



## ORIGINAL ARTICLE

# Australian radiographers' and radiation therapists' experiences during the COVID-19 pandemic

Madeleine C Shanahan, DipAppSc, BEd, MAppSc, PhD,<sup>1</sup>  & Theophilus N Akudjedu, BSc(Hons), MSc, PhD<sup>2</sup> 

<sup>1</sup>Discipline of Medical Radiation Science, Faculty of Health, University of Canberra, Bruce, ACT, Australia

<sup>2</sup>Institute of Medical Imaging & Visualisation, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth, UK

## Keywords

COVID-19, pandemic, PPE, radiation therapist, radiographer, stress

## Correspondence

Madeleine Shanahan, Faculty of Health, University of Canberra, 11 Kirinari Street, BRUCE, ACT, Australia.  
Tel: +61 2 62068521; E-mail: madeleine.shanahan@canberra.edu.au

Received: 17 October 2020; Revised: 27 January 2021; Accepted: 27 January 2021

*J Med Radiat Sci* **68** (2021) 111–120

doi: 10.1002/jmrs.462

## Abstract

**Introduction:** Radiographers and radiation therapists are key patient-facing health practitioners supporting the delivery of optimal patient care during the COVID-19 pandemic. The aim of this research was to investigate the impact of COVID-19 on clinical service delivery and well-being of these healthcare professionals in Australia. **Methods:** A cross-sectional online survey of Australian radiographers and radiation therapists was conducted in June–July 2020. The survey collected data on demographic characteristics, and the impact of COVID-19 on professional practice, infection control and workplace-related stress. **Results:** A total of 218 responses were received. Changes in work hours ( $P < 0.001$ ) and workload ( $P = 0.022$ ) were experienced due to COVID-19. Diagnostic radiographers reported increased procedural pressure on mobile radiography, computed tomography and general radiography. For radiation therapists, most pressure included areas of simulation and linear accelerator. PPE was in short supply at the start of the pandemic, and at the time of the study, shortages were identified for all PPE items. There was no difference in PPE supply reported by diagnostic radiographers and radiation therapists except for hand sanitiser ( $P = 0.003$ ). Respondents experienced increased personal stress (61.4%) and anxiety (58.2%) at work due to COVID-19. In addition, their work caused increased stress to their family, partners or friends (57.4%). **Conclusions:** COVID-19 has resulted in changes to clinical working patterns and service delivery. PPE shortages, as well as increased workplace-related stress, were identified. Workplaces should seek to mitigate the pandemic impact through the provision of adequate PPE for safe practice as well as implement strategies to support and enhance staff well-being.

## Introduction

Diagnostic radiographers and radiation therapists are ranked as high-risk of contracting COVID-19.<sup>1</sup> This high-risk rating was assigned due to physical proximity to patients required by diagnostic radiographers and radiation therapists to perform their work and exposure to disease or infection in the work environment. Due to the nature of work which involves direct and often extended time in contact with patients, physical distancing, whilst recommended where possible for health workers,<sup>2</sup> was described as 'not possible to maintain'<sup>3</sup> for diagnostic radiographers and radiation therapists. As a

result, professional societies have recognised the importance of the adequate provision of personal protective equipment (PPE) for these professional groups to decrease the risk of contracting COVID-19.<sup>3–5</sup> Governments have been called on to ensure that PPE is available to both public and private radiology to ensure the continuity of service throughout the pandemic.<sup>6</sup>

The New South Wales Clinical Excellence Commission<sup>2</sup> describes the best practice management of COVID-19 in healthcare settings. The PPE recommendation from this authority for radiology settings with suspected or confirmed COVID-19 cases is as follows: single-use disposable gloves, single/extended use of surgical masks

that are fluid resistant, plastic apron or fluid-resistant or isolation gown and eye protection. PPE has been reported to be insufficient to meet the needs of Australian healthcare professionals during COVID-19 pandemic.<sup>7,8</sup> It is therefore important to investigate the accessibility of PPE to Australian diagnostic radiographers and radiation therapists.

Diagnostic radiography has an important role in patient investigation and management pathways. The increased use of chest radiography and computed tomography of the chest during COVID-19 pandemic has been recognised.<sup>9</sup> In addition, increased use of mobile equipment is recommended to reduce transmission risk.<sup>10</sup> Within radiation therapy deep cleaning of shared treatment equipment, and treatment interruptions for patients who test positive for COVID-19 as well as for immunocompromised patients that require isolation, precautions must be managed.<sup>11</sup> These changes in work practices may increase complexity and duration of examinations and increase occupational stress, which has previously been described as high for both radiographers and radiation therapists.<sup>12-14</sup> The aim of this research was to assess the perceptions of Australian diagnostic radiographers and radiation therapists on the impact of the COVID-19 pandemic on their practice. This study was part of a larger research project, originating in the United Kingdom (UK), to obtain a more global perspective of the clinical radiography workforce in relation to the COVID-19 pandemic.<sup>15</sup>

## Material and methods

The project was approved by the Human Research Ethics Committees at Bournemouth University (31818) and University of Canberra (2020-4584).

### Study design

A cross-sectional online survey design was utilised. Quantitative and qualitative data were collected through Qualtrics™ (Provo, UT). The questionnaire was developed and pilot tested by a team of academic radiographers.<sup>15</sup> The questionnaire consisted of four key sections: (1) participant demographics, (2) impact of the pandemic on professional practice and workload, (3) infection prevention and control and (4) COVID-19-related stress. To reflect the Australian context, some questions were modified, including replacing the term radiographer (used in the UK to describe both diagnostic and therapeutic radiographers), with radiographer and radiation therapist, and to obtain more specific information regarding the accessibility of PPE.

Clinically practising Australian radiation therapists and diagnostic radiographers were invited to participate in the

study, anonymously via online survey. The introduction to the survey provided participants with information outlining the aims, requirements and confidentiality of the study. Informed consent was obtained in the first item of the online survey, with respondents able to exit at this point if they so preferred. A link to the survey was distributed through email invitation to personal contacts and via e-blast to members of the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) on 24 June 2020. As the link to the survey was electronic, further distribution of the survey link by email or e-blast recipients may have occurred. The survey closed on 15 July 2020.

