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Scientific Article

Implementing a Novel Remote Physician Treatment Coverage Practice for Adaptive Radiation Therapy During the Coronavirus Pandemic

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Abstract

Purpose: The 2019 coronavirus disease 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 hypofractionated treatment schedules where magnetic resonance-guided online adaptive radiation therapy (ART) can aid in dose escalation. This specialized technique requires increased staffing in close proximity, and thus the need for novel coverage practices to increase physical distancing while still providing specialty care.

Methods and Materials: 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 of the 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 and remote-physician computer screens.

Results: For the 14 fractions after implementation, the average time from image registration to the beginning of treatment was 24.9 $\pm$ 6.1 minutes. In comparison, the 20 fractions analyzed without remote coverage had an average time of 29.2 $\pm$ 9.8 minutes. The correlation between the console and remote-physician screens was $R = .95$.

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

Introduction

The 2019 coronavirus disease (COVID-19) pandemic has created a global health care 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 health care workers at a 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 the 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 COVID-19–positive patients to reduce exposure risks for other patients and staff. Additionally, radiation oncology departments have adopted more hypofractionated treatment schedules to decrease patient time in the clinic.[9-12] Magnetic resonance imaging (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 to 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 radiation therapy (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. Herein, we describe the structure and implementation of a remote-physician ART coverage practice in our radiation oncology department.

Methods and materials

Before the COVID-19 pandemic, the ART team included 2 radiation therapists, an advanced practice radiation therapist (APRT), a medical physicist, and a radiation oncologist. Department policies, modeled from national guidelines for stereotactic body radiation therapy 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 to 6 ART treatments a day on an MRI-guided linear accelerator (LINAC; MRIdian; ViewRay, Oakwood Village, OH).

The ART process is as follows. The patient is positioned in a room by the therapy team, followed by volumetric MRI acquisition with registration and couch-shift performed by the therapists. For first fraction stereotactic body radiation therapy or hypofractionated 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 to verify contour integrity. Once contouring is complete, the physicist performs any necessary additional contouring and generates the adaptive plan. The, the physician is called back to the machine to review contours and the plan. Once approved, the medical physicist and therapists perform pretreatment quality assurance. Lastly, all members of the ART team review the pretreatment real-time MRI cine with the physician and provide 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, a collaboration with the vendor was required. A separate, local-area network, ethernet-connected (WiFi-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 they 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

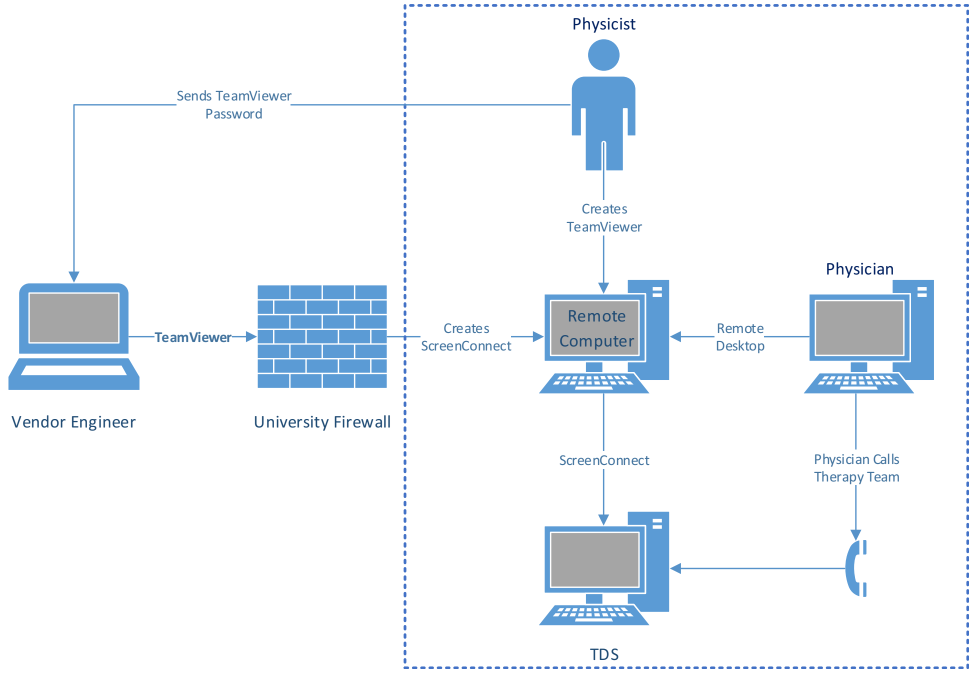

Figure 1 Remote physician adaptive radiation therapy coverage software and hardware system.

