Review Article

Application of X-ray examinations in General practice for the diagnosis of lung damage in patients suspected of COVID-19 infection

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Introduction
 General practitioners who have access to diagnostic investigations from primary health care and clear referral guidelines to follow can utilize these resources as efficiently as hospital physicians and doctors from secondary health care [1-3]. More complex imaging methodologies such as magnetic resonance imaging (MRI) and X-ray computed tomography (CT) cannot be used in Bulgarian General Practice yet and they are subject to restrictions by the National Health Insurance Fund. The most readily available imaging method that general physicians can apply in the diagnosis of COVID-19 patients is convectional chest radiography. This is a first-line test for detecting lung pathology and it is helpful for evaluation of patients with a high pre-test probability of overt COVID-19 pneumonia, clinical follow up, and for the evaluation of potential complications [4].

Goal
The objective of the study was to determine the frequency of application of plain radiography in patients with suspected or confirmed COVID-19 infection in the General practice.

Materials and Methods
Study design
 The research was designed to determine the frequency of use of convectional radiography in patients showing clinical signs of COVID-19 infection in the General practice. It is a cross sectional study by applying an online individual questionnaire.
Criteria for inclusion of individuals in the study:
- Bulgarian General practitioners
- General practitioners, who have a list of patients covering a wide age range
- Criteria for exclusion of persons in the survey:
- Trainees
- Retired General practitioners
- Bulgarian General practitioners working abroad
- Study setting
- The cross sectional online study was conducted in March-April 2021.
- Sample size and subjects of the study

The online individual questionnaire was distributed to 118 members. 106 participants answered fully to all questions in the survey form and only they were included in the study.

Sampling Methods
Cross sectional analysis- online individual survey form
The survey includes questions about the social-demographic profile of general practitioners, including a specification of their practices, as well as specific questions, concerning application of conventional radiography for the diagnosis of lung damage in patients suspected of COVID- 19 infection.

Data analysis Technique
The collected information was processed using the statistical software-IBM SPSS Statistics 19.0. Statistical analyses, for example, Mean, Standard deviation, Mode, Variance, S.E. mean, Maximum, Minimum, Range, Skewness were performed to explore the study sample and the data. A P-value of <0.05 was required for statistical significance.

Ethical Considerations
 Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the author. The respondents were treated according to the Helsinki Declaration of biomedical ethics. Informed consent was obtained from each general practitioner after proper orientation regarding the goals of the survey.

Study Limitations
Limitations of the research that should be mentioned are mainly related to the lack of previous Bulgarian verified research studies on the topic, which can serve as an important opportunity to identify new gaps in the scientific literature and the need for further expanded and in-depth research. Additionally, self-reported data are always associated with a risk of potential sources of bias, especially in the application of an online individual survey form as a research method. The small sample size also determines the

need to study a population with a larger number of participants in the future, which would be considered representative of a group of people to whom results will be generalized.

Results

The study's sample involved 34(32.07%) men and 72(67.92%) women. According to age structure the predominant contingent is over 56 years old. In terms of practice location, town practices comprised 82.07 %of the total, with 10. 37% of practices located in villages and 7.54% both in a town and in a village (Table 1). The single-handed practice is leading, which is typical for the Bulgarian region. According to national guidelines, general practices rapidly adjusted the way they operate during the COVID-19 pandemic to continue personal contact for patients who needed it most. 45.28% of respondents reported that they continue to conduct face to face consultations during COVID-19 pandemic, including prioritizing patients to their clinical needs (Table 2). For the period of the study, almost all family physicians shared up to 5 new cases of positive PCR or antigen testing per week, as well as the same number of patients with manifested pulmonary symptoms requiring chest radiography (87.73%, respectively 89.62%). COVID-19 radiological forms in conventional radiography range from normal findings to patchy involvement of one or both lungs in mild or moderate cases, to diffuse parenchymal infiltration in severe cases. The most common imaging findings in chest X-rays in the General practice were reticular pattern, bilateral and peripheral opacifications and consolidations (42.45%).

Table 1: Practice characteristics.

Practice characteristics	n%
Gender	
Male	34(32.07%)
Female	72(67.92%)
Age	
<45 years	12(11.32%)
46-55 years	41(38.67%)
56-65 years	53(50.00%)
Practice location	
Practice located in a town	87(82.07%)
Practice located in a village	11(10.37%)
Practice located both in a town and in a village	8(7.54%)
Type of practice	
Single-handed practice	103(97.16%)
Group practice	3(2.83%)
Dominant type of consultation during COVID- 19 pandemic	
Face to face consultation	48(45.28%)
Phone consultation	56(52.83%)
Home visit	2(1.88%)

Table 2: Frequency of application of X-ray examinations in the diagnosis of patients suspected of COVID- 19 infection.