### Sample size

Using the total population of individuals who held membership with ASMIRT (7054)<sup>16</sup> as this was the primary survey distribution method, 95% confidence level, and a 5% margin of error, the total sample size of 365 was required.<sup>17</sup> To determine if a generally representative sample was achieved, demographic data of the sample were compared to registrant demographic data from the Medical Radiation Practice Board of Australia (MRPBA).<sup>18</sup>

### Data analysis

Data were uploaded to IBM SPSS Version 25 (IBM, Armonk, NY). Descriptive and inferential statistics were used to analyse the data. Percentages were utilised to describe the overall number of practitioner responses to key variables, with reported percentages based on the number of respondents answering each question. The collected demographic data allowed for cross-tabulations to determine if associations existed. Differences between groups were examined using chi-square analysis, and where cell size was less than 5, Fisher's exact test was utilised.<sup>19</sup> A *P*-value less than 0.05 was the level for statistical significance used throughout the analysis. Content analysis was performed for free-text comments provided by respondents, with key themes provided by the predetermined categories of the questionnaire.

## Results

### Response rate and demographics

This survey recorded 218 valid responses. Data on the demographics of respondents are presented in Table 1. The majority of respondents were diagnostic radiographers (81.2%). Seven participants were not in clinical roles and this excluded them from continuing with the questionnaire. Diagnostic radiographers were

**Table 1.** Demographic characteristics of the participants ( $N = 218$ ).

Characteristic	Frequency	Percent
Gender ( $N = 218$ )		
Male	56	25.7
Female	160	73.4
Prefer not to say	2	0.9
Age ( $N = 218$ )		
Under 29 years	52	23.9
30–39 years	69	31.7
40–49 years	47	21.6
50–59 years	34	15.6
Above 60 years	16	7.3
Primary profession on AHPRA register ( $N = 218$ )		
Radiographer	177	81.2
Radiation therapist	41	18.8
Temporary register	0	0.0
Working in a clinical role during pandemic ( $N = 218$ )		
Yes	207	95.0
No	11	5.0
Primary employer ( $N = 206$ )		
Public health sector	165	80.1
Private health sector – large/corporate	32	15.5
Private health sector – small independent	9	4.4
Geographical Location ( $N = 206$ )		
Metropolitan	120	58.3
Regional	55	26.7
Rural	31	15.0
Years employed in primary role ( $N = 206$ )		
Less than 1 year	16	7.8
1–5 years	43	20.9
6–10 years	41	19.9
11–15 years	39	18.9
16–20 years	21	10.2
More than 20 years	46	22.3

added to the AHPRA pandemic sub-register from 20 April 2020.<sup>20</sup> No survey participants were identified as being on the AHPRA sub-register. The majority of participants (80.1%) were employed in the public health sector, working in a metropolitan location (58.3%) and had worked for 11 or more years in their primary role (51.4%). The representativeness of the study sample was assessed using MRBPA published data for medical radiation practitioners (MRPs).<sup>18</sup> This data includes nuclear medicine technologists, as well as registrants holding provisional and non-practising registration types. Where possible data comparison was made to practitioners holding full registration.

### Impact of COVID-19 on professional practice

Change in work hours and workload due to COVID-19 as well as the expected change in radiation dose was explored. The majority of respondents (132/188; 70.2%) reported no change in their working hours. Responses for

radiographers and radiation therapists are shown in Figure 1. The difference in working hours across the professional group was evident (Fisher's Exact Test = 7.232,  $P = 0.022$ ) with no (0%) radiation therapists reporting a decrease in work hours. Twenty (out of 36; 56%) diagnostic radiographers employed in the private health sector reported that their working hours decreased during COVID-19 pandemic, compared to 5 (out of 120; 4%) of their colleagues employed in the public sector ( $\chi^2 = 54.343$ ,  $df = 2$ ,  $P < 0.001$ ). Respondent free-text comments include the following:

*All staff were forced to take two weeks off around April.*

(Respondent ID: 186, Private Health Sector employee)

*Lost shifts – as private company with less patients attending due to COVID shutdown and public advice to stay home.*

(Respondent ID: 61, Private Health Sector employee)

Change in clinical workload pattern was more evident for diagnostic radiographers than radiation therapists (Fig. 1). Forty-one percent (13/32) of radiation therapists reported no change in clinical workload pattern compared to 14.7% (23/156) of diagnostic radiographers (Fisher's Exact Test = 17.633,  $P < 0.001$ ). Comments by diagnostic radiographers provided insight into change in their clinical workloads.

*Less clinics and booked cases but more ED mobile work? COVID cases.*

(Respondent ID:136)

*Very busy with COVID related Mobiles (donning and doffing takes up a lot of time), COVID protocols in OT as well (dedicated theatres with equipment shielding plastics in place), decrease in elective surgery and outpatients presenting to the department for plain imaging and fluoroscopy.*

(Respondent ID:126)

*More cleaning work and less staff due to social distancing in small workplaces has placed extra strain on staff. Students on placement were ceased, and they were a valuable asset to the company offering a lot of help.*

(Respondent ID:82)

Forty-three (out of 155; 27.7%) diagnostic radiographers expected their personal radiation dose to increase due to changed workload, work hours, or protocols during COVID-19 (Fig. 1), compared to 1 (out of 31; 3%) of their radiation therapy colleagues (Fisher's Exact Test = 14.131,  $P < 0.001$ ). One-third of diagnostic radiographers employed in the public sector (41/119; 34.5%) expected their personal radiation dose to increase due to COVID-19 workplace practice changes compared

