Advances in Radiation Oncology

# Implementing a Novel Remote Physician Treatment Coverage Practice for Adaptive Radiotherapy during the Coronavirus Pandemic

--Manuscript Draft--

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| Manuscript Number: | ADVANCESRADONC-D-20-00155R1 |
| Article Type: | Letter to the Editor |
| Section/Category: | COVID-19 |
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| Abstract: | Introduction: The COVID-19 pandemic has placed an increased importance on physical distancing to minimize the risk of transmission in radiation oncology departments. The pandemic has also increased the use of hypo-fractionated treatment schedules where MR-guided online adaptive radiotherapy (ART) can aid in dose escalation. This specialized technique requires increased staffing in close proximity, thus requiring novel coverage practices to increase physical distancing while still providing specialty care.<br>Methods: A remote physician ART coverage practice was developed and described using commercially available software products. Our remote physician coverage practice provided control to the physician to contour, and review images and plans. The time from completion of image registration to the beginning of treatment was recorded for 20 fractions before remote physician ART coverage and 14 fractions after implementation of remote physician ART coverage. Visual quality was calculated using cross correlation between the treatment delivery computer screen and the remote physician screen.<br>Results: For the 14 fractions after implementation, the average time from image registration to the beginning of treatment was 24.9±6.1min. In comparison, the 20 fractions analyzed without remote coverage had an average time of 29.2±9.8min. The correlation between the console screen and the remote physician screen was R = 0.95.<br>Conclusion: Our novel remote physician ART coverage practice is secure, interactive, timely, and of high visual quality. When utilizing remote physicians for ART, our department was able to increase physical distancing to lower the risk of virus transmission while providing specialty care to our patients in need. |

## Summary

Alternative methods of care are needed to lower the relative risk of infection in radiation oncology departments by promoting physical distancing, and to provide the ability for radiation oncologists to cover adaptive radiotherapy. Our institution developed a novel remote physician adaptive coverage practice during the COVID-19 pandemic. The novel coverage practice is similarly secure, interactive, of high visual quality, and timely to in-person adaptive radiotherapy coverage.

Title Page (WITH Author Details)

# Implementing a Novel Remote Physician Treatment Coverage Practice for Adaptive Radiotherapy during the Coronavirus Pandemic

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**Funding Statement:**

None.

**Conflict of Interest:**

Mr. Price reports personal fees from Sun Nuclear Corporation, personal fees from ViewRay, Inc., outside the submitted work.

Dr. Kim reports grants and personal fees from Varian, grants and personal fees from ViewRay, Inc., outside the submitted work.

Dr. Henke reports personal fees from ViewRay Inc., grants and other from Varian Medical Systems, outside the submitted work.

Dr. Knutson has nothing to disclose.

Dr. Spraker reports grants from Varian Medical Systems, Inc., grants from American College of Radiology, grants from Emerson Collective, outside the submitted work.

Dr. Michalski reports personal fees from ViewRay, Inc, outside the submitted work.

Dr. Hugo reports grants and personal fees from Varian Medical Systems, grants from Siemens, grants from ViewRay, outside the submitted work.

Dr. Robinson reports grants and personal fees from Varian, grants from Elekta, other from Radialogica, outside the submitted work.

Dr. Green reports personal fees from ViewRay, Inc., outside the submitted work.

# Remote Physician Practice for Adaptive Radiotherapy

Abstract

Background and Purposes: The COVID-19 pandemic has placed an increased importance on physical distancing to minimize the risk of transmission in radiation oncology departments. The pandemic has also increased the use of hypo-fractionated treatment schedules where MR-guided online adaptive radiotherapy (ART) can aid in dose escalation. This specialized technique requires increased staffing in close proximity, thus requiring novel coverage practices to increase physical distancing while still providing specialty care.

