



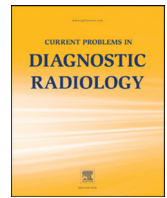
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# Current Problems in Diagnostic Radiology

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## Trainee and Faculty Perceptions of Remote PACS Workstations and Next Steps in a Large US Academic Medical Institution

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### ABSTRACT

**Objective:** Remote workstations were rapidly deployed in our academic radiology practice in late March 2020 in response to the COVID-19 pandemic. Although well-received by faculty, there were concerns for the impact on resident education.

**Materials and Methods:** Surveys of the radiology trainees and faculty were conducted online seven- and thirteen-months following workstation deployment as a part of a quality improvement project to assess the impact on radiology education and faculty wellness, as well as assess the desired trajectory of remote work in an academic setting.

**Results:** The majority of trainees (52%) reported the implementation had negatively impacted resident education, greatest among lower level residents ( $p < .001$ ). This perception did not change despite interventions and perceived improvement in teleconferencing.

Greater than 75% of radiologists with remote workstations reported improved wellness and lower stress levels compared to the onsite radiologists. The majority of all respondents voted to continue or expand remote work following the COVID-19 pandemic in both surveys.

**Conclusions:** Onsite teaching is important for the education of residents, particularly for lower-level residents. However, the adoption of a hybrid model in an academic setting may prove beneficial for faculty wellness and recruitment of the next generation.

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### Description of the Problem

In response to the COVID-19 pandemic, our large academic radiology department was one of many across the country that transitioned to provide remote workstations to faculty.<sup>1-3</sup> Remote teaching posed new challenges to faculty and radiology residents. Academic practices across the country made efforts to survive the pandemic by creating simulated worklists and promoting case sharing and teleconferencing platforms to improve educational efforts.<sup>4-6</sup> However, there was still concern for the overall quality of remote resident education. Academic radiologists had the unique challenge to ensure the ACGME milestones were met and residents were still trained with excellence despite less in-person supervision.<sup>7,8</sup>

At our institution, more than two-dozen remote workstations were deployed across our department. Workstations were provided for faculty considered to be at high risk for COVID-19 complications and to faculty able to contribute across multiple imaging modalities.<sup>9</sup> Those with access to a remote workstation were encouraged, but not required, to work from home during the early months of the pandemic.

By early August 2020, many faculty members with remote workstations chose to engage in onsite work with onsite safety measures,

while others remained exclusively remote. The adoption of teleconferencing among remote faculty was variable. We perceived that faculty in our department were not negatively affected by the integration of remote work, but hypothesized that the resident education experience had suffered.

### Institutional Approach

An anonymous survey was conducted among our faculty radiologists and trainees (resident and fellows) at our large academic institution seven- and thirteen-months following the distribution of home workstations. This survey data was acquired as a quality improvement initiative for our department, and was thus deemed exempt from further review and monitoring by the Institutional Review Board.

Three separate online surveys were distributed in October 2020 and April 2021, targeting trainees, faculty with a remote workstation, and faculty without a remote workstation, hitherto referred to as “onsite”. Questions targeted education, wellness, and desire to continue remote following the pandemic. While the majority of the questions were identical between the two surveys, a few single best answer response options were edited in the April 2021 survey to better reflect overall experience. No question was required. The completed data was included in analysis.

The Chi Square test was employed for statistical analysis. A  $p$ -value  $< 0.05$  was considered statistically significant.

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**TABLE 1**  
Demographics among trainee and faculty participates in the October 2020 Survey

Survey 1			
	Trainee	Faculty, remote	Faculty, onsite
Total number	39	25	22
Sex			
Male	32	13	11
Female	7	10	11
Prefer not to answer	0	2	0
Age			
<50	39	16	14
>50	0	8	8
Academic Rank			
R1	8		
R2	9		
R3	8		
R4	5		
Fellow	9		
Prof		6	8
Assoc. Prof.		8	5
Assist. Prof.		11	8
Instructor		0	1

### Survey 1

#### Demographics

Survey 1 was conducted in October 2020. Eighty-one percent ( $n = 39/48$ ) of trainees, 88% ( $n = 25/28$ ) of remote faculty, and 44% ( $n = 22/50$ ) of onsite faculty completed the survey. Additional demographic data is provided in Table 1.

