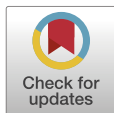




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Research Article

COVID-19 outbreak impact on health professionals: A survey on the Italian radiographer experience

Chiara Martini, MSc^{a,b,*}, Camilla Risoli, RT^c, Marco Nicolò, RT^d, Alessandro Tombolesi, RT^e,
Jacopo Negri, RT^f, Oscar Brazzo, RT^g, Irene Gertrud Rigott, MSc^h, Daniele Di Feo, MScⁱ,
Giuseppe Walter Antonucci, MSc^j, Luca Barbato, MSc^k, Giuseppe Pedrazzi^l, Livia Lo Presti, MSc^m,
Joana Santos, MScⁿ, Matteo Migliorini, MSc^o, Lisa Conversi, MSc^p, Elisa Vetti, MSc^{a,q} and
Angie Devetti, RT^p

^a Department of Health Professions, University Hospital of Parma, Parma, Italy

^b Department of Medicine and Surgery, University of Parma, Parma, Italy

^c Department of Radiology, Hospital of Piacenza, Piacenza, Italy

^d Department of Diagnostic Imaging, Spedali Civili di Brescia, Brescia, Italy

^e Department of Radiology P.O. CTO, Azienda Ospedaliera-Universitaria Città della Salute e della Scienza di Torino CTO - Maria Adelaide, Torino, Italy

^f Department of Radiology, Macerata Hospital, Macerata, Italy

^g Department of Radiology, ASL BA Hospital Di Venere, Bari, Italy

^h Università Cattolica del Sacro Cuore di Roma Claudiana, Bolzano, Italy

ⁱ Department of Diagnostic Imaging, University Hospital Meyer of Firenze, Firenze, Italy

^j Department of Radiology, Hospital of Barletta, Barletta, Italy

^k Department of Radiology, University Hospital Sant'Andrea, Roma, Italy

^l Department of Medicine and Surgery, University of Parma, Parma, Italy

^m Freelance Translator and Interpreter pursuant to Law 4, 14/01/2013

ⁿ Radiologia, Instituto Politécnico de Coimbra, ESTESC-Coimbra Health School, 3046-854 Coimbra, Portugal

^o Department of Radiology, University Hospital of Ferrara, Ferrara, Italy

^p Department of Radiology, Wrexham Maelor Hospital, Wrexham, Gales, Regno Unito

^q Department of Radiology, University Hospital of Santa Maria della Misericordia, Udine, Italy

ABSTRACT

Aim: To evaluate the impact of the Phase 1 COVID-19 (C19) outbreak on Italian Radiographers.

Material and methods: COVID-19 has spread rapidly worldwide. Many patients underwent radiological examinations, leading to a

high risk of infection within the radiology department's staff. Italy was the first-hit European country to face the COVID-19 outbreak and the impact on radiographers was huge. An online survey was disseminated to investigate the involvement and working environment of Italian radiographers during the first outbreak of COVID-19.

Abbreviations: GReSS, Italian Group Risk management and safety in healthcare; C19, COVID-19; HCW, Healthcare workers; CT, Computed Tomography; PPE, Personal Protective Equipment; WHO, World Health Organization; AITASIT, Italian Association System Administrators and Telemedicine; ASIS-TSRM, Italian Radiographer Association of Healthcare Imaging Sciences; AITeRTC, Italian Radiographer Association in Computer Tomography.

* Contributors: CM, CR, and MN conceived the study and drafted the manuscript. AT, JN, OB, IGR, DD, GWA, LB, GP, SD, LLP and MM were involved in the formulation of the measures. JS, EV, LC and AD drafted the work or revised it critically for important intellectual content. The authors declare that they had full access to all the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis.

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Ethical approval: The study was approved by the institutional review board and all participants provided written informed consent.

* Corresponding author at: Department of Health Professions, University Hospital of Parma, Via Gramsci 14, 43126 Parma, Italy.