Materials and Methods: A remote physician ART coverage practice was developed and described using commercially available software products. Our remote physician coverage practice provided control to the physician to contour, and review images and plans. The time from completion of image registration to the beginning of treatment was recorded for 20 fractions before remote physician ART coverage and 14 fractions after implementation of remote physician ART coverage. Visual quality was calculated using cross correlation between the treatment delivery computer screen and the remote physician screen.

Results: For the 14 fractions after implementation, the average time from image registration to the beginning of treatment was 24.9±6.1min. In comparison, the 20 fractions analyzed without remote coverage had an average time of 29.2±9.8min. The correlation between the console screen and the remote physician screen was R = 0.95.

Conclusion: Our novel remote physician ART coverage practice is secure, interactive, timely, and of high visual quality. When utilizing remote physicians for ART, our department was able to increase physical distancing to lower the risk of virus transmission while providing specialty care to our patients in need.

**Introduction:**

The Coronavirus 2019 disease (COVID-19) pandemic has created a global healthcare system crisis with increased demands in medical equipment, space, and staffing[1,2]. In addition to the increased demands, COVID-19 is highly infectious[3,4], placing healthcare workers at risk of infection while caring for patients[5,6] in a time when personal protective equipment is in short supply[7]. This underscores the importance of developing novel approaches to provide care for patients while minimizing risk to patients and staff[8].

Radiation oncology departments have responded to the global pandemic through restructuring of staffing, reducing patient volume, and implementing triage processes for COVID-19 suspected and positive patients to reduce exposure risks for other patients and staff. Additionally, radiation oncology departments have adopted more hypo-fractionated treatment schedules to decrease patient time in the clinic[9–12]. MRI-guided radiation therapy with daily adaptation is an approach that aids in dose escalation with shorter treatment regimens[13,14]. However, staffing requirements for daily adaptation include a radiation oncologist, medical physicist, and 2-3 radiation therapists in close proximity for extended periods of time while sharing common equipment. Possible infection or reallocation of certain specialty team members, such as radiation oncologists, could limit the use of these specialty care procedures. To limit this possibility, new digital care and coverage practices are needed to reduce in-person interactions and subsequent transmission risks for adaptive radiotherapy (ART).

With this in mind, a novel, digital method to provide remote physician ART coverage for image review, contouring, and plan review was created and implemented in our department. Our remote physician ART coverage practice was required to be secure, interactive, of high visual quality, and timely to provide another avenue for physical distancing among staff and patients.

Here we describe the structure and implementation of a remote physician ART coverage practice in our radiation oncology department.

## Materials and Methods

Prior to the COVID-19 pandemic, the ART team included two radiation therapists, an advanced practice radiation therapist (APRT), a medical physicist, and a radiation oncologist. Department policies, modeled from national guidelines for SBRT and prior ART workflow publications[15–20], require physician presence at every fraction for image approval, contour review, plan approval, gating window approval and to direct treatment. Physicist presence is required for contour review and assignment, plan generation, quality assurance, motion management, and troubleshooting. Our department delivers an average of 4-6 ART treatments a day on an MRI-guided linac, MRIdian (ViewRay, Oakwood Village, OH). The ART process is as follows. The patient is positioned in room by the therapy team, followed by volumetric MRI acquisition with registration and couch shift performed by the therapists. For first fraction SBRT or hypo-fractionated treatments, the physician is physically present for registration approval and returns after adapted plan generation. The APRT begins contouring, while the medical physicist arrives during this process, verifying contour integrity. Once contouring is complete, the physicist performs any necessary additional contouring and generates the adaptive plan. The physician is then called back to the machine to review contours and the plan. Once approved, the medical physicist and therapists perform pre-treatment QA. Lastly, all members of the ART team review the pre-treatment real-time MRI cine with the physician providing the final approval of gating parameters. Both the physician and physicist are required to remain readily available during the treatment delivery.