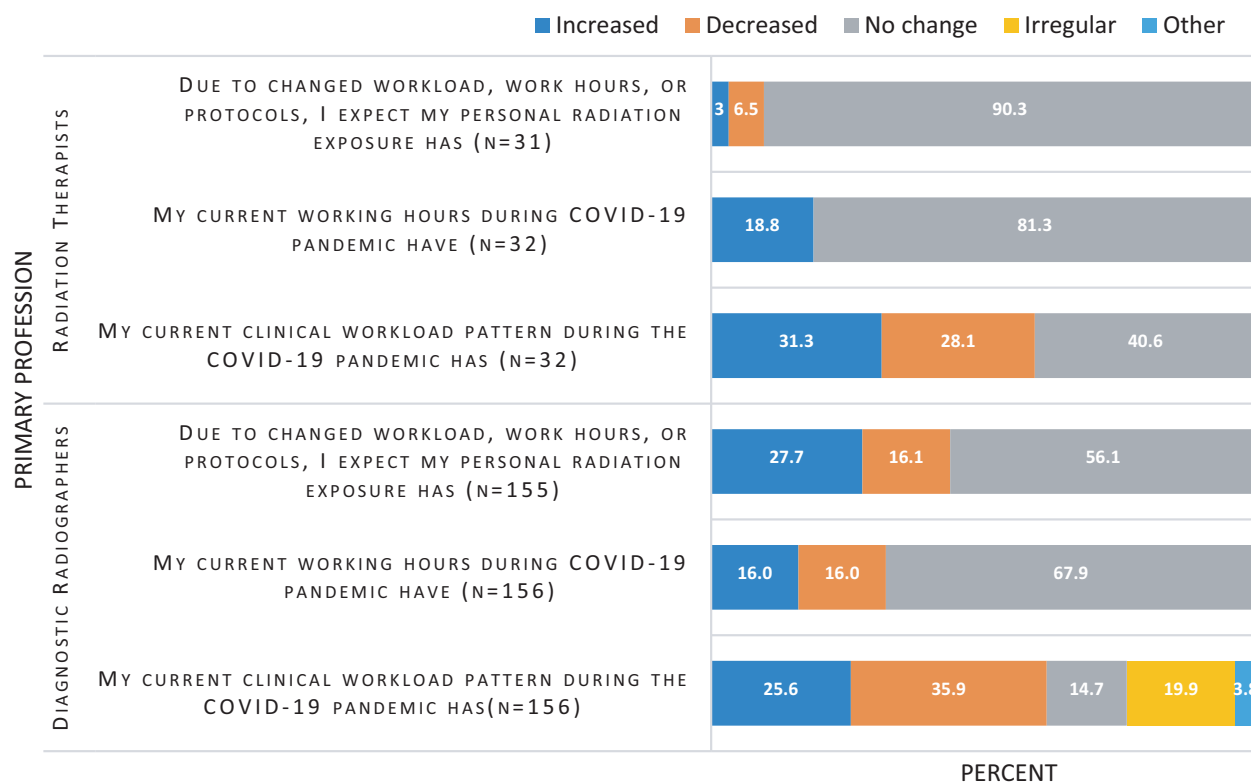


Figure 1. Change in work within diagnostic radiography and radiation therapy practice due to COVID-19.

to 2 (out of 36; 5.6%) employed in the private sector ( $\chi^2 = 19.969$ ,  $df = 2$ ,  $P < 0.001$ ).

The majority of diagnostic radiographers reported most pressure in their facility (Fig. 2) due to COVID-19 on mobile radiography (113/141; 80.1%), computed tomography (99/139; 71.2%) and general radiography (79/144; 54.9%). For radiation therapists (Fig. 2), most pressure was reported in the areas of simulation (14/26; 53.8%) and linear accelerator (13/28; 46.4%).

Local protocols for initial investigation of COVID-19 patients reported by diagnostic radiographers included mobile radiography ( $n = 114$ ), general/planar radiography ( $n = 88$ ), computed tomography ( $n = 58$ ) and ultrasound ( $n = 6$ ). For follow-up investigation of COVID-19 patients, local protocols included computed tomography ( $n = 82$ ), general / planar radiography ( $n = 68$ ), mobile radiography ( $n = 51$ ), ultrasound ( $n = 13$ ), angiography ( $n = 8$ ), MRI ( $n = 8$ ), fluoroscopy ( $n = 6$ ) and ultrasound ( $n = 6$ ).

### Infection control

Respondents were asked about their understanding of COVID-19 transmission, infection control, availability of PPE and their perspective of being frontline healthcare

workers (Fig. 3). All but one respondent, *strongly agree* (111/189; 58.7%) or *agree* (77/189; 40.7%) that they understood the methods of COVID-19 transmission. The vast majority either *strongly agree* (117/189; 61.9%) or *agree* (67/189; 35.4%) that their current understanding of infection prevention principles and control was adequate to protect themselves and their patients during the COVID-19 pandemic. Physical distancing within the workplace was problematic, as the majority of respondents *strongly disagree* (37/189; 19.6%) or *disagree* (75/189; 39.7%) that these requirements are easily met in the workplace. The majority of respondents *strongly agree* (64/189; 33.9%) or *agree* (90/189; 47.6%) that access to PPE was adequately available at the workplace to safely perform their job in the current stage (June–July, 2020) of COVID-19 in Australia. However, adequate access to PPE was less in the initial stage of COVID-19 in Australia and there was less confidence there would be adequate PPE if a future rapid surge in COVID-19 cases occurred. Ninety-five percent of respondents *strongly agree* (146/188; 77.8%) or *agree* (33/188; 17.5%) that they are a part of the major frontline healthcare management team in response to COVID-19. Eight radiation therapists (out of 32; 25%) either were neutral (3/32; 9%) or disagreed (5/32; 16%) with this statement.

