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SWOT Analysis of the Method of Radiographic Assessment of the Pathogen Mechanism in the Lungs of COVID-19 Patients

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Abstract

MRAPL-COVID 19 is an adjusted and simplified method of radiographic assessment of the pathogen mechanism in the lungs of patients who are confirmed cases of COVID-19 by using the PCR test. The basis of this method is the method of Radiographic Assessment of Lung Edema (RALE) score. **Research goal:** To compare and analyze the already applied modified models in COVID-19 patients with our method in order to highlight the advantages and opportunities of its use as well as to perceive the weaknesses and threats of its use. **Methodology:** Application of SWOT analysis in MRPPB-COVID 19. **Results:** The advantages of MRPPB-COVID19 are: fast, simple, easily applied in one step, possibility of individual work and usage in primary and secondary health. It saves time, finances and it is not an invasive method. The single exposure to X-ray compared to CT makes this method safer and less harmful. Unified, standardized and systematized X-ray findings have simplified the access to family doctors and COVID centers. The possibilities are: its easy adaptability allows for its adjustment and use for assessment in other diseases, complementary use with CT, possibilities for software upgrade and artificial intelligence algorithms. The expansion of analysis in the method through implementation of other factors: gender, age, comorbidity, other complications, clinical and laboratory analysis (C-reactive protein and D-dimer) contributes to its improvement. The lower specificity and sensitivity rates are highlighted as shortcomings or weaknesses of this method compared to CT as well as the method's dependency on the picture quality, the individual approach and the experience of the radiologist in the interpretation of the X-ray findings. The threats of this method are: the obsolescence of technology and the scoring method as well as the development of new, more sophisticated and more advanced methods. **Conclusion:** This easily applied and overall cheap method allows for an order in the healthcare system, relieving the burden of tertiary health and a normal flow of the other activities as well as continuous and uninterrupted work of the of the other diagnostic methods. The use of mobile X-ray machine allows for maintaining a higher control of the pathogen which reduces the possibilities of contamination and infection of other patients.

More Information

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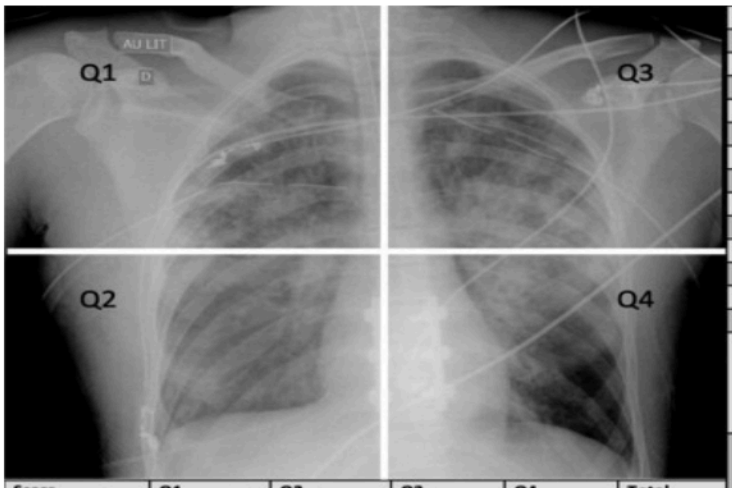
Keywords:

COVID 19,
X-ray,
RALE,
Brixia score,
SWOT analysis.

Introduction

MRAPL- COVID 19 for ranking of the disease is a separate method of radiographic assessment of the pathogen mechanism in the lungs of patients who are confirmed positive cases of COVID 19 by using PCR test.

This method is an adjusted method that use the method of "Radiographic Assessment of Lung Edema (RALE) score" (Warren M. et al. 2018) as a base (see figure 1).



Score	Q1	Q2	Q3	Q4	Total
Consolidation	4	4	4	4	
Density	1	2	3	3	
Quadrant Score	4	8	12	12	36

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

Figure 1. Consolidation and density scoring in the RALE score (Panel A), Calculation of the Radiographic Assessment of Lung Edema (RALE) score (Panel B)

Source: Warren M (2018), Severity Scoring of Lung Edema on the Chest Radiograph is Associated with Clinical Outcomes in ARDS.

