

# Impact of COVID-19 Pandemic on Radiology and Medical Imaging Departments Activities in Romania

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**Abstract**— The COVID-19 pandemic had a major impact on all medical institutions around the world. Since April 2020, when the Fleischner Society published the COVID-19 disease diagnosis guide by imaging methods, the diagnostic challenges were shared between two departments, in vitro diagnosis, and radiology and medical imaging. The paper presents some preliminary results of quantitative research carried out in Romania. The research aimed to identify the perceived impact of the COVID-19 pandemic on the medical staff within the radiology and medical imaging departments in Romania (RMIDR). The research pursued two directions: (A) the effects of the COVID-19 pandemic on RMIDR's organizational procedures and (B) the impact of the COVID-19 pandemic on RMIDR's endowment strategies. A number of 50 RMIDRs were analyzed.

**Keywords**—Radiology; Medical Imaging; COVID-19 pandemic; SARS-CoV-2; survey.

## I. INTRODUCTION

The World Health Organization (WHO) declared the infection with the SARS-CoV-2 virus a pandemic on March 11<sup>th</sup>, 2020 [1]. Since its onset in Romania, the COVID-19 pandemic had a major and unprecedented impact on all medical institutions. From the time when the confirmation of the fact that the SARS-CoV-2 virus can be easily transmitted from one person to another [2], the main concern of medical institutions has been the diagnosis of this virus. As a result, in the “first line” were the in vitro diagnostic departments, namely medical analysis laboratories and molecular biology laboratories. Firstly, the virus could only be diagnosed through methods that involve high costs, such as Real Time Polymerase Chain Reaction (RT-PCR), which represented a real crisis in Romanian hospitals because of their underfunding by government institutions. In April 2020, the Fleischner Society published a guide so that radiologists can diagnose the disease of COVID-19 by imaging methods, especially with ionizing radiation [3]. From that moment, the pressure of diagnosing COVID-19 has been shared between the aforementioned in vitro diagnostic departments and the medical radiology and imaging departments. Concerning the radiology and medical imaging departments in Romania (RMIDR), their main problem has been represented by the lack of equipment, an issue also shown by a study published in 2018 by Eurostat [4].

The paper presents the preliminary results of quantitative research carried out in Romania, whose main objective is to identify the perceived impact of the COVID-19 pandemic on the RMIDR by the medical staff within these departments. The paper is structured as follows. In the second section, *Database and Methods*, the research methodology is described, focusing on the sample structure (50 RMIDRs). In the third section, *Results*, some preliminary results are presented and discussed. The paper closes with the conclusions.

## II. DATABASE AND METHODS

### A. Data collection tool

The data collection has been carried out through a questionnaire survey. For this purpose, an online structured questionnaire has been built, with 28 questions of which 22 closed questions (19 with a single answer and 3 with multiple answers) and 6 open questions. The questions were grouped into three topics: (T1) questions that follow the impact of the COVID-19 pandemic on the organizational procedures within the RMIDR; (T2) questions oriented towards the impact of the COVID-19 pandemic on the strategies (procedures) for the endowment of RMIDR; and (T3) socio-demographic questions.

(T1) The questions from the “Impact of the COVID-19 pandemic on organizational procedures” topic aimed:

- Hospital “doctor-patient circuits”: if it has been necessary to recreate them, who has been the person responsible for designing the circuits, and how the information has been transmitted in RMIDR; the “doctor-patient circuit” (DP-circuit) is the avoidance procedure of direct interaction between the doctor and the patient. For example, to avoid contact, the patient's route to the investigation room should be different from the doctor's route or, if this is not possible, a specific schedule should be implemented;
- Newly hired or relocated personnel in RMIDR for the 2020/2021 period (with predefined answers: doctor, assistant, nurse);
- Difficulties arising in the RMIDR in the 2020/2021 period;
- “remote” measures implemented in RMIDR, in 2020 and in 2021; the answer options being: (a) “Telemedicine”, (b)

“PACS system” (Picture Archiving and Communication System), (c) “Remote access without a PACS or telemedicine system”.