E-mail addresses: martinic@ao.pr.it (C. Martini), d.difeo@meyer.it (D. Di Feo), giuseppe.pedrazzi@unipr.it (G. Pedrazzi), livia@livialopresti.it (L.L. Presti), joanasantos@estescoimbra.pt (J. Santos), evetti@ao.pr.it (E. Vetti).

Results: Of the 840 responders, 65% were men. The majority of the responding Health-care Workers (HCW) was represented by radiographers (96%), from high-prevalence regions (82%; $p < .05$). Forty-five percent were involved in the activation of the protocol for the management of COVID-19 positive patients, without exhaustive indication for Plain Radiography and Computed Tomography (CT). Only 17% of hospitals counted on available guidelines for serious infections ($p < 0.05$). Diagnostic examinations were mainly performed by a single radiographer (62%). Many professionals (69%) confirmed wearing all indispensable PPE in case of COVID-19 positive patients.

Conclusion: The primary objective of management strategies should be to redact standardized policies for the safeguarding of patient's health and operator's safety. All front-line workers, including radiographers working in diagnostic services, should be involved in the decision-making process to generate wellness and awareness.

RÉSUMÉ

But: Évaluer l'impact de la phase 1 de l'épidémie de COVID-19 (C19) sur les radiographes italiens.

Matériel et Méthodologie: La COVID-19 s'est rapidement répandue dans le monde entier. De nombreux patients ont subi des exa-

mens radiologiques, entraînant un risque élevé d'infection au sein du personnel du service de radiologie. L'Italie a été le premier pays européen touché par l'épidémie de COVID-19 et l'impact sur les radiographes a été énorme. Une enquête en ligne a été diffusée pour étudier l'implication et l'environnement de travail des radiographes italiens lors de la première éclosion de COVID-19

Résultats: Sur les 840 répondants, 65% étaient des hommes. La majorité des professionnels de santé (PS) ayant répondu étaient des radiographes (96%), issus de régions à forte prévalence (82%; $p < .05$). 45% étaient impliqués dans l'activation du protocole de gestion des patients positifs à la COVID-19, sans indication exhaustive de radiographie simple et de tomodensitométrie (CT). Seuls 17% des hôpitaux se sont appuyés sur les directives disponibles pour les infections graves ($p < 0,05$). Les examens diagnostiques étaient principalement réalisés par un seul radiographe (62%). De nombreux professionnels (69%) ont déclaré porter tous les EPI indispensables en cas de patients positifs à la COVID-19.

Conclusion: L'objectif premier des stratégies de gestion devrait être de rédiger des politiques standardisées pour préserver la santé des patients et la sécurité des opérateurs. Tous les travailleurs de première ligne, y compris les radiographes travaillant dans les services de diagnostic, devraient être impliqués dans le processus de prise de décision afin de générer du bien-être et de la sensibilisation.

Keywords: Coronavirus; COVID-19; SARS-CoV-2; Radiography; X-ray; Tomography; Computed Tomography; X-ray computed; Infection control; Radiographers; Radiology Technologist; Risk management; Patient Safety; Personal Protective Equipment; PPE

Introduction

A novel coronavirus pneumonia emerged in Wuhan, China, in December 2019, named 2019 novel coronavirus (2019-nCoV) by the World Health Organization (WHO) on 12th January 2020. The outbreak has spread rapidly worldwide since then¹⁻³. At 4 AM on October 7th, 2020, 235 countries reported outbreaks of COVID-19, with the number of cases rising to 35,659,007 [4].

An early and accurate identification of cases leads to early diagnosis, timely isolation, and treatment [5,6]. Nevertheless, many patients, even with mild symptoms [7,8] underwent radiological examinations. Hence, radiology department's staff work in an environment with a high risk of infection [9,10].

Italy was one of the first-hit European countries to face the outbreak of COVID-19 and the impact on healthcare professionals was massive. Therefore the aim of this study was to evaluate the impact of Phase 1 COVID-19 (C19) outbreak on Italian radiographers.

Material and methods

Survey

This is a cross-sectional study consisting of a web-based survey to investigate the involvement, level of knowledge and awareness of Healthcare Workers (HCW) during Phase 1 COVID-19 pandemic, within the radiology department.