Fifty-two percent ( $n = 13/25$ ) of faculty with a remote workstation worked remotely greater than 75% of the time. All radiologists who were over age 50 fell into this category ( $n = 8/8$ ). Forty percent ( $n = 10/25$ ) worked from home less than 20% of the time.

#### Education

Nearly all trainees (87%,  $n = 34/39$ ) had participated in a remote readout at the time of the survey. Fifty-one percent ( $n = 20/39$ ) of the trainees, and nearly all of the R1 and R2 classes (88%,  $n = 13/16$ ), reported that remote work had a negative or very negative effect on education (Fig 1). The majority of all trainees ( $n = 24/39$ ) and nearly all of the R1 and R2 residents ( $n = 14/17$ ) preferred onsite readouts (Fig 2).

Only 30% ( $n = 14/47$ ) of all faculty reported a negative impact on education. There was no statistical significance between onsite and remote faculty ( $P = 0.78$ ).

#### Wellness

Eighty-eight percent ( $n = 22/25$ ) of faculty with remote workstations reported lower daily stress levels, and 78% ( $n = 18/23$ ) reported a positive or very positive impact on overall wellbeing (Fig 3). Onsite faculty reported their stress levels were either unaffected or improved by the implementation of remote work.

#### Future Directions

Despite the impact on education, 77% ( $n = 30/39$ ) of trainees and 63% ( $n = 29/46$ ) of faculty voted for remote work to continue or expand following the COVID-19 pandemic (Fig 4). There was no statistical difference between preferences of onsite and remote faculty ( $P = 0.7$ ). Notably, none of the faculty with remote workstations voted to discontinue remote work.

#### Intervention

In response to the negative effect on radiology resident education, educational tools and clear expectations were provided to the remote faculty regarding remote readouts. Video tutorials, including a best practice primer, were provided on an easily accessible online platform to demonstrate how to screen share, allow the trainee to scroll through the study remotely, and edit the report on a shared screen.

In-person readouts were prioritized for R1 and R2 residents when possible. When it was not possible, teleconferencing using the aforementioned strategies was considered the standard for resident readout.

Finally, webcams were provided by the department to all on campus and remote workstations. Faculty were encouraged to use them during remote readout.

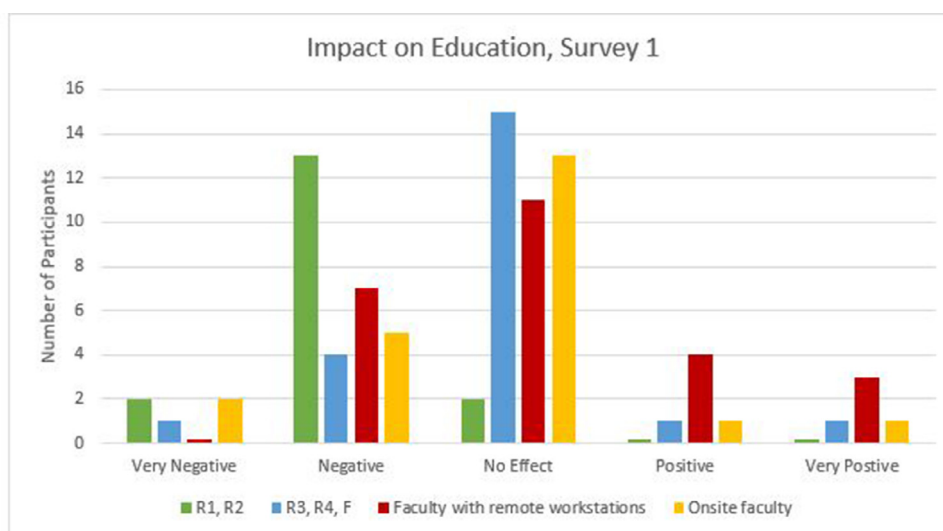
A six-month follow up survey was distributed in April 2021 to reassess perceptions on education and wellness following improved use of teleconferencing methods.

