



Mitigation Tactics Discovered During COVID-19 with Long-Term Report Turnaround Time and Burnout Reduction Benefits

Jonelle M. Petscavage-Thomas, MD, MPH, Seth Hardy, MD, MBA, Alison Chetlen, DO

Rationales and Objectives: The purpose is to describe a hybrid teleradiology solution utilized in an academic medical center and its outcomes on radiology report turnaround time (RTAT) and physician wellness.

Materials and Methods: During coronavirus disease 2019, we utilized an alternating teleradiology solution with procedural and education attendings working in the hospital and other faculty remote to keep the worklist clean. RTAT data was collected for remote vs. in house emergency department (ED) and inpatient cases over a 6-month period. Pre and post implementation burnout surveys were administered.

Results: RTAT significantly improved for ED and inpatient MR and CT, and inpatient US and radiographs when interpreted remotely compared to in-hospital. Physician wellness scores improved and open-ended comments reflected positive feedback about the hybrid work solution. 74% enjoyed the autonomy and flexibility, and 51% said the solution positively influences my desire to remain in my current institution and improves their clinical and/or academic productivity.

Conclusion: Hybrid work from home solutions allow faculty autonomy and flexibility with work-life balance, improving wellness. It is important to alternate the at-home faculty to maintain interdepartmental relations, particularly for junior faculty, and prevent isolation. The hybrid solution also demonstrated improved patient care metrics, possibly due to decreased distractions at home compared to the reading room.

Key Words: burnout; teleradiology; report turnaround time; COVID-19.

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INTRODUCTION

Addressing burnout and promoting physician wellness is a strategic imperative for leadership across the country so that clinical operations are not compromised. Burnout is present in 49–72% of diagnostic radiologists (1–4). Radiology is the seventh highest specialty reporting burnout, compared to prior rank of 15th (5). Radiology residents also have a high self-reported level of burnout at 36.2%, with 64.8% reporting sleep-related impairment (6). Burnout may manifest as disruptive physicians, apathy, emotional exhaustion, and depersonalization, and in some cases, leaving the workforce (7).

Previous research has shown that lack of autonomy and decision-making power in the workplace are negatively

associated with occupational burnout (8). Potential causes of burnout specific to radiology include lack of autonomy/control over work, hamster-wheel of productivity and PACS worklists, lack of recognition, Electronic medical record (EMR), lack of meaningfulness of work, and long work hours (7,9,10). Other causes may include frequent workroom interruptions/noninterpretive work and reading exams on evenings and weekends.

Teleradiology, first practiced in the 1990's, can minimize workroom interruptions (11). Whereas prior to the pandemic, internal teleradiology was primarily used for on-call and weekend coverage (12) this changed rapidly in March 2020 (13,14) as many radiology practices moved to or increased their use of internal teleradiology to ensure a reserve of radiologists with lower exposure to coronavirus disease 2019 (COVID-19) (13,15) who could sustain operations.

A survey of US radiologists during the first month of the pandemic showed that implementation of teleradiology was perceived favorably, with 64.8% reporting decreased stress levels and 64% decreased workroom interruptions (16). 79% reported no change in report turn-around time (RTAT) and no loss of what remains of interprofessional communication (17). That study also found that more than half planned to

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From the Penn State Hershey Medical Center, 500 University Dr. HG300B, Hershey, PA 17033. Received March 24, 2022; revised April 13, 2022; accepted April 15, 2022. The authors declare no conflict of interest. The authors declare no funding sources. Address correspondence to: J.M.P.-T. e-mail: Jthomas5@pennstatehealth.psu.edu

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continue workday teleradiology after the pandemic. However, no follow up data has been presented to assess the long-term radiologist attitudes and RTAT productivity data using workday internal teleradiology.

As the transition to the endemic phase of COVID-19 has occurred we have maintained a hybrid internal teleradiology model. The purpose of this study is to describe our model, provide pre- and post-COVID faculty wellness/burnout survey results in response to a hybrid teleradiology model, and provide RTAT data.