A 36-question survey, "Survey at the time of Phase 1 COVID-19: management of patients with suspected or known COVID-19 in diagnostic imaging", was designed and developed by various Italian Radiographer's Groups and Associations (i.e., AITASIT, ASIS-TSRM, AITeRTC and GReSS) using an online platform ("Google online surveys", developed by Google) in accordance with the Checklist for Reporting Results of Internet E-Surveys (the CHERRIES statement) [11]. The Google Form Link was sent via social media (Facebook, Instagram, and LinkedIn) and email. HCW experts, with more than 15 years of experience (range 5-27; 17.58 ± 7.80), who were directly in contact with positive or suspected positive COVID-19 patients on the frontline, directed the survey, assessed the layout, checked the feasibility and validity of the questions. The online survey was made available online from August 1st to August 31st, 2021.

The survey aimed to assess crucial elements in HCW's experience, focused on radiographer conditions in within the radiology department, to capture key information about the respondents, including gender, age group, type of HCW (e.g., radiographers, nurses), employment contract, workplace (e.g., university hospitals, non-academic hub-and-spoke hospital, general practice clinics, private clinics), and any health problem. All the data were divided in five areas of interest, dealing with topics like geographic and demographic information; presence/absence of specific procedures, dedicated pathways and protocols for different typologies of patients; supplied radiolog-

ical equipment for plain film radiography and CT; correct use of PPE; the sanitification and disinfection protocols used after any radiological examination

Thirteen sections were identified: introduction; demographic and epidemiological data; procedure and diagnostic pathways; Covid-19: phase 1 (March to June 2020) vs. phase 3 (from September 2020) in daily professional practice; risk management, safety of healthcareworkers and patients in Radiology Department; Emergency Department and Oncology Department (follow up); screening (breast, etc.); numbers of radiographers/MRIT\220s, x ray and CT methods of investigation; PPE used for x-ray and CT examination; protocols used in x-ray and/or CT; artificial intelligence software applied in the Radiology Department; disinfection and sanitification in the Radiology Department; stress and burnout.

Other questions assessed the presence in within the radiology departments of dedicated protocols for generic infections, SARS/MERS and COVID-19 positive subjects; whether if HCW were involved in the decision-making process for COVID19 patient's management with tasks beyond their own skills/job roles; guidance/indications about quantity and quality of PPE for plain film/CT examinations involving patients positive for COVID-19; and if the risk increased, implementation of dedicated staffing was also available/obtained. The activation of local protocols for COVID-19 patients management was investigated and respondents were asked whether they personally contributed to its development and/or complied with its requirements. Finally, respondents were asked whether they could keep up with medical literature on COVID-19. All questions were set as mandatory fields. Quantitative data were automatically collected by the software and exported to a tabulated format.

The study was approved by the institutional review board and all participants provided written informed consent.

Although the investigative studies are a deliberate process, a consensus has nevertheless been obtained. All participants were informed about research\220s aim and that the collected data was treated as anonymous and archived in adherence with data protection requirements. Although the setting did not require ethical approval, however, the authors wanted to ensure that the data was not considered to be of a sensitive or confidential in nature, that the issues being researched would not upset or bother the participants and that there was no risk of possible reporting obligations.

Statistical analysis

Data analysis was performed using a commercial statistical package (IBM-SPSS v.27) and an open-source software (R v.4.0.2 plus Core Team, 2020). For the descriptive analysis of the continuous variables, the main indices of position, dispersion and shape were calculated. Where relevant, standard errors and related 95% confidence intervals have also been reported. It was unknown whether the data distribution was normal or not; it was therefore decided to apply both non-parametric and parametric tests as the latter are more reliable

Table 1.
Population's demographics.

