki-laki 162 (48,8%). Jika dilihat berdasarkan usia bahwa yang paling banyak terdiagnosis pneumonia COVID-19 adalah usiia 30-40 tahun 81 (24,4%) dan yang paling sedikit <20 tahun sebanyak 10 (3,0%).

UJI KESEPAKATAN SKOR BRIXIA & RALE

Kurva Bland-altman Brixia&RALE

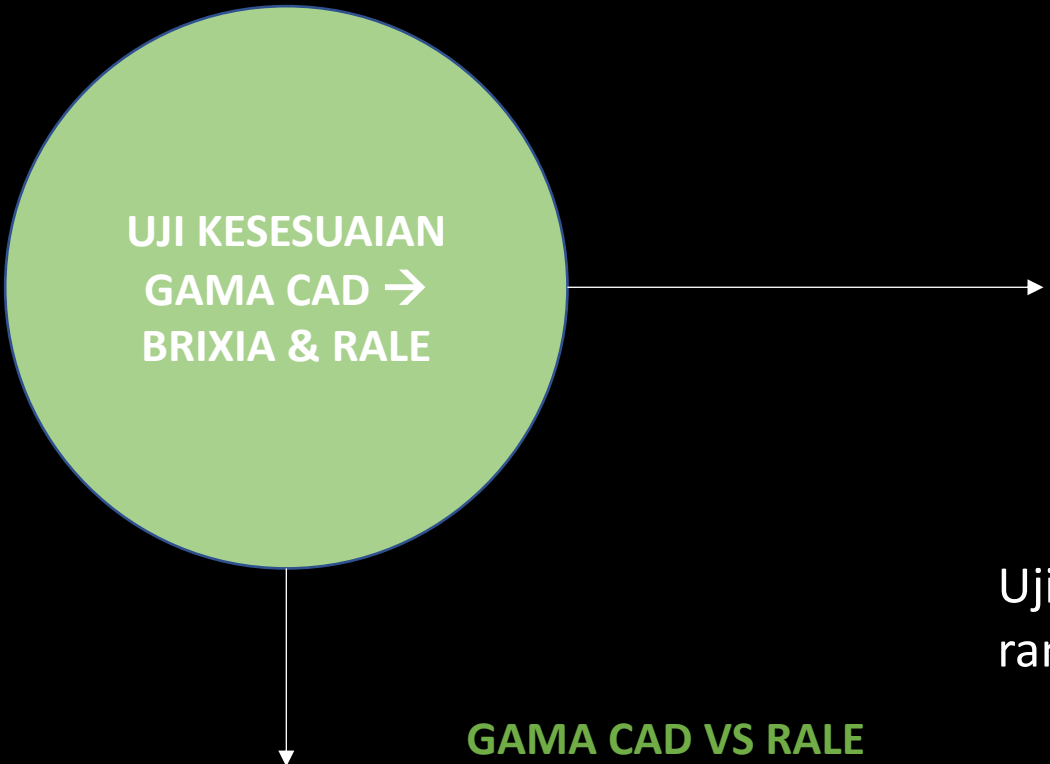
Perbandingan skor brixia & RALE

	Jumlah Subjek	rerata	SD	95% CI
Variabel	n			
Brixia	332	6,05	4,289	5,59 – 6,52
RALE	332	11,14	9,5	10,1 – 12,1
Perbedaan	332	5,08	6,04	4,43 – 5,73



Kurva Bland-Altman dengan simpang baku selisih rerata 6,04, *Limit of Agreement* nilai batas bawah - 16,929 dan atas 6,760 dengan r 0,886 (p 0,00)

Kesimpulan : pengukuran keparahan X-ray toraks pasien pneumonia dengan COVID-19 menggunakan skor Brixia dan RALE memiliki kesesuaian atau reliabilitas yang baik



GAMA CAD VS BRIXIA

Hasil GAMA CAD	Skor Brixia		Jumlah
	Positif	Negatif	n(%)
Positif	300	29	329(99,1)
Negatif	3	0	3(0,9)
Jumlah n(%)	303(91,3)	29(8,7)	332(100)

Uji akurasi menunjukkan sensitivitas sebesar 99%, spesifitas 0%, nilai ramal positif sebesar 91,18% dan nilai ramal negatif sebesar 0%.

GAMA CAD VS RALE

Hasil GAMA CAD	Skor RALE		Jumlah
	Positif	Negatif	n(%)
Positif	303	26	329(99,1)
Negatif	3	0	3(0,9)
Jumlah n(%)	306(91,3)	26(7,8)	332(100)

Uji akurasi menunjukkan sensitivitas sebesar 99,01%, spesifitas 0%, nilai ramal positif sebesar 92,09 dan nilai ramal negatif sebesar 0%.

Luaran Penelitian Gama CAD Covid-19

GAMBARAN RADIOGRAFI TORAKS COVID-19 BERDASAR BRIXIA SCORE
Lina Choriidah, Anita Ekowati, Nurhuda Hendra Setyawan
KSM Radiologi RSUP Dr. Sardjito Yogyakarta

LATAR BELAKANG
Pneumonia Covid-19 telah menimbulkan banyak kematian baik di dunia maupun di Indonesia. Tes diagnostik untuk infeksi COVID-19 adalah RT-PCR tetapi masih kurang ketersediaannya. Radiografi toraks tersedia secara luas, dimanfaatkan pada proses penyaringan dan diagnosis COVID-19. Diperlukan sistem pembacaan radiografi toraks yang mudah dan objektif.