MRAPL-COVID 19 is adapted from the RALE method by simplification, taking only the degree of involvement of the lung parenchyma by the virus SARS-CoV-2 and the resulting complications. In this method we made an analysis of the percentage of the affected surface of the lung parenchyma from the cloudy and milky glass shadings with or without present complications in each lung separate. The second step of the RALE method, which is the grading of 1 to 3 of the density of the opacification zones of the lung parenchyma, was left behind since there are only cloudy or hazy and milky glass shadings in COVID 19 patients and the same are graded in the RALE table by score 1 as given above in figure 1. The grading of a unit tells us of a low density of the cloudy shadings which radiologically are defined as homogeneous shadings with low and constant density. Due to its simplification, MRAPL-COVID 19, allowed for a fast approach and individual work with timely implemented patient triage.

We have graded each lung separately from 0 to 4 depending on the percentage of involvement of the lung parenchyma with SARS-CoV-2 virus. This was done in coordination with the RALE METHOD in figure 1. According to the percentage of the lung parenchyma involvement we introduced:

- **score 0;** without any involvement of the lung parenchyma;
- **score 1;** <25% involvement of the lung parenchyma;
- **score 2;** 25% - 50% involvement of the lung parenchyma;
- **score 3;** 50% - 75% involvement of the lung parenchyma;
- **score 4;** >75% involvement of the lung parenchyma.

The total score is calculated by adding the values from both lungs and it can be graded from 0 to 8 with 9 gradings in total as presented in figure 2. The resulting complications in the lungs of COVID 19 patients, which are mostly caused by bacterial super-infection, are differentiated and interpreted by the X-ray findings in this model.