	N (%)
Gender	
Male	546 (65)
Female	294 (35)
Age (yrs.)	
<25	49 (5.8)
26-35	184 (21.9)
36-45	223 (26.5)
46-55	248 (29.5)
56-65	129 (15.4)
>65	7 (0.8)
Regional distribution (COVID-19 cases/100.000 habitants) ^a	
≥5000 (N=9 regions)	692 (82.4)
<5000 (N=13 regions)	148 (17.6)
Type of Health Professional	
Radiographer	806 (96)
Nurse	26 (3)
Other ^b	8 (1)
Type of workplace	
Academic hospital	55 (6.5)
Non-academic hospital	611 (72.7)
Private clinic	174 (20.7)

^a Population prevalence on August 31st, 2021 (survey closing date)

^b Includes physics, social health workers and hospital administrative staff.

since they are associated with a greater probability of being able to reject an erroneous statistical hypothesis. Both parametric tests (Student's t-test, ANOVA) and non-parametric tests (Kruskal-Wallis test) were used for quantitative group analyses comparisons between groups relating to continuous variables. Qualitative analyses were performed using the chi-square test and Fisher's exact test. Post-hoc test comparisons were obtained using the "rcompanion" R package with "fdr" (false discovery rate) correction for multiple comparisons. The results were considered statistically significant for a *p*-value below 5% (*p*<0.05).

Results

Demographics

A total of 840 people responded to the survey. Of these, 65% were males (93% ranging from 26 to 65yrs; 93%), prevalently radiographers (96%) and a minority were Nurses (3%). The majority work in non-academic hospitals (73%) from high-prevalence COVID-19 regions (82%) (Figure 1). In fact, HCW came from high- rather than low-prevalence regions (82% vs. 18%, respectively; *p*>0.05) (Table 1).

Management strategies and respondents' awareness

Overall, half respondents reported the activation of local protocols for the management of COVID-19 patients in their department, with Radiographer's involvement of 45%

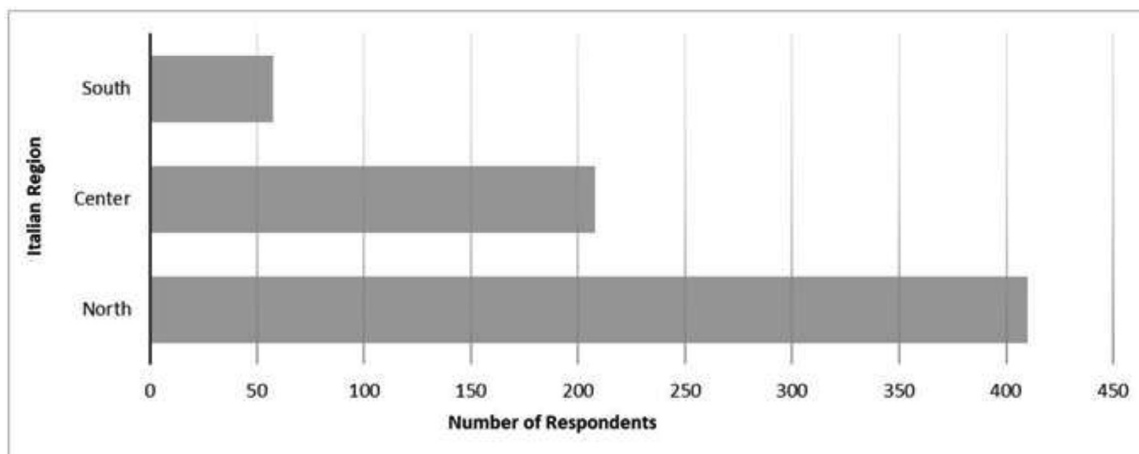


Fig. 1. Distribution of Responders according to the Italian regions most affected by COVID-19.