#### Outcomes

##### Survey 2

##### Demographics

Survey 2 was conducted in April 2021. Sixty-five percent ( $n = 31/48$ ) of trainees, 78% ( $n = 22/28$ ) of faculty with a remote workstation,



**FIG 1.** Perceived impact on education in October 2020 stratified by lower (R1,R2) and upper level (R3, R4, Fellow) trainees, and faculty with and without a remote workstation.

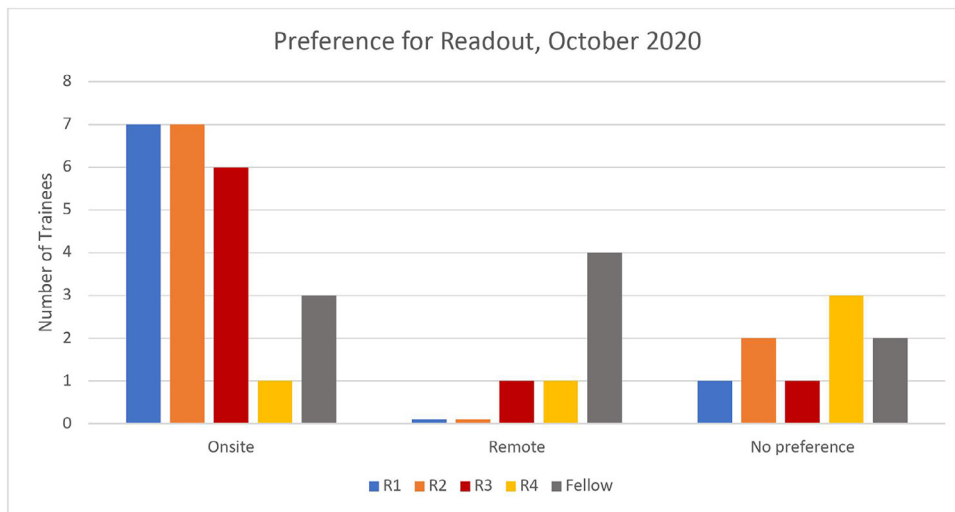


FIG 2. Trainee preference for readout in October 2020 stratified by level of training.

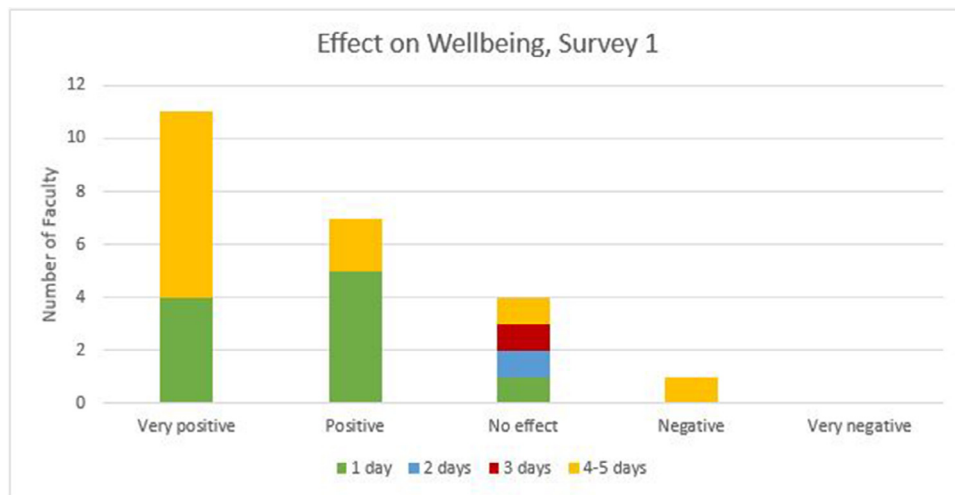


FIG 3. Effect of remote workstation access on wellbeing for remote faculty in October 2020 stratified by how often per week the workstation was used.