(T2) Questions from the “Impact of the COVID-19 pandemic on endowment strategies” topic sought the respondent’s estimation of:

- Number of equipment purchased in the 2020/2021 period, grouped into new equipment (which did not exist in the department before the pandemic) and replaced equipment; respondents had to choose between (a) conventional radiology systems (fixed or mobile), (b) computed tomography systems, (c) magnetic resonance systems, (d) ultrasounds, with the possibility of selecting multiple choices. This equipment has been chosen due to the fact that the literature recommends them in the diagnosis of COVID-19 and in the verification of the treatment effectiveness [5-8];
- Usage level of artificial intelligence (AI) functions in order to diagnose COVID-19 and the reasons why these are not used;
- Financial amount invested in the RMIDR; a verification question has been introduced in the questionnaire (for example a department that received a magnetic resonance system should not mention an invested amount of only 50,000 – 100,000 EURO, the costs of such a system is usually over 400,000 or even 600,000 EURO).

(T3) The social-demographic questions followed: the respondent’s gender, the respondent’s position in the RMIDR, the respondent’s seniority in their position, the type of hospital in which he works as well as the property regime of the institution, and the geographical area.

The questionnaire has been created, sent, and completed using Microsoft Forms. The respondent’s anonymity has been respected by unchecking the option to register the respondent’s identification data.

## B. Target population and sample

The target population of the research has two components. On one hand, as the research objective is about organizational procedures and staffing strategies, this is represented by (1) the total number of radiology and medical imaging departments in Romania (RMIDR). On the other hand, since the information can only be estimated by individuals, the other component is represented by (2) the total number of medical personnel associated with these RMIDRs. (1) There are no statistics that can provide the total number of RMIDR. Studying the literature, the reports published by the National Institute of Statistics, and the legislation, the following were found: at the national level, in Romania, there are 693 hospitals, including institutes and other medical units assimilated into hospitals that provide services of continuous hospitalization [9]. According to Order no. 914/2006 for the approval of the rules regarding the conditions that a hospital must meet to obtain sanitary authorizations to operate, each hospital must have a radio-diagnostic laboratory, i.e., radiology and medical imaging department or section [10]. According to the Activity Report of the National Commission of Nuclear Activities Control in Romania (CNCAN), in 2020, 3100 radio-diagnostic systems were operating on Romania’s territory [11]. Corroborating the

presented information, there are certain reservations regarding the establishment of a real number of RMIDR because in the „Activity of Health Units in 2019”, published by the National Institute of Statistics, private medical imaging centers without daytime hospitalization are not included nor private medical institutions [9]. It can be noted that all 693 hospitals have at least one radiology and medical imaging department each, resulting in a total of a minimum of 693 radio-diagnostic departments. This information is mentioned as minimal because some hospitals may have several radiology and medical imaging departments. Knowing the number of medical radio-diagnostic facilities authorized by CNCAN, it cannot be concluded that there are 3100 medical radiology and imaging departments because more than one equipment can be used in such a department.

(2) Regarding the total number of medical personnel working in this field, the National Institute of Statistics provides this data, mentioning that, on Romania’s territory, there is a total number of 1999 doctors specialized in radiology and medical imaging [9]. However, it cannot be concluded that there would be a number of 1999 radiology and medical imaging departments because in a hospital institution, within the same department, there can be several radiologists. All these radiologists can be employed in private institutions simultaneously with the position held in the public hospital.

The respondents, medical staff working in at least one RMIDR, were selected based on their free will to answer the questions of the questionnaire. The sampling frame has been represented by the customer base or potential customers of a company that sells and provides maintenance services for medical equipment [12]. The sample resulting from the answers collected between 12.04.2022 and 08.08.2022 is made up of 50 items (50 RMIDR), with a response rate of 100%. The social-demographic structure of the sample is presented in Tables I – Tables IV.

TABLE I. POSITION OF RESPONDENTS IN RMIDR

Position	Percentage [%]
Department head	42.00
Specialist doctor	30.00
Primary doctor	28.00
Total	100.00

TABLE II. SENIORITY OF THE RESPONDENTS

Seniority	Percentage [%]
Between 1 and 5 years	20.41
Between 5 and 10 years	26.53
Between 10 and 20 years	28.57
Over 20 years	24.49
Total	100.00

Concerning the distribution of the responses on Romania’s territory, due to the small number of medical units at the county level, grouping by development regions has been used [13]. Table IV presents the obtained distribution of RMIDR analyzed by development regions. It can be observed that the sample includes all eight development regions, the least represented being the “Center” region and the best represented, “Bucharest-Ilfov” region.