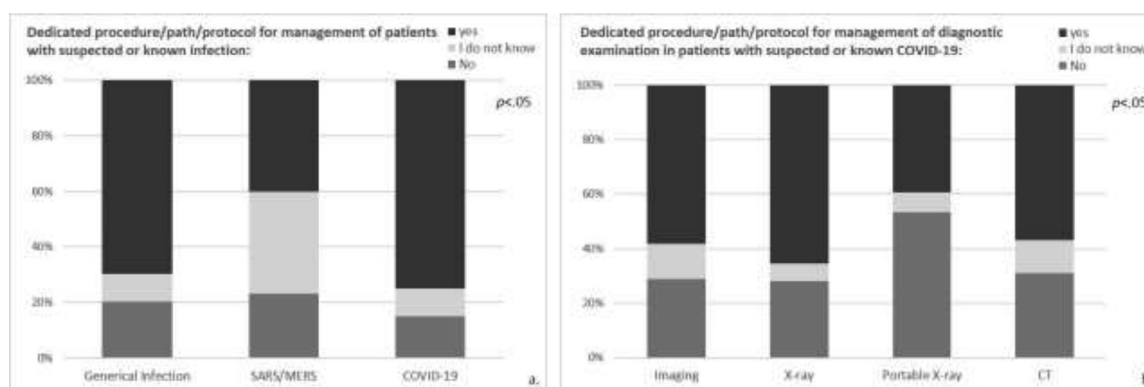


Fig. 2. Awareness of the existence of dedicated procedures for the management, recognition, and logistical isolation of infected patients, within the radiology department.

(Figure 2, a). Nevertheless, only 17% of hub hospitals had available guidelines for serious viral infections (epidemic/pandemic) before 2020.

Most respondents (72%) were aware of procedures for the management of patients with suspected or known (generic) infection and COVID-19, without exhaustive indication for plain film radiography and CT examinations (Figure 2, b). However, 52% of HCW tested, considered themselves capable to perform examinations on COVID-19 positive patients, knowing the correct donning/doffing procedure (62%). Finally, only 38% knew about the existence of protocols for the recognition and logistical isolation of SARS/MERS patients at their workplace.

Significantly higher scores were reported by HCW ($p < 0.05$) on the existence of separate operating instructions for patients with suspected or known COVID-19 into the unit (75%), corresponding to 62% and 53% for radiography and CT room, respectively, with a 57% in case of generically infection, for all diagnostic imaging (Figure 2, b). Only one third of hospitals assigned a dedicated X-ray room, mobile X-ray machine/s and CT scanner for COVID-19 positive patients ($p < 0.05$) (Figure 3).

Imaging and PPE

Among the tested population, the diagnostic examination in plain film X-ray (66%) and CT (58%) were performed by only one radiographer exclusively working in the COVID area.

Although most respondents (68%) confirmed that PPE were not readily available for all HCW at the workplace, 69% declared to wear all indispensable PPE in case of suspected or confirmed patients positive for COVID-19 ($p < 0.05$) (Figure 4). 68% wore two pairs of disposable gloves and fluid-resistant disposable gowns for the management and execution of diagnostic investigations in the case of a positive patient, using mostly FFP2 and FFP3 masks (40%).

After a COVID-19 exam, the diagnostic room was sanitized by a cleaning team for the 50% of cases, nevertheless, 48% of HCW did not know the name of the active ingredient used.

Discussion

Key results

This is the first study that examines the impact of COVID-19 on Radiology departments in Italy. The survey demon-