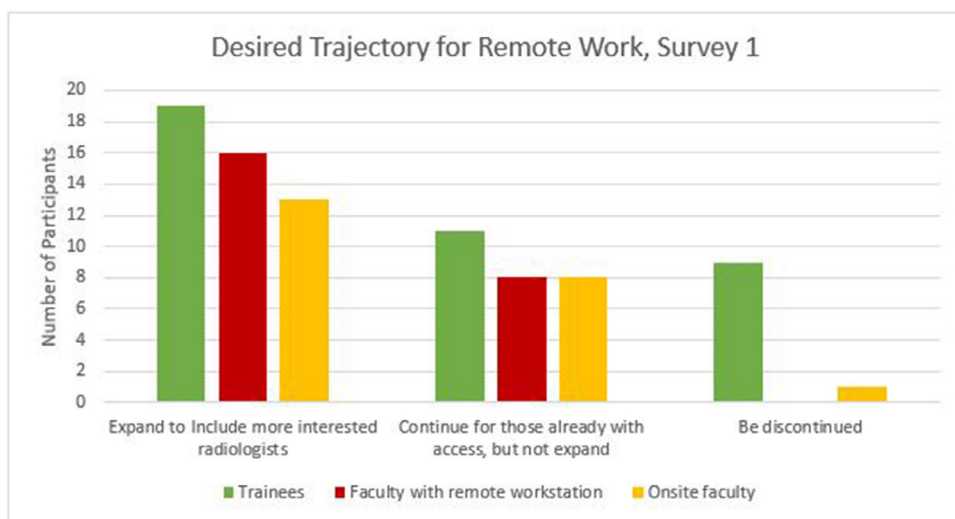


FIG 4. Desired trajectory of remote work following the pandemic in October 2020 stratified by trainees, faculty with and without a remote workstation.

**TABLE 2**  
Demographics among trainee and faculty participants in the April 2021 Survey

Survey 2	Trainee	Faculty, remote	Faculty, onsite
Total number	31	23	21
Sex			
Male	23	15	9
Female	5	8	12
Prefer not to answer	3	0	0
Age			
<50	39	15	13
>50	0	8	10
Academic Rank			
R1	7		
R2	9		
R3	5		
R4	4		
Fellow	6		
Prof		6	8
Assoc. Prof.		5	7
Assist. Prof.		12	6
Instructor		0	0

and 42% (n = 21/50) of onsite faculty completed the survey. Additional demographic data is provided in Table 2.

The majority of faculty with a remote workstation (n = 12/21) worked remotely one day of the week, and a minority worked remotely 4 or more days per week (n = 5/21).

#### Education

Following the aforementioned interventions, 64% (n = 20/31) of trainees reported remote education had improved, 26% (n = 8/31) reported no change, and three trainees reported adoption of new techniques varied among faculty.

Fifty-two percent (n = 16/31) of trainees, and 81% (n = 13/16) of R1 and R2 residents, reported remote work had a negative effect on their education (Fig 5). Eighty-six percent (n = 12/14) of R1 and R2 residents preferred onsite readouts (Fig 6). No trainee preferred remote readout.

The majority of all faculty (53%, n = 21/40), and specifically, the majority of faculty with remote workstations (n = 13/22), reported education was negatively or very negatively impacted by remote work. There was no statistical difference between onsite and remote faculty (P = 0.27).