METHODS

Our institution is a 610 bed Level 1 Trauma academic medical center with three affiliated community hospitals and several outpatient imaging centers. The academic practice division radiologists cover the main level 1 trauma center and three outpatient imaging sites while a community practice division radiologists cover the other imaging sites. There are 50 academic practice radiologists, 31 residents, and six fellows. By division, there are 11 body radiologists, two thoracic radiologists, nine neuroradiologists, seven musculoskeletal radiologists, five breast imaging radiologists, five pediatric radiologists, five nuclear medicine radiologists, five interventional radiologists, and one emergency radiologist. There are typically 2-5 academic faculty assigned per division each day with fellows in neuroradiology, body imaging, musculoskeletal imaging, interventional radiology, and breast imaging. Anywhere between 1 and 5 residents may be present on a subspecialty rotation with 0-5 medical students or visiting residents in the reading room. All divisions except thoracic radiology require a daily procedural attending to cover work such as myelograms, arthrograms, liver biopsies, and barium studies.

In June 2020 the department decided to continue using a hybrid hospital/teleradiology workday practice. This practice includes an hospital based procedural attending coverage and at least one diagnostic teaching attending for educational coverage. The teaching attending duties were to provide view-box and didactic education to the residents and medical students. Depending on the division, one to two attendings were assigned as workday teleradiologists from home with the purpose of “keeping the list clean.” Since geographic reading rooms were no longer an operational barrier for the teleradiologists, larger divisions, such as Abdominal had the ability to cross-cover subspecialties remotely that had previously been segregated, such as ultrasound, plain films, and CT/MR.

Communication with the remote faculty could occur by having their phone number listed on the in PACS chat communicator, instant messaging within the PACS system, or by our HIPAA compliant hospital text system.

Survey Creation and Data Collection

Our department has assessed faculty burnout and wellness since 2016. Prior to the pandemic in September 2017, an 18 question survey was sent to faculty to assess wellness/burnout.

Then in March 2021, approximately 12 months after the pandemic began, and after the implementation of the hybrid radiology solution, an 18 question survey was re-administered to both faculty and residents. Respondents were given two weeks to complete the survey anonymously. Results of departmental surveys were shared at faculty meetings and the anonymous results were also disseminated via email to all departmental faculty members.

The initial fifteen questions of the homegrown 2017 and 2021 departmental faculty survey were identical and modeled after the Maslach Burnout Inventory for Human Services Workers, which examines emotional exhaustion, depersonalization, and personal accomplishment of employees. Both surveys also included a 16th question specifically querying academic rank (i.e., Assistant Professor, Associate Professor, Professor, Ph.D., or other). Questions seventeen and eighteen were different in the 2017 vs 2021 survey to address specific wellness domains that were specific to those time periods, most recently the COVID-19 pandemic and effect on workplace. The final question in the 2021 survey was open ended narrative style questions. 2021 Survey Questions are shown in [Table 1](#).

RTAT

IP addresses were used in conjunction with work shifts to track RTAT based on in hospital vs. remote workstations. These were filtered by modality, day of the week, time of the day, and subspecialty. RTAT was compared for in house vs. remote readers in the hybrid model. Volumes of interpretation for in house vs. remote readers was also tracked.

RESULTS

2021 Survey questions 1-6 and results are shown in [Tables 2](#) and [3](#).

Open ended comments surrounding working remotely included

- Increases both clinical and academic productivity
- If we resume old system post pandemic, job satisfaction would decrease significantly.
- It has increased productivity, satisfaction, and ability to teach without interruptions within the reading room
- 100% I am more focused and productive at home. There are few distractions and I can focus on tasks uninterrupted.
- I have an extra 90 minutes of productive time/day between 6 am and 6 pm because I have no commute.
- Yes, having autonomy to work remotely 20% is a good balance of personal flexibility and engagement with others. I would have concerns that working remotely more than 30-40% could lead to a loss of engagement and harm academic careers that are so dependent on networking in the professional community.
- Yes, the flexibility that allows would be invaluable to me. Time savings that I can use to spend time taking care of