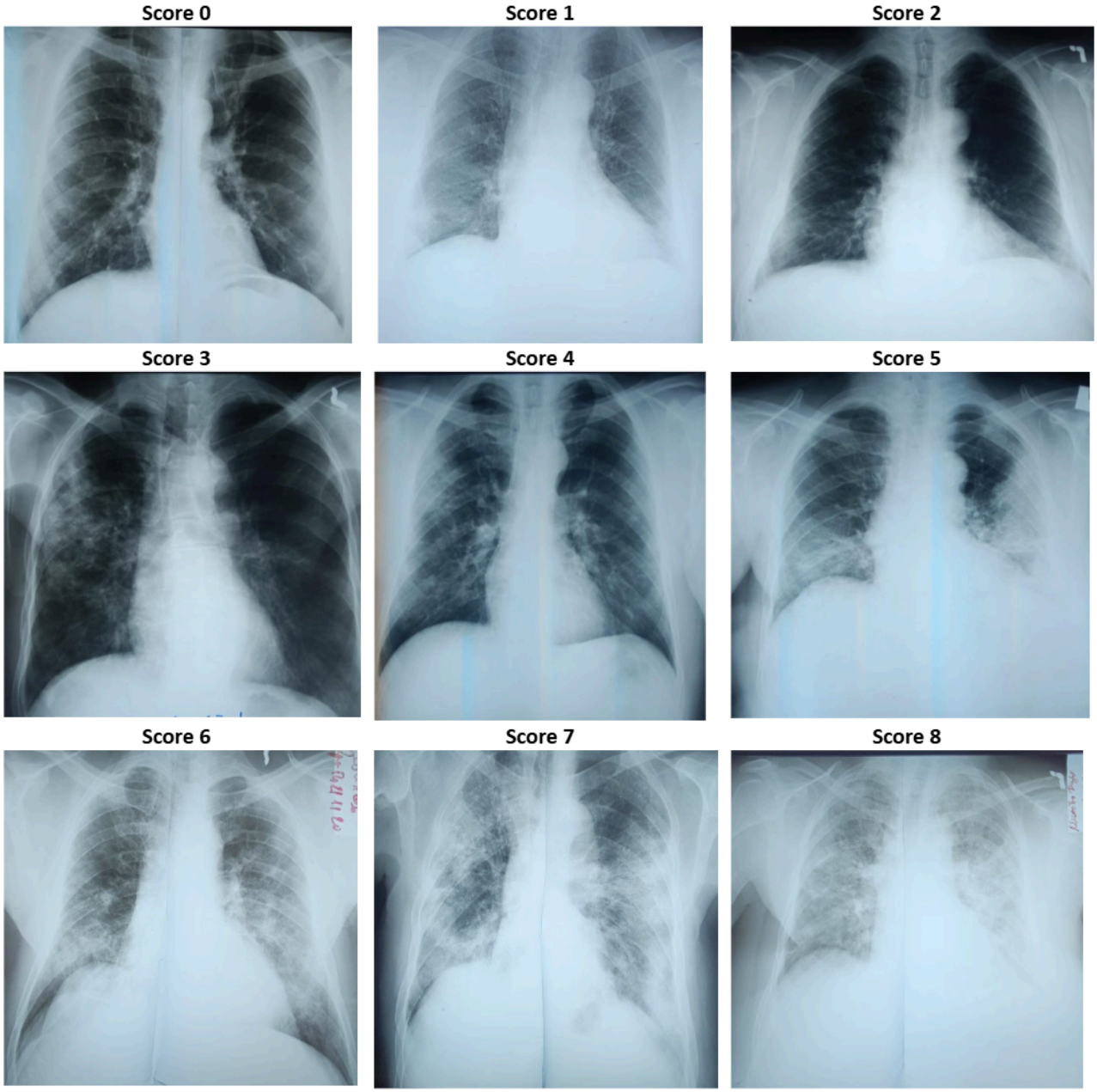


Figure 2. Examples of Score 0 to Score 8 in COVID-19 Patients
Source: Working materials, Radiology Department Kochani.

The X-ray report from the MRAPL-COVID 19 gives us a better visibility and understanding of the findings compared to the classical X-ray report. First, in the MRAPL X-ray report, it is mandatory to state the test date and COVID-19 confirmation date, afterwards, a short classic radiological description of the lung parenchyma involvement is given, which allows for unification, systematization and standardization of the finding by additionally adding the scoring scale. By adding the scoring scale of the RTG, the report is simplified and the real radiological picture of the lung involvement is provided. The resulting complications of the lungs are described and interpreted additionally. In order to observe the radiological approach, a heart with mediastinum was analyzed and interpreted, as well as phrenic/costal sinuses and other structures of the thorax. At the end of each X-ray report, it is mandatory to note who is the X-ray technologist responsible for the respective X-ray picture.

Goal of the Research

Analysis and comparison of the applied and adjusted models, that have in their foundation the method of "Radiographic Assessment of Lung Edema Score – RALE". One of those methods is ours MRPPB, which is also applied in COVID-19 patients and it represents the main subject of this analysis. The aim is to highlight the advantages and possibilities of its use as well as the weaknesses and threats of its use.

Methodology

Application of the SWOT analysis in MRAPL-COVID 19. The specific methodological approach used for the purpose of this work is the so-called SWOT analysis of MRPPB-COVID 19 by which the following things are analyzed and compared:

- Strengths - S
- Weaknesses -W
- Opportunities - O
- Threats - T

The structure of the SWOT analysis is illustrated in figure 3.

Results

By applying the specific methodological approach of SWOT analysis in table 1, we have separated and systematized the positive and negative sides of this method which result from its application, as well as the opportunities and danger which could appear in the future.

Figure 3. Structure or sketch of the method of SWOT analysis

Source: https://www.rhythmsystems.com/

Table 1. Strengths, Weaknesses, Opportunities and Threats of MRPPB-COVID 19 Screening Method

STRENGHTS	**WEAKNESESS**
➢ Fast ➢ Simple to use and easily available ➢ Possibility for individual work ➢ Applied at the primary healthcare level ➢ Saves time ➢ Economical ➢ Less dangerous and non-invasive ➢ Unified ➢ Standardized ➢ Systematized	➢ Lower sensitivity compared to CT ➢ Lower specificity compared to CT ➢ Dependent on the picture quality ➢ Dependent on the individual approach and radiologist's experience
OPPORTUNITIES	**THREATS**
➢ Application and adaptability for assessment of other diseases ➢ Modification for compatible use in lungs CT ➢ Easy adaptability and modification by software update ➢ Expansion by importing the comorbidities and other factors (age, gender) ➢ Expansion by importing resulting complications of the lungs ➢ Expansion by importing the clinical condition ➢ Expansion by importing laboratory analysis	➢ Obsolescence of the scoring method ➢ Obsolescence of the radiological technology ➢ Overseeing the diagnosis due to lack of clinical analysis ➢ Overseeing the diagnosis due to lack of laboratory analysis ➢ Development of newer, more sophisticated and advanced methods