To facilitate remote coverage, collaboration with the vendor was required. A separate, local-area network (LAN), Ethernet connected (Wi-Fi disconnected) computer behind the institution's firewall was secured in the department and access granted to a limited number of physicists and physicians. At the beginning of each treatment day, a new, random password generated TeamViewer (Göppingen, Germany) session was created and communicated with the vendor engineer without knowledge of the remote computer's login. The engineer could then gain access to the remote computer to create a ScreenConnect (ConnectWise, Tampa, FL) session with the treatment delivery system (TDS) that only he or she could create. Once the TeamViewer connection was used, the vendor engineer could not log back in unless a new password was created. The physician can then remotely access the remote computer via a Remote Desktop Connection to view and gain control of the TDS user interface (UI) via the ScreenConnect software. At the end of the treatment day, the computer's Ethernet connection is physically disconnected to avoid any possibility of unauthorized access of the TDS. The system design is illustrated in Figure 1.

The remote physician coverage practice has been performed for 14 patient treatment fractions thus far. The physician was required to be physically on-campus during the remote coverage practice. For the remote physician coverage practice, a text message was sent during patient setup, providing the physician adequate time to access the remote computer. Once ready, the physician called the therapy team via telephone, enabling verbal communication during the remote process. Since simultaneous control of the TDS UI is not advised during this process, the physician would announce when he or she would gain control of the TDS UI. At that point, the ART process was similar to the pre-COVID-19 process where the physician could control the cursor to review setup, adjust registration, contour, review dose, and review/adjust gating parameters just as he or she would if physically present at the machine. A physicist was required to be physically present during all remote steps and to perform dose calculations. If at any time a member of the ART team felt uncomfortable with the remote coverage practice, the physician would come to the machine for in-person adaptation. Any situations requiring in-person adaptation or ART process interruptions due to remote coverage were captured.

Visual quality similarity was determined by calculating cross correlation[21] between the TDS computer screen and the physician's computer screen using a MATLAB script (MathWorks, Natick, MA). To assess timeliness of the remote coverage practice, treatment times were collected from the time of completion of image registration to the time that the treatment delivery commenced. This data was collected for 14 patients after implementation of the remote physician coverage practice and for 20 randomly selected patients without remote coverage. All statistical analysis was performed in Microsoft Excel (Microsoft, Redmond, WA).

## Results

With the assistance of the vendor, we were able to successfully establish a secure and remote connection to our MRIdian system. To gain access to the TDS UI, three levels of passwords were required. Both the institutional physicist and vendor were required to initiate the connection while only the physicist/physician had the password to the remote computer desktop and only the vendor had the password to the ScreenConnect connection to the MRIdian system, thus providing increased security.

Our institution was able to successfully provide remote coverage and control of the ART process on the MR-linac system for 14 ART treatments. Of the 14 remote physician ART treatments, 5 included remote contouring by the physician in addition to image, contour, plan, and gating parameter review for all treatments. In-person physician coverage was not needed for any of the patients in this investigation. Excessive background noises on the call could cause slight distractions or interruptions in our process and were addressed with further communication if it occurred.

In assessing visual quality of the remote coverage practice, the correlation between the TDS computer screen and the remote computer screen was R = 0.95. An example of the remote coverage screen is shown in Figure 2. Physicians noted a subjective minimal delay of the cursor motion compared to being physically at the TDS. They commented that once one was accustomed to this delay and realized the cursor would consistently catch up to all motions and clicks, they could work as efficiently as if physically at the console.

Over the 14 remote physician ART fractions, the average time from image registration completion to treatment delivery was 24.9 ± 6.1min (median = 25.0min). For the five remote physician-contoured ART fractions, the average time from registration to treatment delivery was 25.1±7.5min. The sites treated using the remote coverage practice included 9 liver, 3 pancreas, and 2 adrenal cases from 6 different patients. For the 20 patients without remote coverage, the average time from registration completion to treatment delivery was 29.2 ± 9.8min (median = 23.5 min). The sites analyzed for in-person coverage include 15 pancreas, 4 liver, and 1 lung case from 10 different patients. A distribution of the adaptive process times are shown in Figure 3.