TABLE 1. Wellness Survey Questions

2021 Survey Questions	
Question	Response Options
Q1. Do you feel run down or drained of physical or emotional energy?	Not at all – Rarely – Sometimes – Often – Very often
Q2. Do you find that you are prone to negative thinking about your job?	Not at all – Rarely – Sometimes – Often – Very often
Q3. Do you find that you are harder and less sympathetic with people than perhaps they deserve?	Not at all – Rarely – Sometimes – Often – Very often
Q4. Do you find yourself getting easily irritated by small problems, or by your co-workers and team?	Not at all – Rarely – Sometimes – Often – Very often
Q5. Do you feel misunderstood or underappreciated by your co-workers?	Not at all – Rarely – Sometimes – Often – Very often
Q6. Do you feel that you have no-one to talk to?	Not at all – Rarely – Sometimes – Often – Very often
Q7. Do you feel that you are achieving less than you should?	Not at all – Rarely – Sometimes – Often – Very often
Q8. Do you feel under an unpleasant level of pressure to succeed?	Not at all – Rarely – Sometimes – Often – Very often
Q9. Do you feel that you are not getting what you want out of your job?	Not at all – Rarely – Sometimes – Often – Very often
Q10. Do you feel that you are in the wrong organization or the wrong profession?	Not at all – Rarely – Sometimes – Often – Very often
Q11. Are you becoming frustrated with parts of your job?	Not at all – Rarely – Sometimes – Often – Very often
Q12. Do you feel that organizational politics or bureaucracy frustrate your ability to do a good job?	Not at all – Rarely – Sometimes – Often – Very often
Q13. Do you feel that there is more work to do than you practically have the ability to do?	Not at all – Rarely – Sometimes – Often – Very often
Q14. Do you feel that you do not have time to do many of the things that are important to doing a good quality job?	Not at all – Rarely – Sometimes – Often – Very often
Q15. Do you find that you do not have time to plan as much as you would like to?	Not at all – Rarely – Sometimes – Often – Very often
Q16. Select your academic rank	R1, R2, R3, R4, R5 R6, Assistant Professor, Associate Professor, Full Professor, PhD, Advanced Practice Provider (Physician Assistant, Nurse Practitioner, Radiology Assistant)
Q17. Please share your experience and preference with performing your clinical duties remotely (off campus).	Select all that apply
Q18. If working remotely (in state or out of state) for an extended period of time was offered to faculty, with equitable call, clinical responsibility, and educational responsibility managed by each division, would you be in favor of this opportunity?	Share your thoughts in the comment box with a yes/no and explanation.

my kids or allow me to fit exercising into my day has been so important to my well-being.

For a 6-month period after implementation of hybrid system, RTAT for onsite vs. remote is listed in Table 4. The following were statistically significant (*) in improved RTAT: CT–Ed and inpatient, MR–Inpatient, US–Inpatient, and XR–Inpatient ($p < 0.05$).

DISCUSSION

Historically, the radiology reading room was the “beating heart” of the hospital (18). It represented the physical space to discuss imaging finding with the referring physicians, educate residents and medical students. Even with the adoption of PACS, the frequency of in person visits is lower but there are still numerous phone calls (19) which are still an opportunity to connect with our clinical colleagues. Continued benefits of in person reading rooms include collaboration among radiologists, communication with technologists and nurses,

and education (17). However, the ability to educate residents can be impeded by the constant interruptions and large volumes of work. Furthermore, a physical workspace does enable physicians who wish to be physically present, but “checked out” mentally.

Our own internal burnout data reveals a potentially crippling level of burnout. Within our Likert scales our radiologists identify with “often” or “very often” burnout metrics from 4 to 29% of the time. Given scarcity of radiologists and increasing workloads nationally, replacing burned out radiologists is almost impossible, thus improving job satisfaction is a strategic imperative for departments.