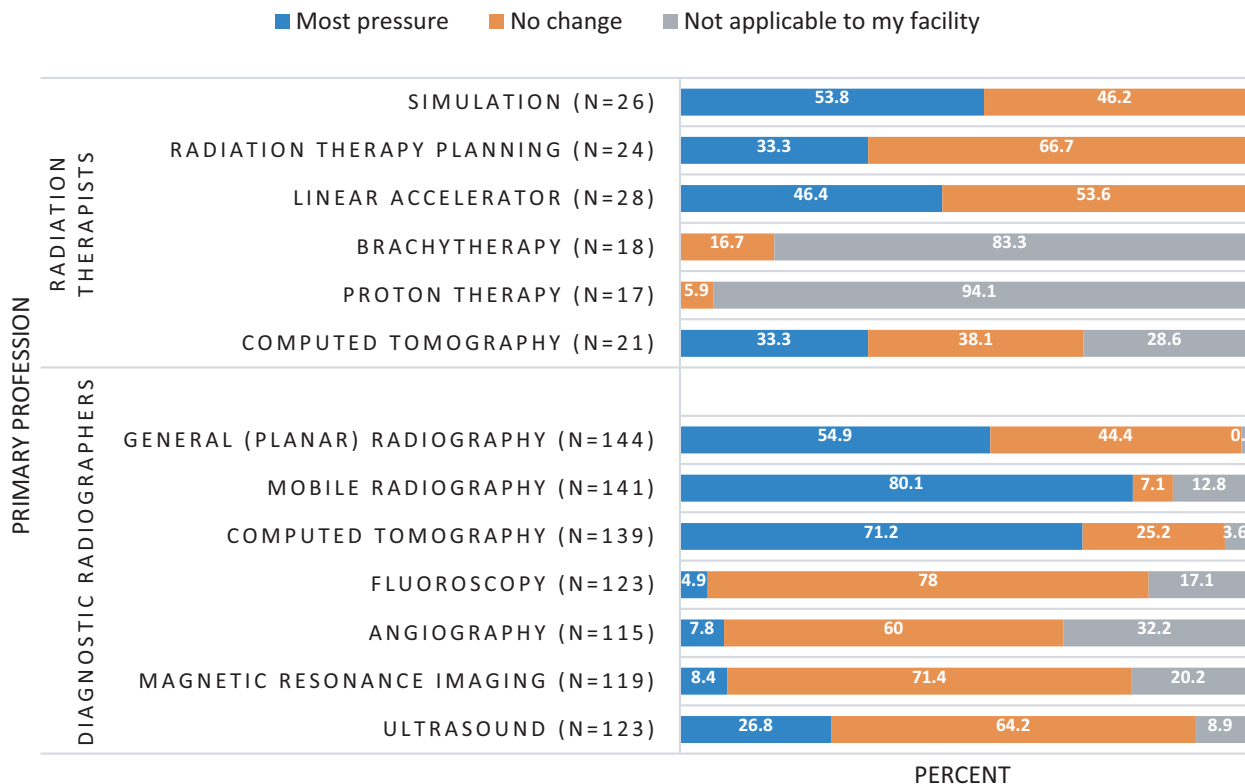


Figure 2. Procedural pressure of COVID-19 on working areas within diagnostic radiography and radiation therapy practice.

Fig. 4 identifies the supply level of PPE. Reported shortage of supply exists for all listed items. Disposable gloves were reported to be in adequate supply by the majority of respondents (172/188; 91.5%). Twenty percent or more of respondents indicated gowns (50/188; 26.5%), plastic aprons 38/188; 20.2%), goggles 48/188; 25.8%), face masks (65/188; 34.6%), face shields (75/188; 40.3%) and hand sanitiser (56/188; 29.8%) were in short supply. There was no difference in PPE supply reported by diagnostic radiographers and radiation therapists except for hand sanitiser, with 52% (16/31) radiation therapists reporting it was in short supply compared to 25% (39/156) of diagnostic radiographers ( $\chi^2 = 8.822$ ,  $df = 1$ ,  $P = 0.003$ ). Plastic aprons were reported to be in short supply by practitioners in rural (9/29; 31%) and regional (15/50; 30%) workplaces compared to their colleagues in metropolitan location (14/109; 12.8%, Fisher's Exact Test = 10.869,  $P = 0.023$ ). Comments highlight lack of supply, theft and PPE being locked away as contributing to the perceived shortages.

*Stock going missing due to theft. Less access to hand sanitiser and cleaning wipes/solution than there was prior. Needing to*

*ask permission to access a face mask when required. Not timely enough.*

(Respondent ID:107)

*PPE is locked away. Not quickly accessible if there is a sudden increase in demand during a shift.*

(Respondent ID:121)

### COVID-19-related stress

The perceived impact of COVID-19 on stress is provided in Figure 5. Over half of respondents reported that they are experiencing increased personal stress (116/189; 61.4%) and anxiety (110/189; 58.2%) at work due to COVID-19. In addition, 108 (out of 188; 57.4%) respondents reported that their work was causing increased stress to their family, partners, or friends. Comments from respondents identified stressors that related to isolation, uncertainty and lack of professional recognition.

*Making the decision to not see my parents or grandparents to protect them has mentally been so hard.*

(Respondent ID: 96)