#### Wellness

More than 75% of faculty reported access to a remote workstation had a positive or very positive impact on their wellbeing regardless of how the faculty worked remotely (Fig 7).

The lower stress levels among remote faculty did not significantly change. However, 26% (n = 5/19) of onsite faculty members reported increased stress levels secondary to remote work in Survey 2. This was previously unreported.

#### Future Directions

The majority of trainees (79%, n = 22/28) and faculty (66%, n = 27/41) voted to continue or expand remote work (Fig 8). Again, none of the remote faculty voted to discontinue remote work. Statistically, more onsite faculty voted to expand remote work compared to faculty already working remotely (P = 0.02). More women faculty radiologists voted to expand remote work compared to the men (P < 0.04). One's age greater or less than 50 did not have an effect on how the faculty voted (P = 0.9).

The majority of onsite faculty were interested in future access to a remote workstation in both surveys, 59% (n = 13/22) in Survey 1 and 68% (n = 13/19) in Survey 2. Procedural workload or lack of confidence in internet reliability were cited as reasons for disinterest.

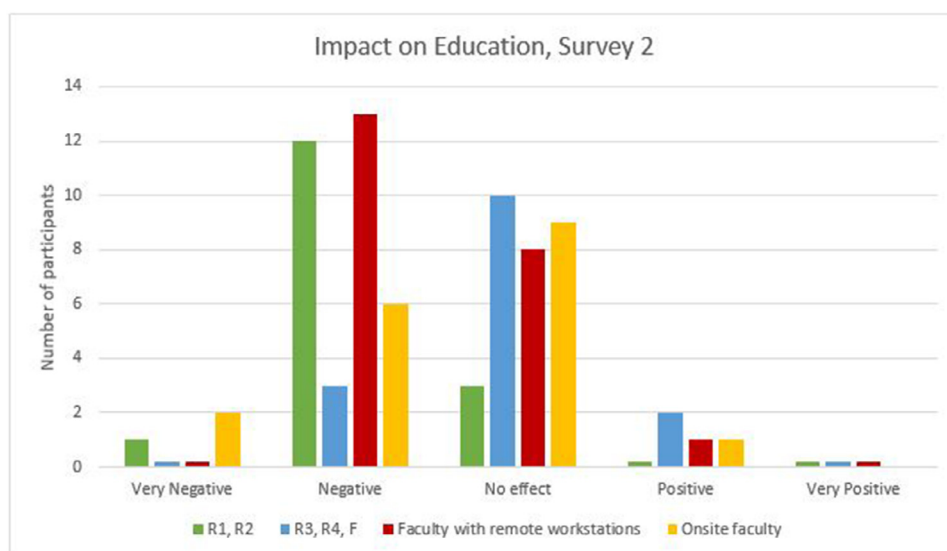
Eighty-six percent (n = 19/22) of faculty with remote workstations reported that it was a high or very high priority to maintain access to a remote workstation in the future.

The majority of trainees in both surveys, 77% (n = 30/39) in Survey 1 and 67% (18/27) in Survey 2, reported they would be interested or very interested in a job that offers a remote work option in the future. Only one trainee reported no interest.

#### Discussion

Trainees at our institution, particularly the first and second-year residents, perceived a negative impact on education secondary to remote work despite improvement in teleconferencing methods. Remote readouts can be optimized and still be insufficient for daily education. Reading room management, interactions with technologists, unhampered discussion of seemingly small findings, and mentorship are all critical to radiology education. Nuances are learned in the first few years and practiced for a lifetime. They are insufficiently taught with a remote primary educator.

So, why was it that the majority of all faculty and trainees advocated to at least continue, if not expand, remote work in our department?



**FIG 5.** Perceived impact on education in April 2021 stratified by lower (R1,R2) and upper level (R3, R4, Fellow) trainees, and faculty with and without a remote workstation.