In our survey over half of all respondents felt that the COVID-19 work from home flexibility increased their well-being and job satisfaction; providing autonomy and familial flexibility and positively influencing their desire to remain at their current institution. Flexibility to provide child-care to sick children, balancing school holidays, or virtual schooling during the pandemic, are workplace options that did not exist before COVID-19 changes. Some have suggested that

TABLE 2. 2021 Survey Questions

2021 Survey Questions 1-6 and Results are Shown Below					
Question	Not at all	Rarely	Sometimes	Often	Very Often
Q1. Do you feel run down or drained of physical or emotional energy? N = 50	14% (7)	26% (13)	42% (21)	12% (6)	6% (3)
Q2. Do you find that you are prone to negative thinking about your job? N = 50	14% (7)	40% (20)	26% (13)	14% (7)	6% (3)
Q3. Do you find that you are harder and less sympathetic with people than perhaps they deserve? N = 50	30% (15)	34% (17)	32% (16)	0% (0)	4% (2)
Q4. Do you find yourself getting easily irritated by small problems, or by your co-workers and team? N = 50	8% (9)	40% (20)	34% (17)	6% (3)	2% (1)
Q5. Do you feel misunderstood or underappreciated by your co-workers? N = 50	30% (15)	32% (16)	22% (11)	10% (5)	6% (3)
Q6. Do you feel that you have no-one to talk to? N = 50	52% (26)	26% (13)	16% (8)	4% (2)	2% (1)
Q7. Do you feel that you are achieving less than you should? N = 49	36.7% (18)	12.3% (6)	34.7% (17)	12.2% (6)	4.1% (2)
Q8. Do you feel under an unpleasant level of pressure to succeed? N = 50	34% (17)	18% (9)	34% (17)	10% (5)	4% (2)
Q9. Do you feel that you are not getting what you want out of your job? N = 50	26% (13)	26% (13)	40% (20)	6% (3)	2% (1)
Q10. Do you feel that you are in the wrong organization or the wrong profession? N = 49	51% (25)	14.3% (7)	30.6% (15)	2% (1)	2% (1)
Q11. Are you becoming frustrated with parts of your job? N = 50	16% (8)	24% (12)	42% (21)	12% (6)	6% (3)
Q12. Do you feel that organizational politics or bureaucracy frustrate your ability to do a good job? N = 49	10.2% (5)	30.6% (15)	30.6% (15)	8.2% (4)	20.4% (10)
Q13. Do you feel that there is more work to do than you practically have the ability to do? N = 50	22% (11)	26% (13)	34% (17)	14% (7)	4% (2)
Q14. Do you feel that you do not have time to do many of the things that are important to doing a good quality job? N = 50	24% (12)	36% (18)	30% (15)	8% (4)	2% (1)
Q15. Do you find that you do not have time to plan as much as you would like to? N = 50	20% (10)	24% (12)	32% (16)	20% (10)	4% (2)

remote reading may also allow practices to flex radiologist hours improving operational flexibility (18). At least one division in our department exercised this option, allowing familial caregivers (exclusively female) to better manage work-life balance. We hope this flexibility provides a retention and perhaps recruitment advantage for our department by flattening disparate work expectations and structural discrimination (policies that are race or gender neutral in intent but have negative effects on women, minorities, or both) for colleagues (19).

Teleradiology provides the benefit of being removed from the workroom interruptions. The data from RTAT support that even with potential distractions from children or not being monitored by peers, aggregate work output does not suffer but in fact significantly improved across several

modalities. These trends are consistent with national experience, which also note that working from home in a teleradiology setting adds to employee's overall sleep hygiene and sleep time as well as personal flexibility during the day (20).

While operational leaders still must monitor productivity to ensure the remote readers are performing their clinical tasks, we feel the benefits of autonomy among the workforce outweigh any risk of opportunistic behavior. Division chiefs must also ensure that there is equity amongst faculty for the rotation and flexibility if there are emergencies that require revision to clinical assignments. In the future, another option is to provide blocks of weeks of remote reading for those wishing to reside in a different seasonal locations.