Frequency of application of X-ray examinations in the diagnosis of patients suspected of COVID- 19 infection	n%
Average number of patients with positive PCR test Average number of patients with positive PCR test	
<5 patients	93(87.73%)
Between 5-10 patients	12(11.32%)
>10 patients	1(0. 94%)
Average number of patients with manifested pulmonary symptoms requiring chest radiography per week	
<5 patients	95(89.62%)
Between 5-10 patients	11(10.37%)
>10 patients	0(0.00%)
The most common findings in chest radiography:	
Normal X-ray at the onset of the disease	31(29.24%)
Atypical pneumonia with presence of(Pleural effusion / Pneumothorax/Miliary pattern / Nodule/mass or,Cavitation etc.)	3(2.83%)
Typical pneumonia(Bilateral with occupation of lower lung fields (typical Reticular pattern), Peripheral/diffuse type with occupation of multiple lung fields in both hemithoraces. (Ground-glass opacities) Patchy or confluent multifocal (Consolidation)	45(42.45%)
Indeterminate type(Unilateral with occupation of middle and upper lung fields/Central type with consolidation)	19(17.92%)
Absence of shared information for X- ray pathology by General practitioner	8(7.54%)

Discussion

A reverse transcription-polymerase chain reaction (RT-PCR) is the standard test for the detection of SARS-CoV-2, but its sensitivity can range [5-7]. These false negatives RT-PCR results are a real clinical problem, especially in the early stages. The situation is similar in COVID-19 antigen tests [8,9]. Their sensitivity also varies by time elapsed since exposure to the coronavirus [10]. Shrestha B. and co-authors recommend this test should be interpreted cautiously depending upon the prevalence of COVID-19 infection in a particular communities and the clinical and epidemiological context of the person who has been tested [8]. In a time where the coronavirus cases are increasing at an alarming rate, plain radiography also plays an important role in the diagnostic and therapeutic protocol for COVID-19 patients in the General practice. The clinical spectrum of COVID-19 ranges from asymptomatic and paucisymptomatic forms to severe forms characterised by respiratory failure, sepsis, shock and organ dysfunction syndromes [7]. A review of some international scientific publications shows that the percentage of COVID-19 asymptomatic patients varies between 30 and 40 [7,11,12]. In symptomatic individuals, COVID-19 is predominantly manifested by systemic and / or respiratory symptoms, which requires early diagnosis, properly grading the severity of the disease and directing treatment in outpatient or hospital conditions. In addition, the signs of coronavirus infection are very often nonspecific. This creates difficulties in clinical differentiation of COVID-19 and other common respiratory infections [7,13,14]. The presence of accompanying or new founded conditions which resemble the findings of COVID-19 at radiography is an additional challenge in the diagnostic aspect [6]. Moreover, proper interpretation of a chest x-ray picture is based on a good collaboration between the physician who treats and is familiar with medical history of the patient, and the radiologist. This collegial connection is extremely useful in the General practice where conventional chest radiography is the first line imaging test in patients with suspected or confirmed COVID-19 due to its availability, accessibility and inexpensiveness. In the General practice, plain radiography is the only possible, quick and non-invasive method for detecting pathological changes in the lungs due to restrictions from the contract partner - the National Health Insurance Fund. During the COVID-19 pandemic this imaging diagnostic method, which is less sensitive than computed tomography[15], is very often used by the respondents, facilitates their work and supports the diagnostic process in patients with coronavirus infection. The optimal chest X-ray includes posteroanterior (PA) and lateral projections with the patient standing [12]. Sometimes it is possible false positives on chest X-rays caused by lack of inspiration, breast prominence and poor positioning of the patient [7, 12]. False negative results of chest x-ray picture are not excluded. They are usually due to the prematurity of the imaging test, the limitations of the X-ray technique or the absence of pulmonary disease at the time of presentation [7,15,16]. Respondents shared that chest X-rays may be normal in mild cases or in the initial stages of the disease, while patients with moderate to severe symptoms are unlikely to have a normal chest x-ray. Pathological changes in the lungs are especially visible on an X-ray in the second week of the patient's illness. International studies have also confirmed that in the early phase of the COVID-19 infection, it is normal to be unable to detect lung involvement by conventional radiography and findings are more extensive 10-12 days after the onset of symptoms [7,15]. Lung radiography is most often performed when the patient's symptoms worsen. In mild to moderate course of the disease, it is possible to apply conventional radiography earlier. However, due to the risk of a false-negative X-ray result, it should be performed at least one week after a positive PCR test result. Some researchers have divided chest X-rays in patients with suspected COVID-19 disease into four categories to facilitate diagnosis- normal X-ray picture, chest X-ray with typical findings commonly associated with COVID-19 in the scientific literature, chest X-ray with indeterminate findings and chest X-ray with atypical and uncommon findings [7,15,17-20]. General practitioners presented the findings visible on chest X-ray of their patients, which were suspected or with a confirmed diagnosis of COVID-19 in a similar model. The normal and negative finding from conventional radiography does not rule out SARS-CoV-2 infection, as may be the case in mild forms of the disease according to 29.24% of respondents. Several family doctors shared the cases of developing COVID-19 symptoms from the respiratory system, which was not detected by standard radiography, as well as for patients with negative PCR or antigen test results but with positive chest radiography. Almost all respondents expressed an opinion that the imaging findings vary not only depending on the stage of the disease during the X-ray scan, but also on the patient`s age, immunity status, underlying diseases and drug interventions. 42.45 % of medics reported typical radiological findings on the chest of their patients suspected of COVID-19 disease, including reticular pattern, areas of ground glass density and consolidations, which often had a correlation with the severity of the symptoms. Initially, chest images show multiple small patchy shadows and interstitial changes, remarkable at the periphery of the lungs [13,21,22]. International research has shared that the most common findings on chest x-rays ware multifocal, peripheral ground glass opacities affecting the lower lobes, combined with zones of reticular changes [3-4,15,23-27]. In the course of illness, the ground glass opacities progressed into consolidations peaking around 6–11 days [28]. According to Martínez Chamorro E. and co-authors between the first and third week from the onset of symptoms, typical X-ray findings may progress to diffuse disease [7]. Wu D. and co-authors have concluded that severe cases can further develop to bilateral multiple ground-glass opacity, infiltrating shadows, and pulmonary consolidation [22]. Septal thickening, pleural effusion, lymphadenopathy, cavitation and bronchiectasis have been observed less frequently as noted by other researchers [15,25,28]. 17.92% of respondents indicated the existence of cases with indeterminate findings from chest radiography in their practices, requiring a differential diagnosis with other infections or complications of accompanying diseases. The percentage of general practitioners reporting the diagnosis of COVID-19 suspected patient with atypical chest X-ray manifestations is minimal (2.83%), but this determines the need for deeper and more specific knowledge about SARS-CoV-2