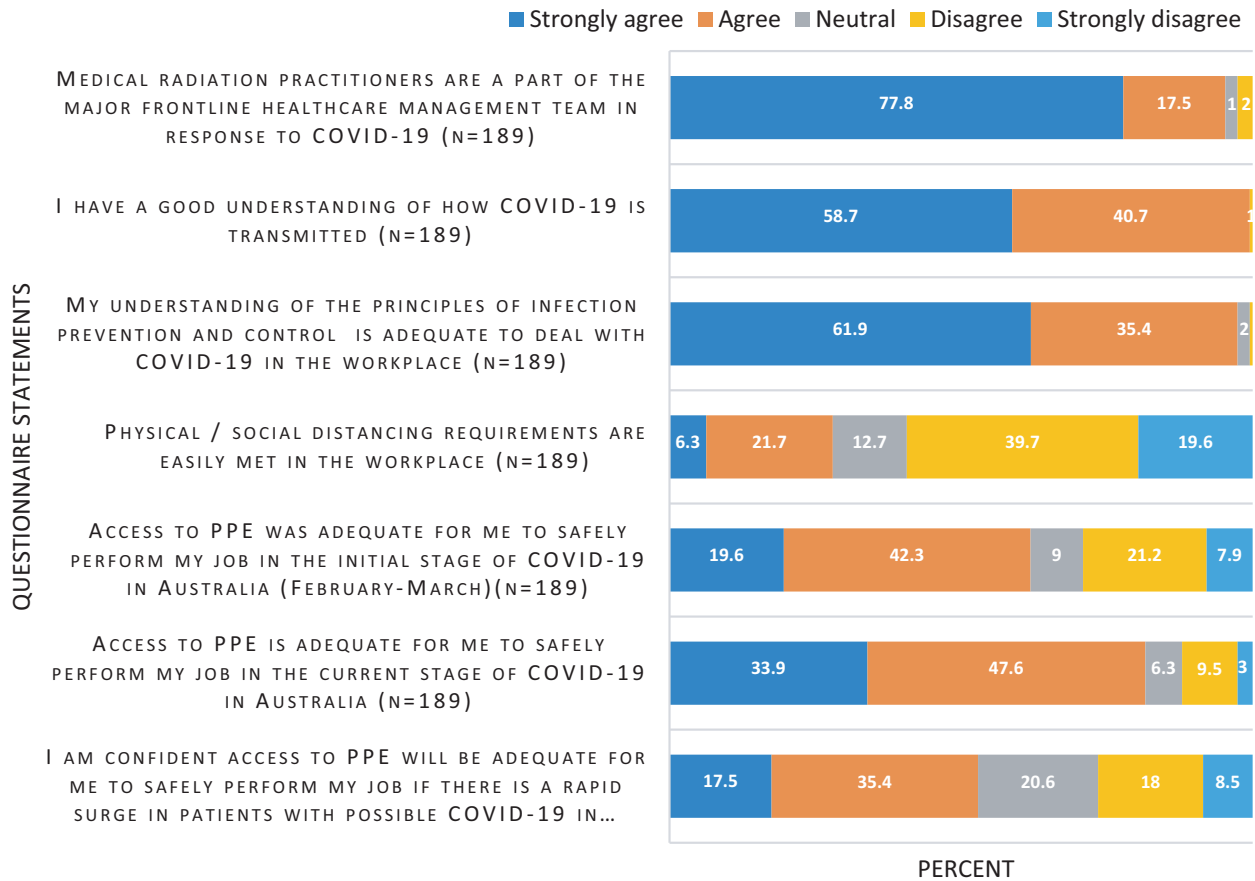


Figure 3. Infection transmission, infection control and PPE for COVID-19 (all respondents).

*I have felt increased stress and pressure as I am also pregnant and there was not much knowledge of the side effects upon pregnant patients.*

(Respondent ID:127)

*We are the forgotten front line. All anyone can talk about is the nurses and doctors and how hard it is for them... We however will see every single covid patient multiple times throughout their stay- from when they first come in, if they go to ICU, the ward etc. ... I think that is the thing that has upset me the most during all of this. The lack of acknowledgement that my profession exists.*

(Respondent ID:140)

The majority of respondents (78.8%; 149/189) decided not to self-isolate from other members of their household.

*Early on, I had made plans to self-isolate from my family, but it turned out not to be as bad as we thought. But that thought is still there if cases ramp back up.*

(Respondent ID:143)

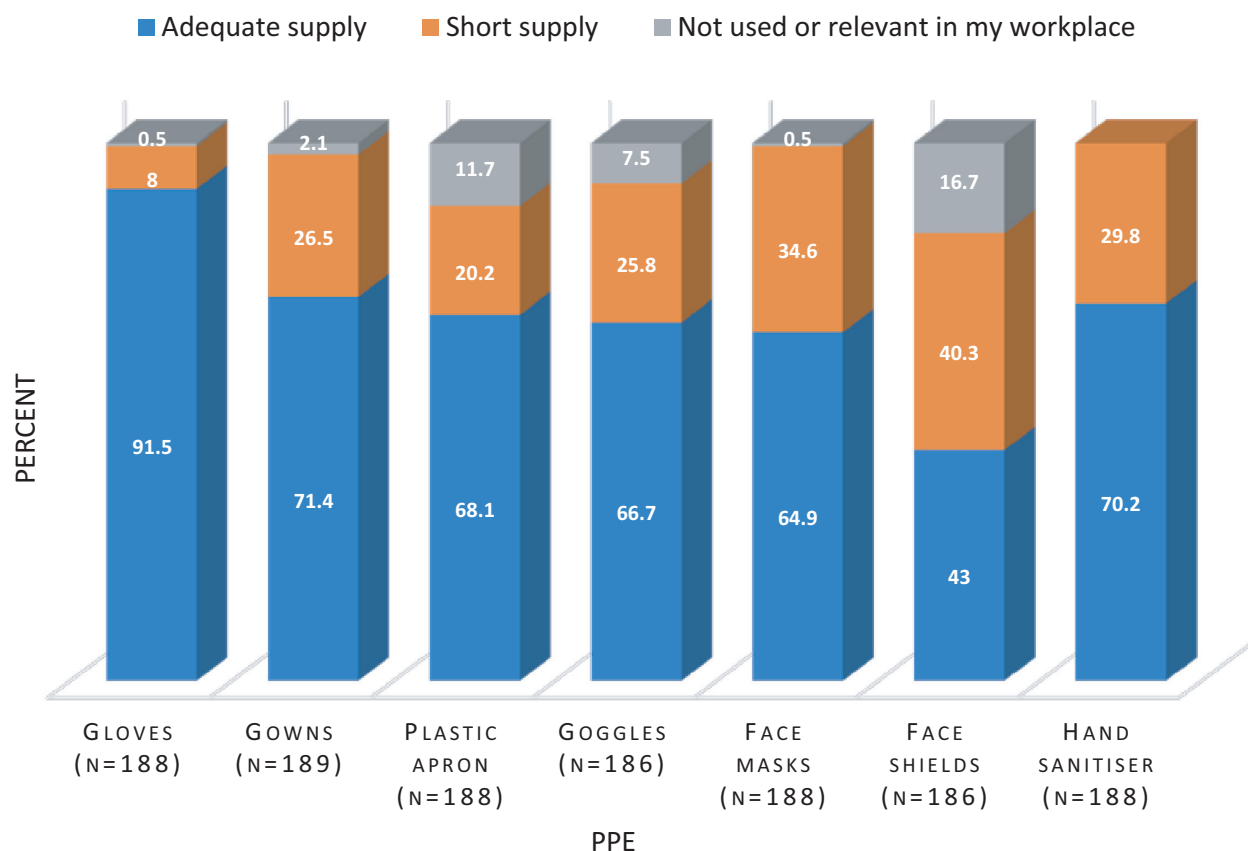
*I haven't physically self-isolated from members of my household as we are all frontline healthcare workers, and decided it was best for our mental health and wellbeing to have a sense of normalcy at home, it gives us an opportunity to debrief and bond over these challenging times.*

(Respondent ID:126)

Approximately half of the respondents (102/188; 54.3%) reported that their workplace provided adequate social and psychological supports for dealing with stress related to COVID-19.