TABLE III. HOSPITAL TYPE

Hospital type	Percentage [%]
Universitary Hospital	2.00
County Hospital	24.00
Town Hospital	24.00
Other	50.00
Total	100.00

TABLE IV. DISTRIBUTION OF RMIDRS BY DEVELOPMENT REGIONS

	Region	Percentage [%]
1.	North East	14.00
2.	South East	14.00
3.	South Muntenia	18.00
4.	South West Oltenia	8.00
5.	West	6.00
6.	North West	8.00
7.	Center	2.00
8.	Bucharest-Ilfov	30.00
	Total	100.00

### III. RESULTS

The responses regarding the 50 analyzed departments have been grouped into two categories: (A) The impact of the COVID-19 pandemic on RMIDR's organizational procedures and (B) The impact of the COVID-19 pandemic on RMIDR's endowment strategies.

#### A. The impact of the COVID-19 pandemic on the organizational procedures of RMIDR

The preliminary results of the research show that in 34% of RMIDRs the DP-circuit has been not recreated, the reasons stated by the respondents being: "they were (already) compliant" (70.59%) and "it has been not possible" (29.41%) without specifying the reason (it can be supposed that due to the lack of space). Furthermore, the results indicate that in 84.62% of the RMIDRs, the DP-circuits were carried out by the epidemiologist of the medical unit, in 11.53% by the head of the RMIDR, and in the last 3.85% of the RMIDRs, by the medical unit's manager himself. Regarding the implemented procedures, the medical staff has been updated in several ways (not only through formal written procedures), as in Table V.

TABLE V. MEDICAL STAFF UPDATE REGARDING THE DP-CIRCUIT

Update methods	Percentage [%]
Verbally, by an individual from inside the institution	8.00
Verbally, by an individual outside the institution	4.00
Informal written message	18.00
Formal written message	64.00
No former additional training	6.00
Total	100.00

The newly hired or relocated staff is another aspect specific to the COVID-19 pandemic. Table VI shows that, in the 2020/2021 period, only one doctor (in 32% of cases) or only one assistant (in 22% of units) has been brought to most RMIDRs. There were also situations (4%) where more than four doctors and/or assistants were hired/relocated. To identify whether and what percentage of medical units implemented more than one "remote" technology, a multiple-choice question

has been applied. The results show that all 50 RMIDRs implemented at least one remote technology, 24% of them implemented two remote technologies and 4% used all three measures considered: telemedicine, PACS system, and remote access without a PACS system or telemedicine. The most popular remote technology implemented has been the PACS system (62% of RMIDRs had such a system among the implemented measures), as can be observed in Table VII. This can be justified by the fact that a PACS system would be much more appropriate for these departments being mostly dedicated to DICOM (Digital Imaging and Communications in Medicine) type images, obtained from the equipment used in roentgen diagnosis.

TABLE VI. NEWLY HIRED/RELOCATED MEDICAL PERSONNEL IN RMIDRS, IN 2020/2021 PERIOD

No. pers Pers.Type	0*	1	2	3	4	>4**	Total
Doctor	56%	32 %	6%	2%	0%	4%	100%
Assistant	52 %	22%	6%	8%	8%	4%	100%
Orderly	94%	4 %	2%	0%	0%	0%	100%

\*"0" = no newly hired/relocated individual; \*\*">4" = over 4 newly hired/relocated individuals

TABLE VII. REMOTE TECHNOLOGIES IMPLEMENTED IN RMIDRS, IN 2020/2021 PERIOD

No. Tech. Tech. type	One remote tech. impl.	Two remote tech. impl.	Three remote tech. impl.	TOTAL
Telemedicine	16%	16%	0%	32%
PACS system	54%	8%	0%	62%
Remote access	30%	0%	4%	34%
TOTAL	100%	24%	4%	