## Discussion

With proper IT infrastructure and vendor collaboration, we were able to successfully implement a novel remote physician ART coverage practice. There were no hardware or software limitations that would prevent implementation in other radiation oncology departments with the MRIdian MR-Linac, and potentially with other vendors as well. This novel remote coverage practice provides flexibility during the COVID-19 pandemic due to staffing restrictions from illness or reallocation to other departments for clinical care. It is especially useful if a physician has been exposed to a COVID-19 patient but is asymptomatic and thus clear to work per hospital policy. The ability for physicians to contour and approve plans remotely is a high standard of physical distancing in these increased risk scenarios. With the physician working remotely, the potential of spread within the department is decreased since the physician has more interactions with a variety of groups, including patients, in the department.

Leadership and compliance teams' support/approval to implement this remote physician ART coverage practice was necessary. A potential hurdle to successful implementation was the added critical physician planning review and approval steps during on-line ART treatments, which increases the amount of high risk potential failure modes compared to conventional treatments[17,22]. Understanding the risks presented in these previous publications while incorporating more verbal communication during the remote physician coverage practice contributed to leadership and compliance support. In addition to real-time remote decision making, cyber security concerns for direct remote control of the TDS over an internet network also posed an obstacle. Collaboration with our IT group and vendor was paramount to ensure proper security of the system and limit the chance of unauthorized access to the TDS. Requiring that both the vendor engineer and physicist to have login credentials at separate steps in the process to initiate remote connection also increased security and lowered the possibility of an individual mistakenly gaining access to the TDS.

Remote coverage should not degrade the image quality of the TDS since physicians need to segment and evaluate contours remotely. Potential image degradation could lead to inaccurate contours that could negatively affect patient care. A high correlation calculated translates to minimal image quality loss thus providing our physicians with similar visual perception to in-person coverage.

A remote physician coverage practice for ART should not be significantly more time consuming than the established process. The average times of the adaptive processes were within 5 minutes of each other; the remote physician coverage practice being less time consuming. Since the remote coverage practice was implemented after our department instituted policies to decrease patients on treatment, it is difficult to determine if remote physician coverage was faster or if these times are a result of decreased clinical activity. Our physicians typically cover multiple radiopharmaceutical procedures, consults, follow-ups and on-treatment visits, in addition to their ART coverage roles. Also, some adaptive cases are more challenging than others requiring more time in the adaptive process to achieve an appropriate plan which would not average out over 14 fractions. Regardless of needing more data to confirm its timeliness compared to our traditional practice, we were able to eliminate upwards of 20-30 minutes of physician time physically at the machine, thus limiting in-person social interactions associated with risk of COVID-19 transmission.

It is important to note that permission from hospital compliance and departmental leadership teams was in context of a global pandemic with high risk of infection to patients and staff. In a time where proximity can result in morbidity or mortality, it is a secure and efficient practice to continue providing high quality and shortened treatment schedules for radiation oncology patients. Outside of a pandemic setting, remote physician coverage within a department may provide faster responses from physicians who may be located elsewhere in the radiation oncology department. Providing remote coverage technology may also increase the accessibility and relative ease for physicians to cover their patient's adaptive treatment throughout the course of radiotherapy, thus limiting cross-coverage. In a scenario where an institution does not have an APRT, a dosimetrist, physicist, or another physician located in the department can assist in contouring and/or other workflow steps based on their established process. The reliance on IT support and the vendor can make access to this technology more difficult if a certain IT expertise or vendor support is not readily available during implementation or treatment setup. Further collaboration is needed with vendors, especially those without remote capabilities, to improve and/or utilize this technique on all adaptive platforms. Even without remote control capabilities, remote view-only of the treatment delivery is possible with commercially available products[23], thus facilitating some form of remote coverage practice on other platforms for the time being.