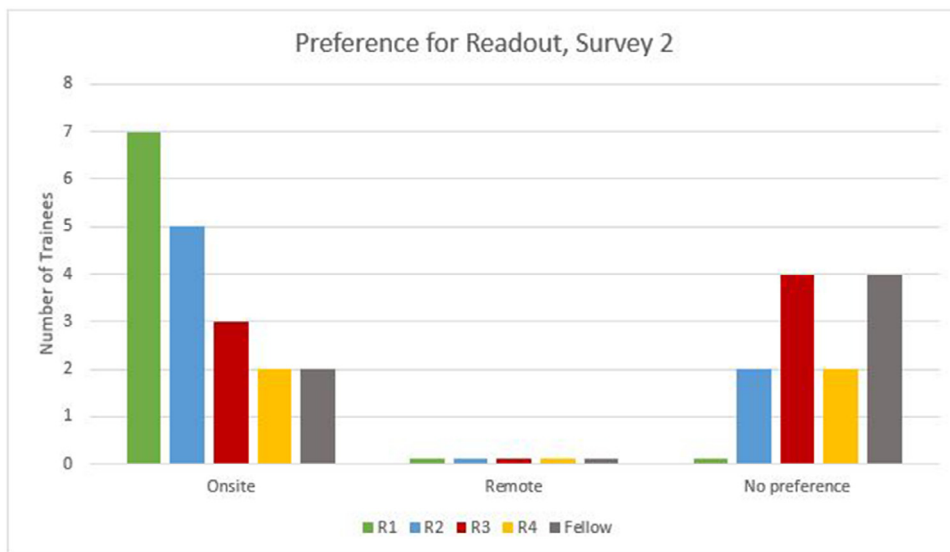


FIG 6. Trainee preference for readout in April 2021 stratified by level of training.

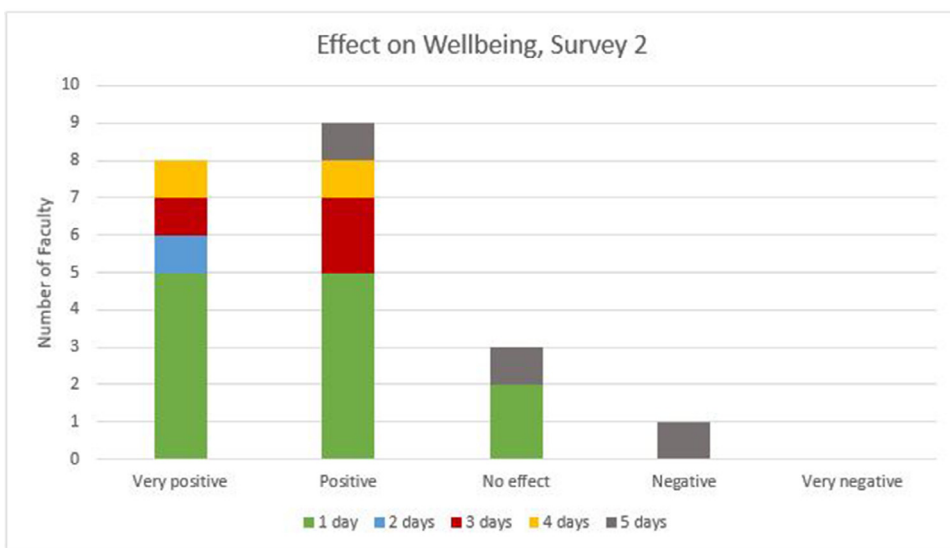


FIG 7. Effect of remote workstation access on wellbeing for remote faculty in April 2021 stratified by how often per week the workstation was used.