infection and its manifestations, complications and dimensions visible through plain radiography.

Conclusion
Conventional radiography will always remain the gold standard for examining the chest and changes in it. COVID-19 lung involvement images have certain features that can be detected by chest X-rays. So that this imaging method is particularly suitable, convenient, easy and non-invasive for the diagnosis of COVID-19 suspected patients in the General practice. Its application at the appropriate time provides an opportunity for general practitioners to make an adequate diagnosis and to offer appropriate treatment to persons suspected of coronavirus infection.

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Conflict of Interest
The author declares that there is no conflict of interests to the research, authorship, and/or publication of this article.

References
1. Collie DA, Sellar RJ, Steyn JP, Cull RE (1999) The diagnostic yield of magnetic resonance imaging (MRI) of the brain and spine requested by general practitioners: comparison with hospital clinicians. The British journal of general practice the journal of the Royal College of General Practitioners 49(444):559-561.
2. White PM, Halliday-Pegg JC, Collie DA (2002) Open access neuroimaging for general practitioners--diagnostic yield and influence on patient management. The British journal of general practice: the journal of the Royal College of General Practitioners 52(474):33-35.
3. Cherryman G (2006) Imaging in primary care. The British journal of general practice: the journal of the Royal College of General Practitioners 56(529):563-564.
4. Elsharkawy M, Sharafeldeen A, Taher F, et al. (2021) Early assessment of lung function in coronavirus patients using invariant markers from chest X-rays images. Sci Rep 11:12095.
5. Mossa-Basha M, Meltzer CC, Kim DC, Tuite MJ, Kolli KP,Tan BS (2020) Radiology Department Preparedness for COVID-19: Radiology Scientific Expert Review Panel. Radiology 296(2):E106-E112.
6. Kanne JP, Little BP, Chung JH, Elicker BM, Ketai LH (2020) Essentials for Radiologists on COVID-19: An Update-Radiology Scientific Expert Panel. Radiology 296(2):E113-E114.
7. Martínez Chamorro E, Díez Tascón A, Ibáñez Sanz L, Ossaba Vélez S, Borruel Nacenta S (2021) Radiologic diagnosis of patients with COVID-19. Diagnóstico radiológico del paciente con COVID-19. Radiologia 63(1): 56-73.
8. Shrestha B, Neupane AK, Pant S, Shrestha A, Bastola A, et al. (2020) Sensitivity and Specificity of Lateral Flow Antigen Test Kits for COVID-19 in Asymptomatic Population of Quarantine Centre of Province 3. Kathmandu University medical journal (KUMJ) 18(70):36-39.
9. Krüger LJ, Gaeddert M, Köppel L, Brümmer LE, Gottschalk C, Miranda IB, et al. (2020) Evaluation of the accuracy, ease of use and limit of detection of novel, rapid, antigen-detecting point-of-care diagnostics for SARS-CoV-2. medRxiv 2020Oct4.
10. Brümmer LE, Katzenschlager S, Gaeddert M, Erdmann C, Schmitz S, et al. (2021)Accuracy of novel antigen rapid diagnostics for SARS-CoV-2: A living systematic review and meta-analysis. PLoS Med 18(8):e1003735.