### Discussion

To the best of the authors' knowledge, this study is the first to survey Australian radiation therapists and radiographers on the perceived impact of the COVID-19 pandemic on their practice. The demographic data showed that the age group of respondents in this study is similar to national data for MRPs holding full registration (Fig. 6).<sup>18</sup> The percent of this study's respondents who identified as female



**Figure 4.** Supply of PPE in COVID-19 (all respondents).

71.7% is similar to published national data of 68.1%.<sup>18</sup> The percent of radiographers (81%) and radiation therapists (19%) in this study (Table 1) approximates national data (85%, 15%, respectively).<sup>18</sup> These findings suggest that the sample is representative of Australian MRPS.

Medical imaging has a key role in the diagnosis and management of patients severely impacted by COVID-19.<sup>21</sup> Patients with cancer must continue to receive life-saving radiation therapy treatment during the pandemic,<sup>22</sup> involving immunocompromised patients, as well as managing treatment pauses or delayed treatment starts if patients test positive to COVID-19.<sup>11</sup> Almost all respondents (95.5%) strongly agree or agree that medical radiation practitioners are essential frontline staff in the management of COVID-19 patients, which is similar<sup>23</sup> to or higher<sup>15</sup> than that reported by international colleagues.

Patterns of work changed during the pandemic. Diagnostic radiographers reported an increase in mobile radiography which is consistent with recommended practice to decrease disease transmission.<sup>10,21</sup> Infection control requirements increased the length of time and complexity of procedures. These findings are consistent with those reported from the UK.<sup>15</sup>

Management of suspected or confirmed COVID-19 patients in patient-facing environments requires strict adherence to PPE and infection control protocols.<sup>24-26</sup> The vast majority of Australian radiographers and radiation therapists reported to have good knowledge of disease transmission and infection control principles to deal with COVID-19 outbreak. The levels reported in the current study exceed those reported by international colleagues.<sup>15,23</sup> For example, 97% of Australian respondents agreed or strongly agreed that their understanding of the principles of infection prevention and control was adequate to deal with COVID-19 in the workplace, compared to 62.5% of colleagues in the UK.<sup>15</sup> This may reflect the earlier timing (April-May) of the UK study,<sup>14</sup> as well as workplace strategies including mandatory PPE training<sup>27</sup> adopted in Australia to support staff successfully implement infection control practices in the pandemic. With respect to PPE, at the time of the study (June–July 2020), the majority of respondents reported that PPE in the workplace was adequate to safely perform their job. However, shortages were also reported for all PPE items investigated in this study (Fig. 5). Respondents expressed uncertainty that adequate PPE would be available if there was a future surge

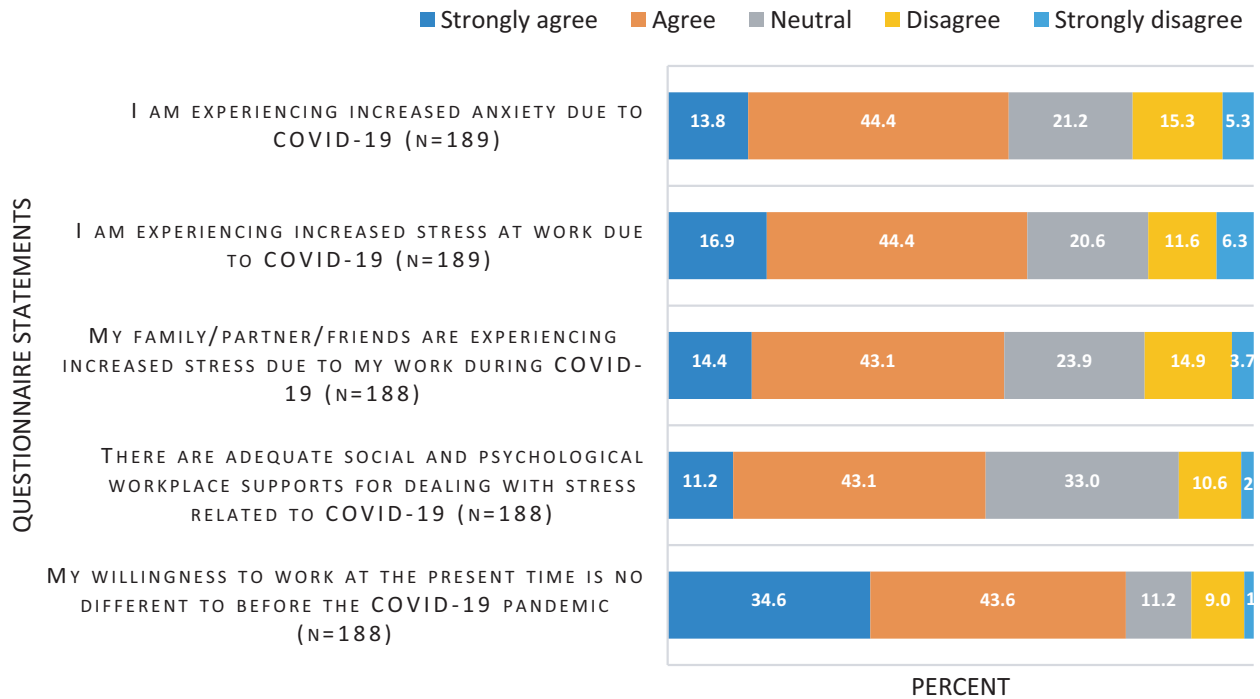


Figure 5. COVID-19-related work-related stress (all respondents).