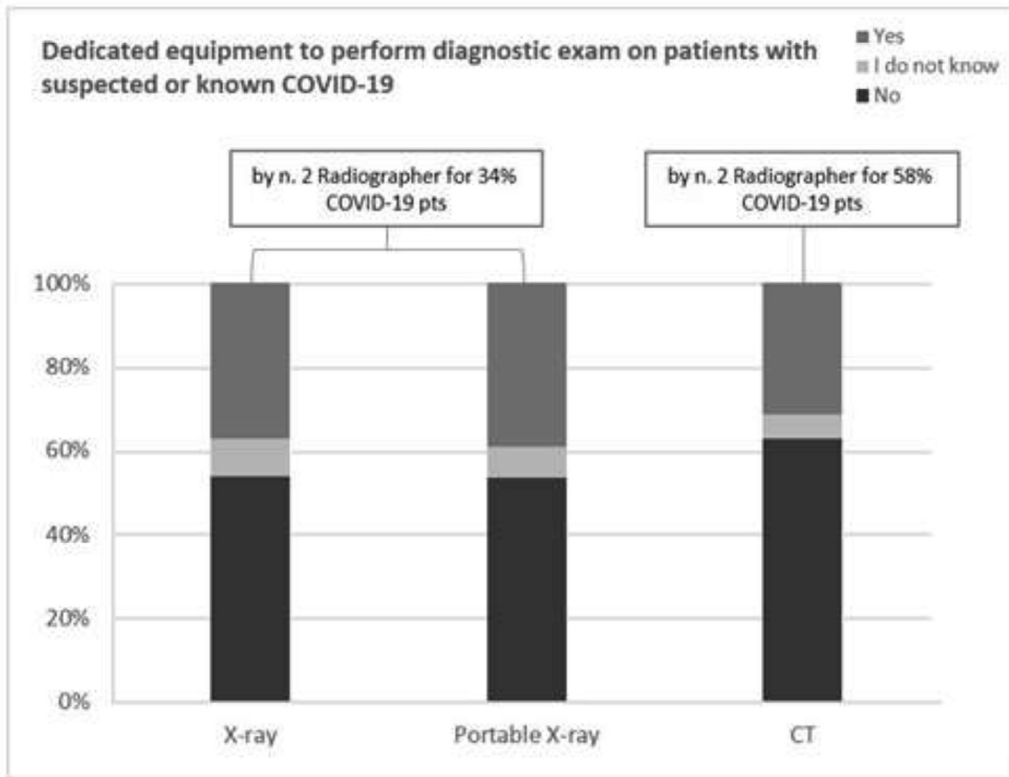


Fig. 3. Diagnostic investigations for patients with COVID-19. The responders considered themselves as capable of managing a COVID-19 exam for the 52%. The HCW tested know the correct dressing/undressing procedure for the 62%.

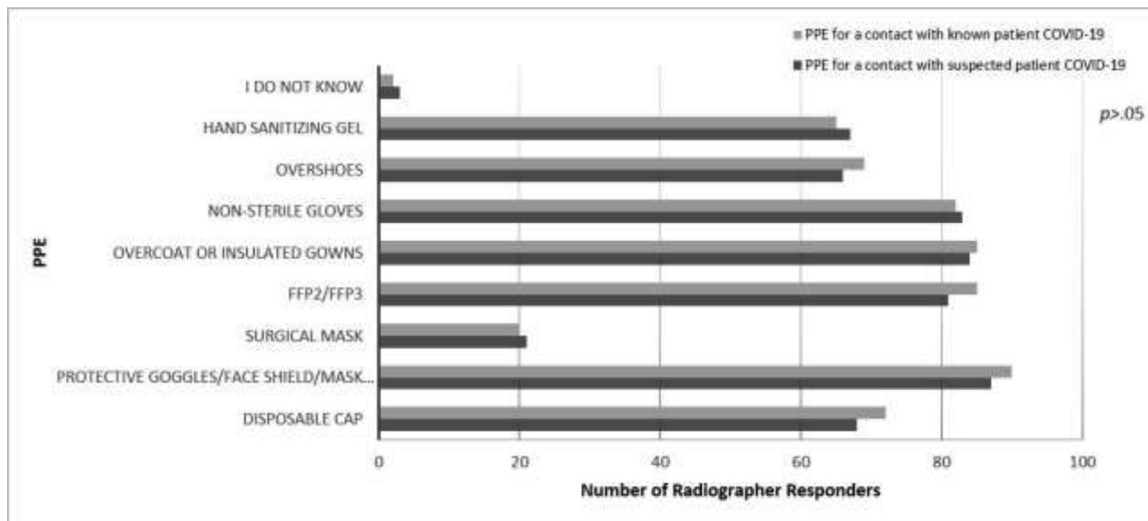


Fig. 4. Comparison between PPE to wear in case of patient with suspected or known COVID-19.

strated profound variations across high- and low-prevalence regions, especially between the perception and the reality in one's own working environment. Most respondents were radiographers, and the response rate (4%) was far higher than previously reported from surveys on HCW Italian population (i.e., usually not exceeding 2-3%).