TUJUAN
Aplikasi Penggunaan Brixia Score Pada Pasien Covid-19

CASE SERIES

S, 55 tahun - **membak**
20/1/2021 Skor = 10 22/1/2021 Skor = 13

S, 77 tahun - **progresif**
19/1/2021 Skor = 7 22/1/2021 Skor = 9

TN, 61 tahun - **progresif**
15/1/2021 Skor = 15 19/1/2021 Skor = 18

AH, 28 tahun - **membak**
12/8/2020 Skor = 5 14/8/2020 Skor = 7

17/8/2020 Skor = 2 8/9/2020 Skor = 2

17/8/2020 Skor = 10 12/8/2020 Skor = 10

20/8/2020 Skor = 10 24/8/2020 Skor = 6

25/8/2020 Skor = 6 18/9/2020 Skor = 2

DISKUSI
Brixia Score
Pembagian paru-paru menjadi enam zona pada foto toraks frontal. Garis A digambar vertikal membagi inferior lengkung aorta. Garis B digambar vertikal membagi inferior vena pulmonalis inferior kanan. Zona atas A dan D; Zona tengah B dan E; C dan F zona bawah.

Skor 0 tidak ada kelainan paru.
Skor 1 infiltrat interstitial.
Skor 2 infiltrat interstitial dan alveolar (interstitial dominant).
Skor 3 infiltrat interstitial dan alveolar (pre-alveolar dominant).

KESIMPULAN
Brixia Score merupakan sistem penilaian tingkat keparahan dan perkembangan keterlibatan paru pada pasien rawat inap dengan COVID-19 secara semi kuantitatif.
Sistem scoring cukup sederhana dan mudah diulang pada pasien radiografi toraks.
Bermanfaat dalam meningkatkan objektivitas pembacaan radiografi toraks.

REFERENSI
[1] Cheng, M. P., Papenburg, J., Desjardins, M., Kang, J. S., Quach, C., Uebachs, M., et al. 2020. Diagnostic Testing for Severe Acute Respiratory Syndrome-Related Coronavirus-2. *Ann. Intern. Med.*, hal. 0020-1301, doi:10.7326/M20-1301.
[2] Rubin, G. D., Haramati, L. B., Kanne, J. P., Schlager, N. W., Yim, J.-I., Anderson, D. J., et al. 2020. The Role of Chest Imaging in Patient Management during the COVID-19 Pandemic: A Multinational Consensus Statement from the Fleischner Society. *Radiology*, hal. 201365, doi:10.1148/radiol.2020201365.
[3] Burghies, A., Mandoli, R. COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. *Radiol med* 125, 509-513 (2020). <https://doi.org/10.1007/s12547-020-01200-9>

Poster Publikasi

42 Singapore Medical Journal
Concordance of Brixia and RALE Scores in Evaluation of COVID-19 Pneumonia Patient using Chest Radiography in Indonesian Referral Hospital
--Manuscript Draft--

Manuscript Number:	
Full Title:	The Concordance of Brixia and RALE Scores in Evaluation of COVID-19 Pneumonia Patient using Chest Radiography in Indonesian Referral Hospital
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Abstract:	Introduction The COVID-19 pandemic has put intense pressure on the health care systems worldwide. As the lung complication of COVID-19, Pneumonia can lead to worsening symptoms and an increased case fatality rate. Chest radiography can predict the severity of patient deterioration and outcomes from COVID-19 pneumonia. The most widely used to help predict the severity was Brixia and RALE scores. We aimed to assess the Radiologists' agreement on diagnosed pneumonia COVID-19 by RT-PCR in chest radiograph (CXR) using the Brixia and RALE (Radiographic Assessment of Lung Edema) score. Methods This retrospective study routinely used the CXR results of COVID-19 patients at a single referral center in Indonesia. This research was conducted at Dr. Sardjito Central General Hospital from May 2020 - January 2021. Two separate radiologists scored initial chest radiographs for RALE and Brixia independently. The analysis assessed included a descriptive analysis of demographic data, and Bland-Altman plots were used to visualize intra-observer agreement. Results A total of 332 samples were 162 men (48.8%) and 170 women (51.2%) with a mean age of 42.37. The ICC of Brixia score (0.855, CI:0.794-0.895) and RALE score (0.756, CI:0.662-0.812). Bland-Altman analysis revealed a bias of 5.08±6.04 (95% limits of agreement of -6.760 and 16.929) for Brixia and RALE scores and significantly correlated ($r=0.886$ ($p<0.05$)). The average score of Brixia (6.29±4.430) and RALE (11.56±9.997) in men was higher than in women. Conclusion Agreement of Radiologists in diagnosing pneumonia COVID-19 using

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Publikasi

Kesimpulan

- Brixia Score dan RALE merupakan sistem penilaian tingkat keparahan dan perkembangan keterlibatan paru pada pasien rawat inap dengan COVID-19 secara semi-kuantitatif
- Sistem skoring cukup sederhana dan mudah diulang pada pasien radiografi toraks dan bermanfaat dalam meningkatkan objektivitas pembacaan radiografi toraks
- Keberlanjutan pemanfaatan AI terkait pembacaan CXR Covid-19 dan penyakit paru lain diperlukan sebagai second reader bagi radiolog dan meningkatkan objektivitas

Referensi

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