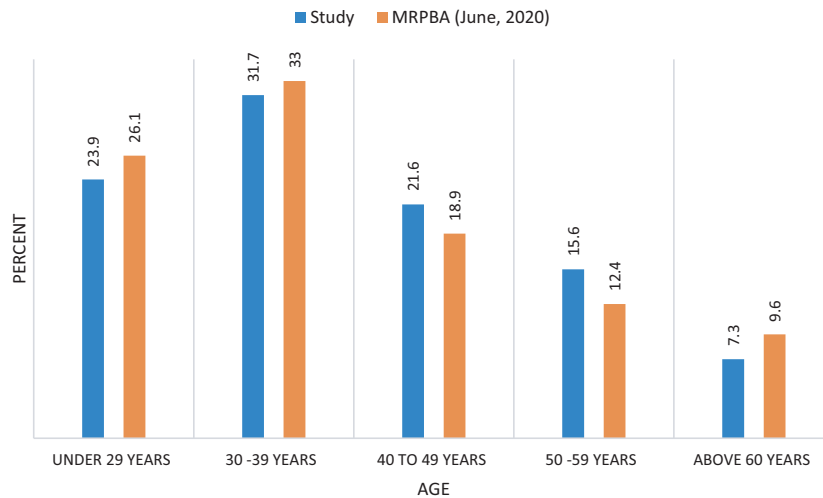


Figure 6. Comparison of age groups of respondents in this study to national data for medical radiation practitioners.<sup>18</sup>

in COVID-19 cases. In the Australian state of Victoria, a second wave of COVID-19 which peaked 7 August 2020<sup>28</sup> resulted in an increased number of workplace acquired COVID-19 infected health professionals.<sup>28,29</sup> Health professionals continue to raise concerns that PPE supplies were insufficient.<sup>28</sup> This suggests that PPE concerns of radiographers and radiation therapists expressed in this study were warranted.

COVID-19 has presented a working environment characterised by major changes in work practices for Australian radiographers and radiation therapists.<sup>27,30</sup> This is likely to have contributed to the perceived general increase in workplace-related stress due to COVID-19 reported by respondents in this study. Increased workplace-related stress due to COVID-19 was reported by radiographers and radiation therapists in the UK<sup>15</sup> and



Middle East, North Africa and India.<sup>23</sup> Workplaces in Australia have adopted a range of strategies to support the well-being of radiographers and radiation therapists. These included prioritising safety of vulnerable staff by encouraging working from home,<sup>30</sup> redeployment to a lower risk work area or taking leave,<sup>27</sup> daily communication with all staff,<sup>27</sup> regular check-in with staff working from home,<sup>30</sup> CARE Champions,<sup>30</sup> and virtual morning teas and after work drinks.<sup>30</sup> Approximately half (54.3%) of respondents in this study *strongly agree* or *agree* that there are adequate psychosocial support structures at work. This is higher than that reported by their colleagues (37.4%) in the UK<sup>15</sup> and similar to data (52.5%) from Middle East, North Africa and India.<sup>23</sup> It is therefore important that successful strategies are shared and implemented to mitigate the impact of COVID-19 on the well-being of radiographers and radiation therapists. In addition, it is recommended that future research include short- and long-term follow-up and evaluation of COVID-19 workplace support interventions as well as workplace-related stress.

Governments in Australia and internationally prepared a surge workforce of health professionals to manage the pandemic by including students and retired health practitioners onto a temporary register. International studies have reported student and retired radiographers contributing to the pandemic surge workforce.<sup>15,23</sup> This demonstrates that internationally, radiographers on the temporary register were utilised during the pandemic to provide additional diagnostic capacity. No radiographers on the sub-register were respondents to this survey. It is not known if any of the Australian radiographers on the temporary register<sup>20</sup> were deployed during the timeframe of this study to provide additional diagnostic capacity.

A number of limitations are associated with this study. Firstly, the sample size was small. The current study achieved 60% (218/365) of the required minimum sample,<sup>17</sup> and in particular as few radiation therapists responded to the survey results must be interpreted with caution. The small sample size (6–7% margin of error) may reflect the challenging time during which the study was conducted, that is during a pandemic. Secondly, the study made use of self-report data such as changes in procedural volumes of the various imaging modalities and expected change to radiation dose rather than quantifying actual change.

## Conclusion

This survey has highlighted the important patient-facing role of radiographers and radiation therapists during the COVID-19 pandemic. COVID-19 has resulted in changes to clinical working patterns and service delivery. PPE shortages, as well as increased workplace-related stress,

were identified. Workplaces should seek to mitigate the pandemic impact through the provision of adequate PPE for safe practice as well as implement strategies to support and enhance staff well-being.

## Acknowledgements

We would like to thank all the radiographers and radiation therapists who took time from their busy schedules during the COVID-19 pandemic to take part in this study. The study team also would like to thank the Australian Society of Medical Imaging and Radiation Therapy for the support provided in distribution of the survey.

## Conflict of Interest

The authors declare no conflict of interest.

## References

1. Tableau Public. COVID-19 occupation risk assessment – by major occupational group; Available from: <https://public.tableau.com/profile/occupation.and.industry.analysis#!/vizhome/COVID19OccupationRiskAssessmentTop200EmployingOccupationsbyIndustry/Dashboard1> (28 September 2020).
2. NSW Government Clinical Excellence Commission. Infection prevention and control: management of COVID-19 in healthcare settings. Version 3.2 11 May 2020; Available from: [http://www.cec.health.nsw.gov.au/\\_\\_data/assets/pdf\\_file/0006/567987/Infection-control-nCoV-2019-Hospital-Setting-V2-.pdf](http://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0006/567987/Infection-control-nCoV-2019-Hospital-Setting-V2-.pdf) (28 September 2020).
3. Australian Society of Medical Imaging and Radiation Therapy (ASMIRT). ASMIRT position statement. Personal protective equipment for medical radiation practitioners during the COVID-19 pandemic. Medical imaging and radiation therapy access to PPE 2020; Available from: <https://www.asmirt.org/media/2205/2205.pdf> (28 September, 2020).
4. International Society of Radiographers and Radiologic Technologists (ISRRT). Full guideline for protective measures. COVID-19–ISRRT response document – appropriate and safe use of medical imaging and radiation therapy with infection control measures considered in addition to standard radiation protection procedures 2020; Available from: [https://www.isrrt.org/pdf/NEW\\_ISRRT\\_COVID\\_19\\_Response\\_document\\_052020.pdf](https://www.isrrt.org/pdf/NEW_ISRRT_COVID_19_Response_document_052020.pdf) (20 September, 2020).
5. Society of Radiographers. COVID-19: personal protective equipment (PPE) 2020; Available from: <https://www.sor.org/news/covid-19-personal-protective-equipment-ppe> (26 September 2020).
6. Royal Australian and New Zealand College of Radiologists (RANZCR), Australian Diagnostic Imaging Association