11. Mizumoto K, Kagaya K, Zarebski A, Chowell G (2020) Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles European communicable disease bulletin 25(10):2000180.
12. Oran DP, Topol EJ (2020) Prevalence of Asymptomatic SARS-CoV-2 Infection: A Narrative Review. Annals of internal medicine 173(5):362-367.
13. Huang C, Wang Y, Li X, Ren L, Zhao J, et al. (2020) Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet (London, England) 395(10223):497-506.
14. Wang D, Hu B, Hu C, Zhu F, Liu X, et al. (2020) Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. JAMA 323(11):1061-1069.
15. Wong H, Lam H, Fong AH, Leung ST, Chin TW, et al. (2020) Frequency and Distribution of Chest Radiographic Findings in Patients Positive for COVID-19. Radiology 296(2):E72-E78.
16. Manna S, Wruble J, Maron SZ, Toussie D, Voutsinas N, et al. (2020) COVID-19: A Multimodality Review of Radiologic Techniques, Clinical Utility, and Imaging Features. Radiology Cardiothoracic imaging 2(3): e200210.
17. Litmanovich DE, Chung M, Kirkbride RR, Kicska G, Kanne JP (2020) Review of Chest Radiograph Findings of COVID-19 Pneumonia and Suggested Reporting Language. J Thoracic Imaging 35(6):354-360.
18. Jacobi A, Chung M, Bernheim A, Eber C (2020) Portable chest X-ray in coronavirus disease-19 (COVID-19): A pictorial review. Clinical Imaging 64:35-42.
19. Vancheri SG, Savietto G, Ballati F, Maggi A, Canino C, et al. (2020) Radiographic findings in 240 patients with COVID-19 pneumonia: time-dependence after the onset of symptoms. European Radiology 30(11):6161-6169.
20. Ng MY, Lee E, Yang J, Yang F, Li X, et al. (2020) Imaging Profile of the COVID-19 Infection: Radiologic Findings and Literature Review. Radiology Cardiothoracic Imaging

2(1):e200034.

21. Chan JF, Yuan S, Kok KH, To KK, Chu H, et al. (2020) A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet (London, England) 395(10223):514-523.

22. Wu D, Wu T, Liu Q, Yang Z (2020) The SARS-CoV-2 outbreak: What we know. Int J Infectious Diseases: IJID: official publication of the International Society for Infectious Diseases 94:44-48.

23. Chen D, Jiang X, Hong Y, Wen Z, Wei S, et al. (2021) Can Chest CT Features Distinguish Patients With Negative From Those With Positive Initial RT-PCR Results for Coronavirus Disease (COVID-19)?. AJR American J Roentgenology 216(1):66-70.

24. Jacobi A, Chung M, Bernheim A, Eber C (2020) Portable chest X-ray in coronavirus disease-19 (COVID-19): A pictorial review. Clinical Imaging 64:35-42.

25. Yoon SH, Lee KH, Kim JY, Lee YK, Ko H, et al. (2020) Chest Radiographic and CT Findings of the 2019 Novel Coronavirus Disease (COVID-19): Analysis of Nine Patients Treated in Korea. Korean J Radiology 21(4):494-500.

26. Borghesi A, Maroldi R (2020) COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. La Radiologia medica 125(5):509-513.

27. Schiaffino S, Tritella S, Cozzi A, Carriero S, Blandi L, et al. (2020) Diagnostic Performance of Chest X-Ray for COVID-19 Pneumonia During the SARS-CoV-2 Pandemic in Lombardy, Italy. J Thoracic Imaging 35(4): W105-W106.

28. Rousan LA, Elobeid E, Karrar M (2020) Chest x-ray findings and temporal lung changes in patients with COVID-19 pneumonia. BMC Pulm Med 20.