Future steps for this work include gathering more data on the timing of the process as the patient load returns to normal. In addition, we would like to identify if there are certain treatment sites that shouldn't be covered with remote physician ART. Increased remote coverage experience will help identify these cases. Our institution will also perform a formal FMEA analysis to identify crucial steps and further improve our process. In addition to providing remote coverage, this technology provides a platform for collaboration amongst sub-specialists in our department if not readily available to come to the treatment machine. However, for simultaneous collaboration amongst multiple users, view-only access may be the best approach. Based on initial experience, our department was able to successfully implement this novel technology, providing information on treatment coverage alternatives for other institutions with a MRIdian system as we continue to manage COVID-19 across the world.

## Conclusion

At our institution, we were able to implement remote physician treatment coverage alternatives for adaptive radiotherapy on a MRIdian system during the COVID-19 pandemic. Our system and remote coverage practice is similarly secure, interactive, of high visual quality, and timely compared to our in-person treatment coverage practice. High quality specialty care is still achievable during the COVID-19 pandemic with remote techniques that promote physical distancing to help limit the spread of COVID-19 amongst our radiation oncology team and patients.


## Acknowledgements

We would like to thank the engineers and IT professionals both at our hospital and the vendor: XXX of XXX; XXX, XXX, and XXX of XXX.; XXX of XXX.


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**Statement of Ethics Board Approval**

All patients included in this study were treated with MRIgRT in 2020 and are part of a prospective MRIgRT patient registry (registry #2013111222).

**Figure Captions**

Figure 1. Remote physician ART coverage software and hardware system.

Figure 2. Example of remote coverage screen.

Figure 3. Distribution of adaptive process times with and without remote coverage.