Source: Author's work

Discussion

The standard posterior/anterior (PA) and forced anterior/posterior (AP) projections provide frontal i.e. coronal section of the lungs with mediastinal organs, which were proven to be the most optimal in COVID-19 patients, mostly because of the peripheral (alveolar), multifocal and bilateral exposition of the disease at lungs level as well as the possibility of easy differentiation of both most common pathogen mechanisms of COVID-19 disease in lungs, which actually need a completely different approach (Dragana Mogilevska-Gruevska et al 2022).

The **advantages (or strengths)** of MRAPL-COVID 19 are multiple. This method is quick, simple and easily adaptable in one step with the possibility of individual work of one doctor radiologist. MRAPL-COVID 19 is adapted and simplified method which has taken RALE method at its foundation, by taking only the first step

i.e. the level of involvement (consolidation) of the lung parenchyma. In the RALE method, which is the basis of this method, there are 36 scores and three steps are used in achieving the total score value. (Warren M et al. 2018). In the first step, both lungs are divided in 4 zones (Q1, Q2, Q3 and Q4) and the percent of consolidation i.e. involvement of the lung parenchyma is separately assessed in each zone (score 0 = without any involvement of the lung parenchyma, score 1; <25% involvement of the lung parenchyma, score 2; 25% - 50% involvement of the lung parenchyma, score 3; 50% - 75% involvement of the lung parenchyma and score 4; >75% involvement of the lung parenchyma). The second step defines the density level in the involved segments by grading from 1 to 3. The third step gives the total score value by calculating each zone separately as a product of the consolidation and density (Con. X Den. = Q). At the end, the total score is achieved by summing up all four zones (Q1+Q2+Q3+Q4) by using 36 scores (Warren M. et al. 2018). Through the literature we observe the application of similar adapted methods for grading the COVID disease and those methods have also taken the RALE method as their base. So, the most commonly used and overmodulated "Brixia" method, also uses the base of RALE method, although, this method is more complicated and uses 18 scores and two steps. In the first step, the lungs are divided into six zones: A, B, C for the right lung and D, E, F for the left lung of the frontal projection of the X-ray image. In the second step, each of the six zones gets a degree from 0 to 3 according to the abnormalities of the lungs (Andrea Borghesi et al. 2020). This method needs at least two but preferably three trained and experienced specialists out of which at least one is an experienced thoracic radiologist sub-specialist with at least 8 years of work experience (Satiawati R et al. 2021). The simplified Indonesian model is adapted from the "Brixia" method that also uses the RALE method at its basis (Satiawati R et al. 2021). It consists of 12 reduced scores and requires two specialist radiologists in the analysis of the findings. We have to mention that these two methods include the asymptomatic patients, unlike our MRPPB-COVID 19. Due to its complexity, they need specially trained staff and specialists with long work experience and that is the reason why these methods are exclusively applied on hospitalized patients in clinical conditions in order to assess the death outcome or the application of respiratory support in the patients (Satiawati R et al. 2021). Because of this, all these methods are mostly used in tertiary level.

Due to its simplicity and easy approach, MRAPL COVID 19 is used in primary level. The availability and presence of conventional X-ray apparatus in all health institutions in primary level allows for an easy approach and use of this method, additionally providing a relief in the secondary and tertiary health institutions. Its application saves time and finances which relieves the healthcare fund, lowers the financial expenditures for transport of patients, and at the same time avoids unnecessary CT imaging of COVID 19 patients at secondary or tertiary level. By selecting and prioritizing the patients according to the X-ray image of the scoring method, the overload is lifted from the healthcare system to a higher level which allows for a normal flow of the other health activities and normal work of all diagnostic methods. All of this allows for establishing an order in the healthcare system.

This method is non-invasive and the single exposure to X-ray compared to CT makes this method significantly safer and less harmful.