Interpretation

General considerations In this survey-based study, we obtained the opinions of Italian radiographers (96% of the sample) regarding the risk they were exposed performing radiologic examinations during local early stages of the COVID-19 outbreak. Responses came from radiographers and other HCW in

many departments of Italian hospitals, as well as health maintenance organizations and private clinics, thus providing a heterogeneous and highly representative sample.

Differences between local application of guidelines It is very concerning that a very small number of hub hospitals had guidelines available for serious viral infections (epidemic/pandemic) before 2020 or that the guidelines were not even widespread among staff. Local protocols for the management of COVID-19 patients were activated, at the time of the survey, only in half of the wards with a non-homogeneous involvement of the professional figure of the radiographer, exposing healthcare workers to a greater biological risk in a time window where the national incidence of the pathology was very high and cases among health workers amounted to 11.5% of the total reported cases [12]. Although positioning documents were immediately issued by the scientific societies of the radiological area, the organizational fragmentation of the Italian health system made their application patchy. In a territory with the same prevalence of disease, exist several health companies that approach the application of operational recommendations in a different way. Even within the same health authorities, the different hospitals could adopt different measures. The explanation of this must first be sought in the contingent mission of each hospital unit; some were destined to welcome COVID-19 positive patients only occasionally while others were hubs where, during all phases of the pandemic, COVID departments with different intensity of care were provided.

Self-evaluation and finding information resources Most respondents believed themselves capable of managing donning/doffing procedures during a COVID-19 patient's examinations, also thanks to the numerous written and video resources made available by mass media and social media. Often, there were no specific exhaustive operative instructions for plain film radiography and CT diagnostics. This could be attributed to the lack of involvement of this professional profile in their editing or to the underestimation of the biological risk in the radiological environment compared to other healthcare contexts.

Radiological equipment The shortage of equipment to dedicate exclusively to radiological investigations on COVID-19 patients has probably led to a limit in ensuring separate diagnostic pathways, an increase in examination timings due to the necessary sanitization and a greater frequency of donning/doffing cycles during the same shift.

Equipment setting and psychological distress We showed that in most cases the radiographer worked alone in the covid area, although the recommendations indicate at least 2 operators [14]. This led to the use of the PPE uniform for several hours continuously to protect the health of the operator, with a consequent reduction in comfort that could have resulted in a state of psychological distress.

Use of PPE At the time of the survey, March – May 2020, most Radiographers reported using PPE during the visits of COVID-19 suspected or positive patients. The personal protective equipment made available was heterogeneous and considered insufficient for all the healthcare workers present during

the examinations; this reflects the global difficulty in procuring PPE during the first pandemic wave.

Study limitations There are several limitations to this study. Firstly, due to the rapid unfolding of events related to an increasing local number of individuals with COVID-19 infection, the operative setting of the various radiological services changed rapidly. Secondly, the number of respondents was very high if compared with the total Italian population of active Radiographers during the pandemic [13].

Implications for practice

- The implementation of dedicated diagnostic protocols for serious infections in clinical practice
- The implementation of diagnostic referral processes for health emergencies
- Including healthcare professionals at the forefront of developing guidelines or proposing local or national recommendations
- Enable healthcare professionals to work with full awareness

Conclusion

The primary objective of management strategies should be to undertake a standardization of policies to safeguard both patients and operators' health and safety. Managers must be liable for finding and transmitting information and documents, whether internal or external to the organization, useful for carrying out the activity safely to all staff. This study demonstrates why all healthcare workers on the front line, as well as radiographers in the diagnostic pathways, should be involved in the decision-making process. In order to generate a sense of well-being and awareness among workers (and reduce the risk for patients), it is necessary to sensitize the top management of healthcare organizations to introduce specific procedures for diagnostic settings. Even if the emergency nature of the still ongoing pandemic is universally recognized, it is nevertheless necessary to set up a working environment that facilitates the timely modification of diagnostic paths and not to be unprepared for future similar circumstances.

Acknowledgments

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jmir.2022.02.006](https://doi.org/10.1016/j.jmir.2022.02.006).

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