- (ADIA), Australian Society of Medical Imaging and Radiation Therapy (ASMIRT), et al. COVID-19 Essential role of clinical radiology services position statement 2020; Available from: <https://www.ranzcr.com/our-work/coronavirus/position-statements-and-guidance> (16 September 2020).
7. Halcomb E, McInnes S, Williams A, et al. The experiences of primary healthcare nurses during the COVID-19 pandemic in Australia. *J Nurs Scholarsh* 2020; **52**: 553–63. <https://doi.org/10.1111/jnu.12589>.
  8. Homer CSE, Davies-Tuck M, Dahlen HG, Scarf VL. The impact of planning for COVID-19 on private practising midwives in Australia. *Women Birth* 2021; **34**(1): e32–e37.
  9. Royal Australian and New Zealand College of Radiologists (RANZCR). Guidelines for CT Chest and Chest Radiograph reporting in patients with suspected COVID-19 infection, 24 April, 2020; Available from: <https://www.ranzcr.com/our-work/coronavirus/position-statements-and-guidance> (16 September, 2020).
  10. International Society of Radiographers and Radiologic Technologists (ISRRT). COVID-19 - ISRRT Response Document - appropriate and safe use of Medical Imaging and Radiation Therapy with infection control measures considered in addition to standard radiation protection procedures. April 2020 – Version 1; Available from: [https://www.isrrt.org/pdf/NEW\\_ISRRT\\_COVID\\_19\\_Response\\_document\\_052020.pdf](https://www.isrrt.org/pdf/NEW_ISRRT_COVID_19_Response_document_052020.pdf) (16 September, 2020).
  11. Rivera A, Ohri N, Thomas E, Miller R, Knoll MA. The Impact of COVID-19 on Radiation Oncology Clinics and Patients With Cancer in the United States. *Adv Radiat oncol* 2020; **5**: 538–543. <https://doi.org/10.1016/j.adro.2020.03.006>.
  12. Rutter DR, Lovegrove MJ. Occupational stress and its predictors in radiographers. *Radiography* 2008; **14**: 138–143. <https://doi.org/10.1016/j.radi.2006.09.008>.
  13. French HC. Occupational stresses and coping mechanisms of therapy radiographers - a qualitative approach. *J Radiother Pract* 2004; **4**: 13–24.
  14. Singh N, Knight K, Wright C, et al. Occupational burnout among radiographers, sonographers and radiologists in Australia and New Zealand: Findings from a national survey. *J Med Imaging Radiat Oncol* 2017; **61**: 304–310. <https://doi.org/10.1111/1754-9485.12547>.
  15. Akudjedu TN, Lawal O, Sharma M, et al. Impact of the COVID-19 pandemic on radiography practice: findings from a UK radiography workforce survey. *BJR Open* 2020; **2**: 20200023. <https://doi.org/10.1259/bjro.20200023>.
  16. Australian Society of Medical Imaging and Radiation Therapy (ASMIRT). ASMIRT Annual Report 2019. Melbourne, Victoria: Australian Society of Medical Imaging and Radiation Therapy (ASMIRT); 2020.
  17. Qualtrics. Calculating sample size, nd: Available from: <https://www.Qualtrics.com/blog/calculating-sample-size/> (30 July, 2020).
  18. Medical Radiation Practice Board of Australia (MRPBA). Registrant Data 30 June 2020; Available from: <https://www.medicalradiationpracticeboard.gov.au/About/Statistic.s.aspx> (30 August, 2020).
  19. Warner RM. Applied statistics: From Bivariate through multivariate techniques. SAGE, Thousand Oaks, CA, 2008.
  20. Australian Health Practitioner Regulation Agency (Ahpra). Pandemic response sub-register 2020; Available from: <https://www.ahpra.gov.au/News/COVID-19/Pandemic-response-sub-register.aspx> (30 August, 2020).
  21. Stogiannos N, Fotopoulos D, Woznitza N, Malamateniou C. COVID-19 in the radiology department: What radiographers need to know. *Radiography* 2020; **26**: 254–63. <https://doi.org/10.1016/j.radi.2020.05.012>.
  22. Filippi AR, Russi E, Magrini SM, Corvò Renzo. Letter from Italy: First practical indications for radiation therapy departments during COVID-19 outbreak. *Int J Radiat Oncol Biol Phys* 2020; **107**(3): 597–9.
  23. Elshami W, Akudjedu TN, Abuzaid M, et al. The radiology workforce's response to the COVID-19 pandemic in the Middle East, North Africa and India. *Radiography* 2020; <https://doi.org/10.1016/j.radi.2020.09.016>
  24. Niu Y, Xian J, Lei Z, Liu X, Sun Q. Management of infection control and radiological protection in diagnostic radiology examination of COVID-19 cases. *Radiation Medicine and Protection* 2020; **1**: 75–80. <https://doi.org/10.1016/j.radmp.2020.05.005>.
  25. Qu J, Yang W, Yang Y, Qin L, Yan F. Infection control for CT equipment and radiographers' personal protection during the coronavirus disease (COVID-19) outbreak in China. *Am J Roentgenol* 2020; **215**: 940–4. <https://doi.org/10.2214/AJR.20.23112>.
  26. Zanardo M, Martini C, Monti CB, et al. Management of patients with suspected or confirmed COVID-19, in the radiology department. *Radiography* 2020; **26**: 264–8. <https://doi.org/10.1016/j.radi.2020.04.010>.
  27. Eastgate P, Neep MJ, Steffens T, Westerink A. COVID-19 Pandemic – considerations and challenges for the management of medical imaging departments in Queensland. *J Med Radiat Sci* 2020; **67**: 345–51. <https://doi.org/10.1002/jmrs.423>.
  28. Smith P. Covid-19 in Australia: most infected health workers in Victoria's second wave acquired virus at work. *BMJ* 2020; **370**: m3350. <https://doi.org/10.1136/bmj.m3350>
  29. Cunningham M. 'Deeply distressing': Doctors, radiographer among COVID-19 patients fighting for life. *The Age*, July 31, 2020.
  30. Anderson N, Thompson K, Andrews J, et al. Planning for a pandemic: Mitigating risk to radiation therapy service delivery in the COVID-19 era. *J Med Radiat Sci* 2020; **67**: 243–8. <https://doi.org/10.1002/jmrs.406>.