TABLE VIII. RANKING THE ISSUES FACED DURING THE PANDEMIC, BY THE RMIDRS' STAFF

Iss. grade Iss. Type	Very low	Low	Medium	High	Very high	Total
Lack of personnel	22%	24%	18%	26%	10%	100%
Worn-out medical devices	28%	18%	18%	12%	24%	100%
Insufficient medical devices	20%	30%	20%	12%	18%	100%
Lack of COVID-19 diagnostic devices	32%	30%	18%	8%	12%	100%
Sudden increase in medical interventions	22%	16%	42%	10%	10%	100%

Another objective of the study has been to evaluate the perception of the medical staff from RMIDRs, regarding the difficulties that appeared in the 2020-2021 interval. Thus, the respondents were asked to rank, from their perspective, the degree of difficulty of the following situations: insufficient staff, obsolete equipment, insufficient equipment, the lack of equipment necessary for the COVID-19 diagnosis, and the increase of radiological investigations number as a result of the high rate of occupied beds in the hospital. The results obtained, shown in Table VIII, emphasize that there has been a relatively

uniform distribution of the previously listed perceived difficulties. A slight tendency can be observed that the "wear and tear of devices" represented the most difficult aspect of the pandemic.

#### B. The impact on RMIDR's endowment strategies

The preliminary results of the research indicate that all 50 analyzed RMIDRs have purchased at least one piece of equipment, as follows: 64% of them purchased mobile x-ray equipment, 48% a fixed conventional radiology equipment, 30% a CT scanner, 6% a magnetic resonance device, respectively 30% an ultrasound (see Table IX). Can be noticed that 6% of the analyzed RMIDRs were able to purchase all five equipments. In Table X it can be seen that 34% of RMIDRs made purchases in the 50,000 - 100,000 EURO range. This finding confirms the fact that the radiology systems that fall within this value are the mobile and fixed ones for conventional radiology, which, according to Table IX, were predominantly purchased.

TABLE IX. DEVICES PURCHASED BY THE RMIDRS, IN 2020/2021 PERIOD

No. Equip. Equip. type	1*	2	3	4	5	Total
Mobile x-ray	60%	0%	2%	2%	0%	64%
Fixed conventional x-ray	24%	22%	2%	0%	0%	48%
CT scanner	12%	6%	12%	0%	0%	30%
Magnetic resonance device	0%	4%	0%	0%	2%	6%
Ultrasound	4%	10%	10%	2%	4%	30%
TOTAL	100%	42%	26%	4%	6%	

\*"1" = only one purchased equipment

TABLE X. RMIDR INVESTMENTS, IN 2020/2021 PERIOD

Sum [EURO]	Percentage [%]
Between 50 000 – 100 000 EURO	34.00%
Between 100 000 – 250 000 EURO	16.00%
Between 250 000 – 400 000 EURO	22.00%
Between 400 000 – 600 000 EURO	16.00%
Between 600 000 EURO	12.00%
Total	100.00

TABLE XI. AI ADOPTION STATUS IN RMIDRS, IN 2020/2021 PERIOD

	Percentage [%]
No AI technology present	70.00
AI technology present, but not used	14.00
AI technology present and frequently used	10.00
AI technology present and rarely used	6.00
Total	100.00

Another research purpose has been to examine the existence and usage of artificial intelligence (AI) functions within the RMIDR. The results show that 70% of the analyzed RMIDRs do not have AI technology, and if they do have AI technology, the technology is not that much used, as per Table XI. The reasons given by the respondents who answered that they do not use the AI function or rarely use, it was: "we do not

possess the knowledge to use it" (10%), "it is difficult to use" (40%), "we do not trust the technology" (50%).

#### IV. CONCLUSIONS

This paper presents the preliminary results of ongoing research, whose objective is to identify the effects of the COVID-19 pandemic on the radiology and medical imaging departments in Romania (RMIDRs). Two directions were pursued: (A) the effects of the COVID-19 pandemic on RMIDR's organizational procedures and (B) the impact of the COVID-19 pandemic on RMIDR's endowment strategies. The first results show that all analyzed departments purchased at least one piece of equipment, 34% of RMIDRs making purchases in the (50,000; 100,000) EURO range. Regarding AI acceptance, 70% of RMIDRs do not have AI functions, whilst 50% of respondents present in RMIDRs with AI functions do not use them, stating that they "don't trust the technology".

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