In order to implement such a hybrid model, an academic organization must have adequate staffing to provide the in-

TABLE 3. Hybrid Solution Question Responses

In 2021, There were 50 Total Respondents

Q16. Please Select Your Academic Rank	Number of Respondents in 2021 Survey	Response Rate within Each Cohort
Advanced Practice Providers	2	100% response rate
Assistant Professors	15 (15/27)	55% response rate
Associate Professors	5 (5/10)	50% response rate
Full Professors	9 (9/19)	47% response rate
Diagnostic and Interventional Radiology Residents	19 (19/32)	59% response rate
	<ul style="list-style-type: none"> • R1 (5) • R2 (5) • R3 (1) • R4 (3) • R5 (3) • R6 (2) 	
Q 17. Please share your experience and preference with performing your clinical duties remotely (off campus). <i>N</i> = 43	Respondents selected "all that apply"	
Increased clinical or academic productivity	51% (22)	
Decreased clinical or academic productivity	12% (5)	
Plan to continue performing my job off campus when duties allow	56% (24)	
Increased my well-being and job satisfaction	51% (22)	
Enjoyed the autonomy and flexibility	74% (32)	
Positively influences my desire to remain in my current institution	51% (22)	
Feel disconnected from workplace community and events	28% (12)	
Negatively affected education and collaboration	21% (9)	
Positively affected education and collaboration	19% (8)	

house education and procedural coverage. Each attending having a home workstation prior to the pandemic was an operational advantage we enjoyed as the epidemic began, but may not be present everywhere. In cases of staffing shortages, the hybrid model allows a flexible schedule for faculty, potentially as a recruitment/retention tool.

Potential disadvantages of teleradiology include minimized patient contact, diminished interpersonal communication, cost of a home workstation, and reliance on IT and telecommunications. However, rotating staff daily helps maintain the interpersonal communications and patient contact while still providing an extra day or two of autonomy per week. By having radiologists at home decompressing the worklists, and designated teaching faculty who would balance clinical workload and education of our trainees, we believe that the

educational experience could be improved within our reading rooms.

One potential challenge with the hybrid model is the ability to adapt on days of multiple procedure add-on cases. In the full staff model, there were enough faculty on site to accommodate extra procedural volume while still having staff dedicated to resident education. With only two faculty on site, if there were simultaneous procedures, the residents were left alone in the reading room with no assistance during phone calls and less time for education.

A notable economic benefit for health systems is the decreased cost of teleradiology to the hospital. The variable cost of a radiologist reading remotely is \$0 at their home compared to the cost of utilities and high cost of real estate. Since hospital real estate is a precious resource and training programs are expanding, additional space for residents is required. In our experience hospital PACS workstations have increasingly become an operational bottleneck. By utilizing workstations in attendings' homes we have mitigated this bottleneck and provided a financial benefit for the hospital.

There is increasing discussion regarding the environmental impact of our departments (21), and the past meeting of the Association of University Radiologists is dedicated to this topic. Furthermore, a recent Call to Action in the New England Journal of Medicine highlights health care's carbon emissions. These authors claim that reducing the health care sector's environmental effects and reducing greenhouse-gas emissions would not only improve health for everyone but

TABLE 4. Average Report Turnaround Time for Studies Complete to Final Signature in Hybrid System

Modality	Onsite	Remote
CT – ED	35	28*
CT – Inpatient	138	89*
MR – ED	52	39*
MR – Inpatient	312	80*
US – ED	24	18
US – Inpatient	84	65*
XR – ED	14	12
XR – Inpatient	78	57*

*p < 0.05.

reduce costs of care and potentially reduce existing health care inequities (22). While a comparative analysis of energy used in a radiology department is beyond this manuscript, it is highly likely that the most variable source of carbon emissions is the commutes of personnel to and from the hospital. Furthermore, environmental concerns tend to resonate more strongly with younger generations from which radiology departments wish to recruit (23). Thus, leadership interested in minimizing carbon emissions within health care and improving the organization's attractiveness among younger generations may wish to utilize and market their hybrid model. Utilization of a hybrid model in a radiology department could therefore reduce the carbon footprint as fewer staff would drive into work, thereby reducing the number of parking spaces needed as well as fewer offices and work spaces.

Ultimately, the hybrid model implemented during the early days of COVID-19 has the pleasant consequence of mitigating burnout and sustaining clinical operations, while improving productivity. Other benefits may include improved hospital net revenue and recruitment/retention advantages for female and/or younger colleagues.