Figure 1

Click here to access/download;Figure;Figure 1 Remote Physician ART Workflow.pdf

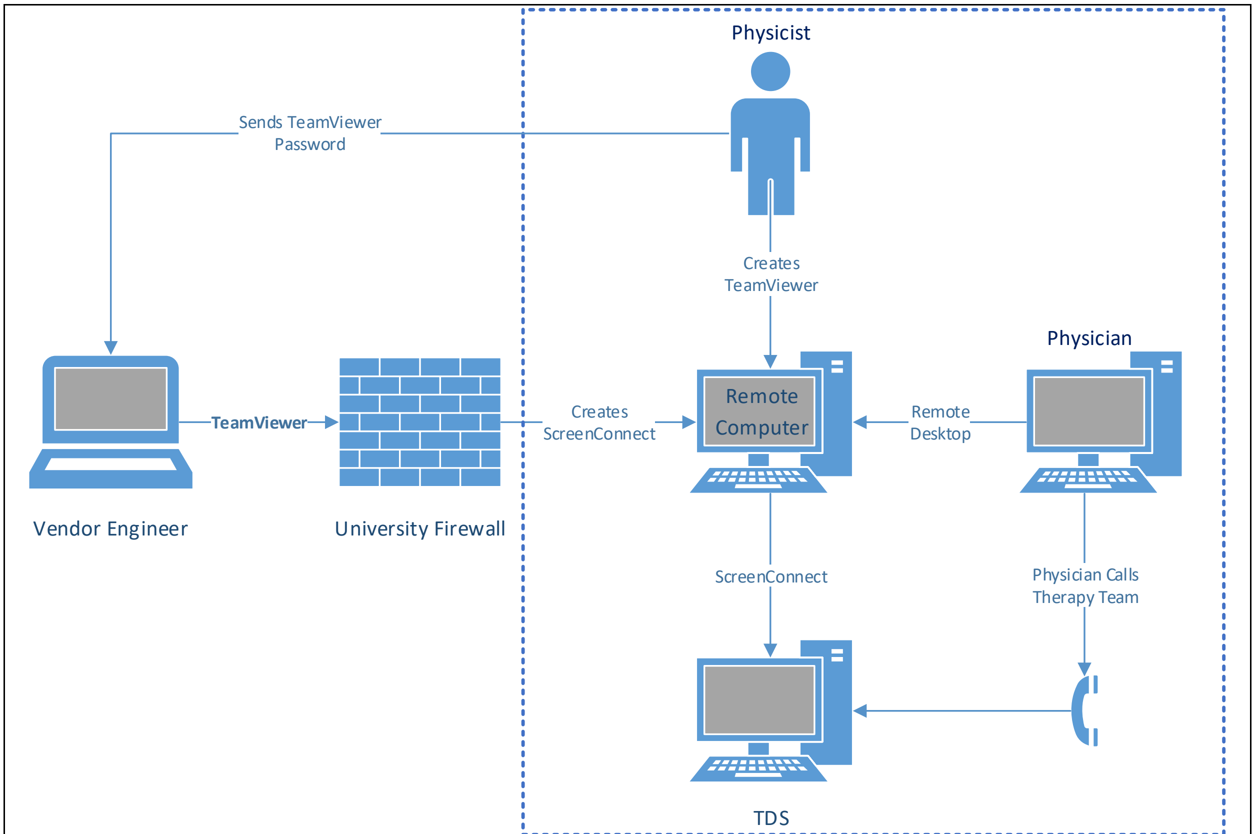


Figure 1. Remote physician ART coverage software and hardware system.

Figure 2. Example of remote coverage screen.

Figure 3

Click here to access/download;Figure;Figure 3 Time Distribution.docx.pdf

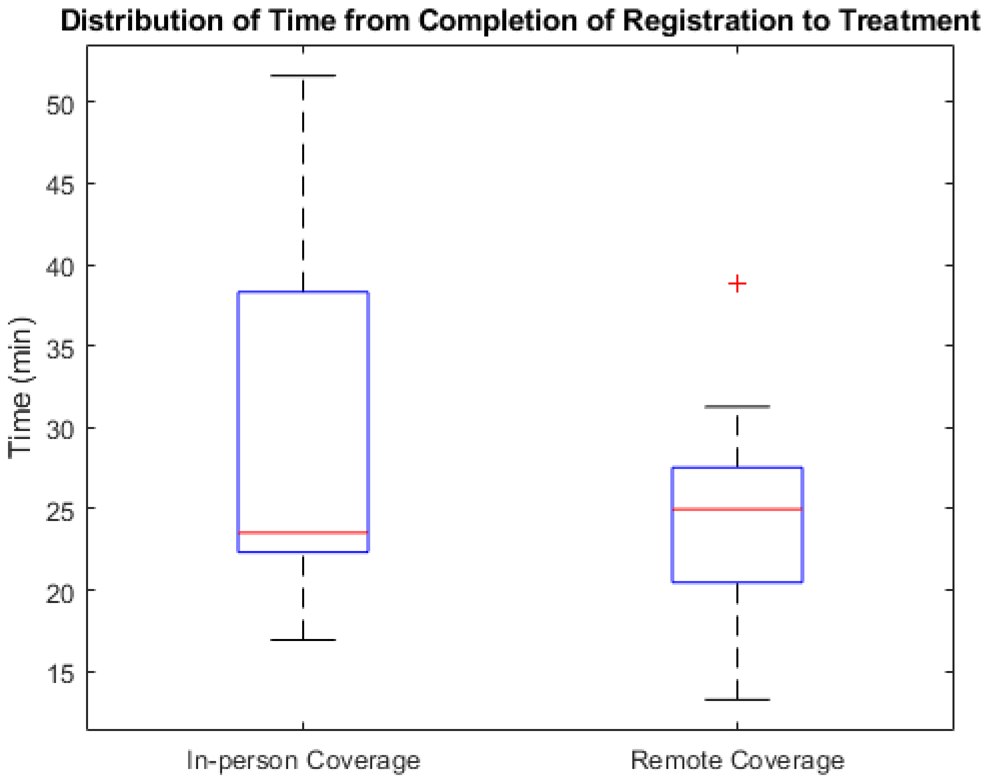


Figure 3. Distribution of adaptive process times with and without remote coverage.