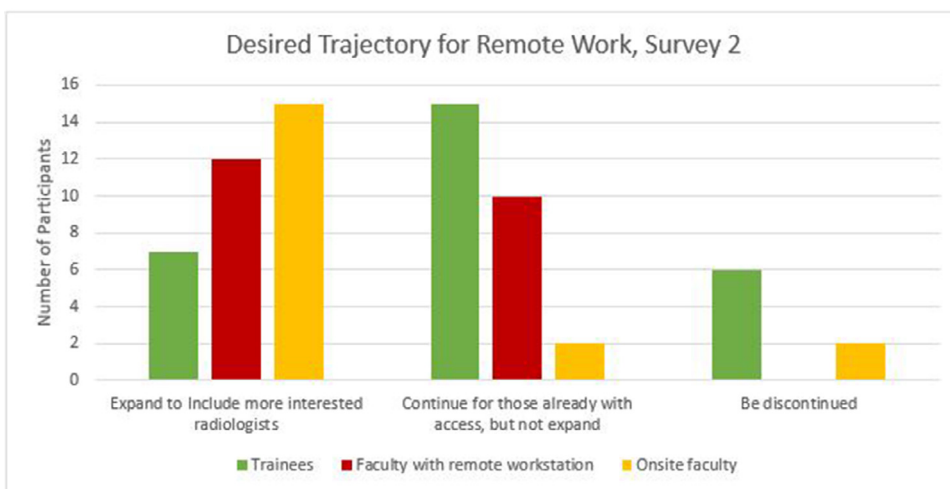


FIG 8. Desired trajectory of remote work following the pandemic in April 2021 stratified by trainees, faculty with and without a remote workstation.

The answer is complex. Our survey identified one key element – the wellness benefits for those with access to a remote workstation. Nearly all faculty with remote access reported it improved their wellness and decreased their stress levels. Importantly, the majority of those with remote access held it as a high or very high priority to maintain this in the future.

It should not be taken lightly, however, that 25% of onsite faculty moved from feeling unaffected in October 2020 to feeling more stress in April 2021. Reading room management, resident education, contrast coverage, and procedural responsibilities fell primarily and disproportionately to onsite faculty. Furthermore, the medical necessity for remote work fell with an effective and widely available vaccine. Those without remote access may have felt an unfair burden with seemingly unjust cause.

Despite increasing stress, the majority of onsite faculty did not vote to discontinue remote access, but actually to be included.

Teleradiology has been a growing trend across private radiology practices, with benefits for after-hours overages and ability to read in a greater geographic area.<sup>10,11</sup> These benefits can be harnessed in an academic practice for worklist decompression, additional coverage after hours, increased access to lead multidisciplinary conferences, and improved sense of flexibility and control among the faculty.

As more faculty gain access to remote workstations, the reading room responsibilities can alternate and may be more evenly distributed. For instance, a call forwarding mechanism could be considered to forward a reading room telephone line to the remote radiologist's personal phone when on service. If even a small percentage of faculty worked remotely every day, it would decrease crowding of the reading rooms and allow more space for onsite collaboration with referring physicians, a premium at our institution.

Another key consideration for remote access in the academic setting is that the majority of our trainees, all of whom were in the millennial generation, stated that they were interested in having the option to work remotely in their future jobs. The integration of a remote work option, particularly the effective integration of a hybrid model, may play a role in recruiting the next generation into academics.

## Limitations

This data was collected within our singular radiology department, and the small sample size is a limitation to the generalizability of our findings. A small majority of the residents in their last year of training completed both surveys, which limits the validity of the data among the upper-level residents.

Interpretation of the first year resident data is somewhat limited, as they had no comparative experience of radiology residency pre-pandemic. They also rotated through sections with disproportionately higher numbers of exclusively remote faculty early in training. Significant variability was present among faculty members regarding approach to teleconferencing, limiting the generalizability of some of the questions.

## Conclusion

The pandemic has propelled academic radiology into previously resisted territory of remote work. Surveys conducted at our institution, revealed that remote teaching was insufficient particularly for the training of lower-level residents. In-person readouts were preferred among all residents, and should be prioritized when possible. However, access to a remote workstation has clear wellness benefits for faculty, no matter how often the remote workstation was used.