REFERENCES

- Bundy JJ, Hage AN, Srinivasa RN, et al. Burnout among interventional radiologists. *J Vasc Interv Radiol* 2020; 31:607–613. e1 2.
- Shanafelt TD, Boone S, Tan L, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Arch Intern Med* 2012; 172:1377–1385.
- Chew FS, Mulcahy MJ, Porrino JA, et al. Prevalence of burnout among musculoskeletal radiologists. *Skeletal Radiol* 2017; 46:497–506.
- Pulcrano M, Evans SRT, Sosin M. Quality of life and burnout rates across surgical specialties: a systematic review. *JAMA Surg* 2016; 151:970–978.
- Harolds JA, Parikh JR, Bluth EI, et al. Burnout of radiologists: frequency, risk factors, and remedies: a report of the ACR commission on human resources. *J Am Coll Radiol* 2016; 13:411–416.
- Higgins MCSS, Siddiqui AA, Kosowsky T, et al. Professional fulfillment, intention to leave, and sleep-related impairment among radiology trainees across the United States (US): a multisite epidemiologic study. *Acad Radiol* 2022. S1076-6332(22).
- Canon C, Chick JFB, Dequesada I, et al. Physician Burnout in radiology: perspectives from the field. *AJR* 2021. online first manuscript.
- W Hales T, H Nochajski T, A Green S, et al. Twelve-month organizational study examining the associations among behavioral healthcare worker's perceptions of autonomy, decision-making power, organizational commitment, and burnout: reconceptualizing the role of commitment in shaping staff member experiences of the work environment. *J Community Psychol* 2021. doi:10.1002/jcop.22711. Epub ahead of print. PMID: 34545577.
- Giess CS, Ip IK, Gupte A, et al. Self-reported burnout: comparison of radiologists to nonradiologist peers at a large academic medical center. *Acad Radiol* 2022; 29:277–283.
- Fishman MDC, Mehta TS, Siewert B, et al. the road to wellness: engagement strategies to help radiologists achieve joy at work. *Radiographics* 2018; 38:1651–1664.
- Silva III E, Breslau J, Barr RM, et al. ACR white paper on teleradiology practice: a report from the task force on teleradiology practice. 2013
- Prabhakar AM, Glover 4th M, Schaefer PW, et al. Academic radiology departmental operational strategy related to the coronavirus disease 2019 (COVID-19) pandemic. *J Am Coll Radiol* 2020; 17:730–733.
- Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020; 382:727–733.
- Bruno MA, Petscavage-Thomas J. Brief communication: a departmental 'command center' to facilitate staff safety and patient care during the peak of the COVID-19 pandemic. *Clin Imaging* 2021; 74:19–21.
- Malhotra A, et al. *JACR* 2020; 14:1525–1531.
- Quraishi MI, Rizvi AA, Heidel RE. Off-site radiology workflow changes due to the coronalvirus disease 2019 (COVID-19) pandemic. Case studies in clinical practice management. *J Am Coll Radiol* 2020; 17:878–881.
- Yacoub JH, Swanson CE, Jay AK, Cooper C, Spies J, Krishnan P. The Radiology Virtual Reading Room: During and Beyond the COVID-19 Pandemic. *J Digit Imaging* 2021; 34:308–3119. doi:10.1007/s10278-021-00427-4. PMID: 33620622; PMCID: PMC7901504.
- Wachter R. *Radiology rounds in the digital doctor*. New York: McGraw Hill Education, 2015:47–63.
- Hardy SM, McGillen KL, Hausman BL. Mom's added burden. *J Am Coll Radiol* 2021; 18:103–107.
- Stropoli R. Are we really more productive working from home? *Chicago Booth Rev* 2021. Available at: <https://www.chicagobooth.edu/review/are-we-really-more-productive-working-home> Accessed January 4, 2022.
- Schoen J, McGinty G, Quirk C. Radiology in our changing climate: a call to action. *J Am Coll Radiol* (1546-1440) 2021; 18:1041.
- Dzau VJ, Levine R, Barrett G, et al. Decarbonizing the US Health Sector—a call to action. *New England J Med* 2021.
- Ballew M, Marlon J, Rosenthal S, et al. Do younger generations care more about global warming? Yale Program on Climate Change Communication. 2019. Available at: <https://climatecommunication.yale.edu/publications/do-younger-generations-care-more-about-global-warming>. Accessed December 14, 2021