We searched for a way how to best use the classical radiology in diagnosing COVID 19, which was the only method available in PHI "General hospital with extended activities" in Kochani, a secondary health institution. By using MRPPB COVID 19 we created the needed triage in the severity of the disease by timely referral of patients with severe radiological image and complications to a tertiary level. At the same time, we stopped the unnecessary CT imaging and exposure to higher X-ray radiation in patients with less severe radiological image (Mogilevska-Gruevska, D et al. 2024). The aim from the application of this method was to unify, standardize and systematize the radiological reports which eases the analysis approach, as well as the interpretation and differentiation of the X-ray finding. all of that allows for an easier monitoring of patients by the COVID 19 center and the doctors of family medicine, providing timely approach and care of patients. The interpretation of the radiological finding in these patients from the classical X-ray report was significantly burdened due to the multifocal presentation and involvement of both lungs. The report was quite long and a lot of time was lost in describing, and still, it did not provide the real radiological image in front of family doctors and COVID 19 center. Taking into consideration that every shadow of the involved segment, lobules and lobe of each lung is mandatory to be described according to the location, shape, size, intensity, homogeneity and the limitation of the environment, the resulting classical report becomes heavy and loses its core value. That is why the family doctors as well as the COVID center do not get complete view of the real radiological image which additionally compromises the clinical picture in these patients (Mogilevska-Gruevska, D. et al. 2024).

The **opportunities** of this method are its easy adaptability, which allows for its adaptation and use in assessment of other diseases, compatible application in scoring of COVID patients with CT findings (Piotr G Wasilewski et al. 2020) as well as the possibility for its software upgrade by using artificial intelligence

(Viacheslav V. Danilo et al. 2022). Besides its application in shaping the final outcome or prognosis of the COVID 19 disease, it also provides an opportunity for expansion of the model by connecting other factors such as comorbidities, resulting complications in lungs, age, gender (Mogilevska-Gruevska, D. et al. 2024), clinical and laboratory (C-reactiv protein and D-dimer) analysis (Amela Sofic et al. 2022) etc. All of this leads to its higher update and achievement of even higher level of sensitivity and specificity in the prognosis of the final outcome of the COVID 19 disease (Mogilevska Gruevska D. et al. 2024).

The lower sensitivity and specificity of the X-ray apparatus compared to CT are highlighted as **weaknesses** of this method. So, for example, some authors point out to the CT as being more accurate method with sensitivity rate of 83% and specificity rate of 94% compared to the classical radiography, which accuracy in diagnosis at the start of the disease is lower with a rate of 69% (E. Martinez Chamorroa et al. 2021; Ho Yuen Frank Wong et al. 2020; Ran Yang et al. 2020). The influence of the mechanical quality of the X-ray image can be highlighted as a disadvantage of this method which has a great influence over the analysis and interpretation of the X-ray findings. The individual radiological approach i.e. the sensitivity of the eye as well as the experience and expertise of the radiologist during the analysis of the images (Andrea Broghesi et al. 2020) have great influence over the quality of diagnosis (sensitivity and specificity), knowing that the hazy shadowing are with low intensity and constant density and if you take their values according to the table in Figure 1, they need to be graded with the lowest 1. This requires great skills with expertise and experience of the radiologist and precision in the sharpness of the eye sight.

Aging (obsolescence) of the technology and scoring system, as well as the development of newer, more sophisticated and advanced methods of radiological assessment of the pathogenesis of the disease, are perceived as the **threats (or dangers)** for this method.

Conclusion

MRAPL-COVID 19 scoring system, which is available, reliable and relatively cheap diagnostic method, has a great potential for maintaining an order in the healthcare system. By selecting and prioritizing the patients according to the radiological image from the scoring method, the overload of the healthcare system is reduced and it is brought to a higher level which allows for a normal flow of the other health activities and normal work of other diagnostic methods. The availability and presence of conventional X-ray machines in all health institutions from primary level allows for an easy approach to this method and relieves the secondary and tertiary institutions. By using the classical X-ray apparatus, the healthcare fund is relieved and the financial expenditures for unnecessary transport and CT imaging of COVID patients in secondary and tertiary level are decreased and this in turn saves time and relieves the healthcare system. The scoring method is safe, it is non-invasive and harmless method, easily adaptable, unified, standardized and systematized for all COVID patients. The classical X-ray compared to the CT uses significantly less X-ray radiation i.e. the exposure to X-rays is lower and single, while the examination time is shortened. By using the mobile X-ray apparatus, higher control of disease-spread-measures is achieved which reduces the possibilities of contaminating other patients.

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