A hybrid model for remote work among academic radiologists offers the advantages in flexibility while maintaining fairness among shared in-person responsibilities, namely contrast coverage and procedural workload. Wider distribution and the sustainable integration of remote work in the academic setting may improve overall

longevity of a radiologist's career and may help recruit the next generation of radiologists into academics. While the incorporation of remote work may be met with resistance, we predict that most will be asking themselves, "Why didn't we do this sooner?"

## Conflict of Interest

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The authors declare that they had full access to all of the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis.

## Author Contributions

Rachel Zimmerman Bass: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization, Andrew Dennis Smith: Conceptualization, Methodology, Writing - review & editing, Mark C Langston: Conceptualization, Writing - review & editing, Mason B. Frazier: Conceptualization, Writing - review & editing, Sрни Tridandapani: Conceptualization, Methodology, Validation, Writing - review & editing, Visualization, Supervision.

## References

- Li CH, Rajamohan AG, Acharya PT, et al. Virtual read-out: Radiology education for the 21st century during the COVID-19 pandemic. *Acad Radiol* 2020;27:872–81, <https://doi.org/10.1016/j.acra.2020.04.028>.
- Nadgir R. Teaching remotely: Educating radiology trainees at the workstation in the COVID-19 era. *Acad Radiol* 2020;27:1291–3, <https://doi.org/10.1016/j.acra.2020.05.018>.
- Moadel RM, Zamora E, Burns JG, et al. Remaining academically connected while socially distant: Leveraging technology to support dispersed radiology and nuclear medicine training programs in the era of COVID-19. *Acad Radiol* 2020;27:898–9, <https://doi.org/10.1016/j.acra.2020.04.005>.
- Recht MP, Fefferman NR, Bittman ME, et al. Preserving radiology resident education during the COVID-19 pandemic: The simulated daily readout. *Acad Radiol* 2020;27:1154–61, <https://doi.org/10.1016/j.acra.2020.05.021>.
- Matalon SA, Souza DAT, Gaviola GC, et al. Trainee and attending perspectives on remote radiology readouts in the era of the COVID-19 pandemic. *Acad Radiol* 2020;27:1147–53, <https://doi.org/10.1016/j.acra.2020.05.019>.
- McRoy C, Patel L, Gaddam DS, et al. Radiology education in the time of COVID-19: A novel distance learning workstation experience for residents. *Acad Radiol* 2020;27:1467–74, <https://doi.org/10.1016/j.acra.2020.08.001>.
- Wang GX, Chou SS, Lamb LR, et al. Opportunities for radiology trainee education amid the COVID-19 pandemic: Lessons from an academic breast imaging program. *Acad Radiol* 2021;28:136–41, <https://doi.org/10.1016/j.acra.2020.09.009>.
- Chertoff JD, Zarzour JG, Morgan DE, et al. The early influence and effects of the coronavirus disease 2019 (COVID-19) pandemic on resident education and adaptations. *J Am Coll Radiol* 2020;17:1322–8, <https://doi.org/10.1016/j.jacr.2020.07.022>.
- Tridandapani S, Holl G, Canon CL. Rapid deployment of home PACS workstations to enable social distancing in the coronavirus disease (COVID-19) era. *AJR Am J Roentgenol* 2020;215:1351–3, <https://doi.org/10.2214/AJR.20.23495>.
- Hanna TN, Steenburg SD, Rosenkrantz AB, et al. Emerging challenges and opportunities in the evolution of teleradiology. *AJR Am J Roentgenol* 2020;215:1411–6, <https://doi.org/10.2214/AJR.20.23007>.
- Rosenkrantz AB, Hanna TN, Steenburg SD, et al. The current state of teleradiology across the United States: A national survey of radiologists' habits, attitudes, and perceptions on teleradiology practice. *J Am Coll Radiol* 2019;16:1677–87, <https://doi.org/10.1016/j.jacr.2019.05.053>.