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 they 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 they would if physically present at the machine. A physicist was required to be physically present during all remote steps and 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 and physician's computer screens 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. These data were collected for 14 patients after implementation of the remote-physician coverage practice and for 20 randomly selected patients without remote coverage. All statistical analyses were performed in Microsoft Excel (Microsoft, Redmond, WA).

Results

With the assistance of the vendor, we successfully established a secure and remote connection to our MRIdian system. To gain access to the TDS UI, 3 levels of passwords were required. Both the institutional physicist and vendor were required to initiate the connection, but 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 to provide increased security.

Our institution successfully provided remote coverage and control of the ART process on the MRI-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

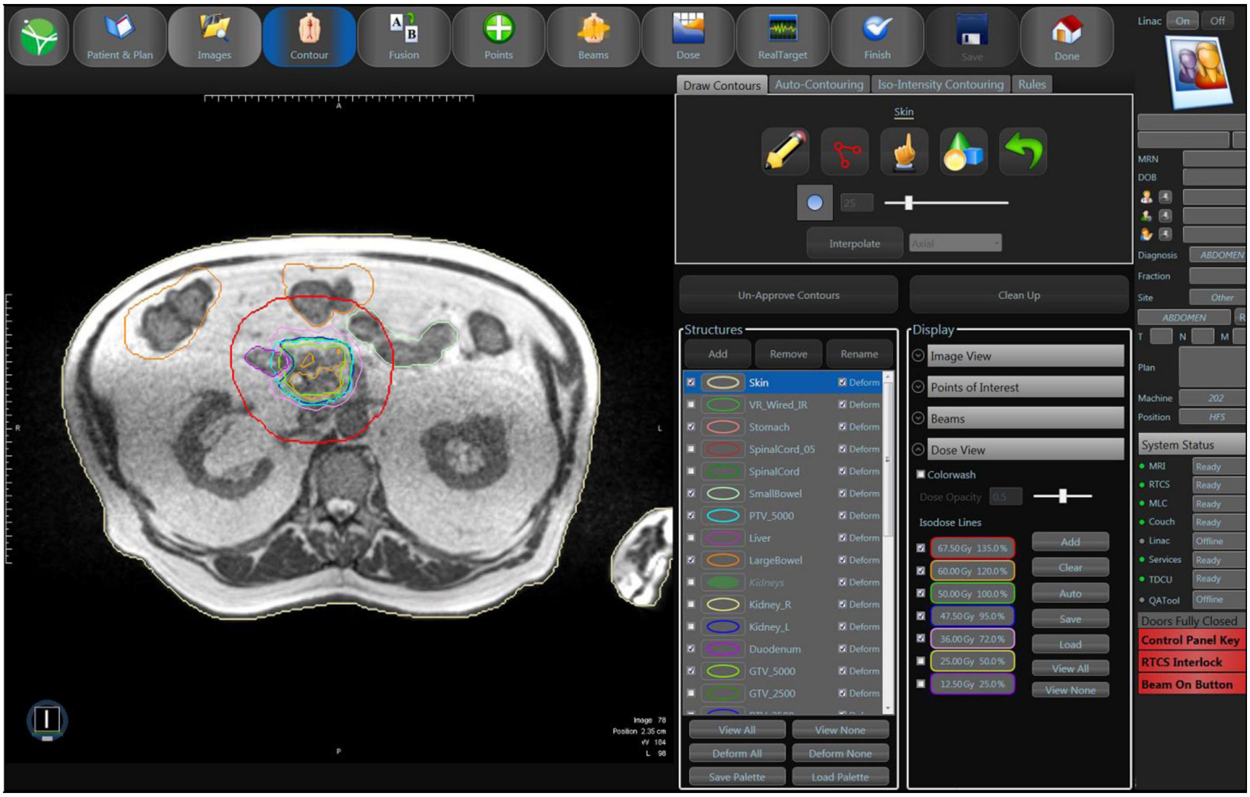

Figure 2 Example of remote coverage screen.

investigation. Excessive background noises on the call could cause slight distractions or interruptions in our process and were addressed with further communication as needed.

In assessing visual quality of the remote coverage practice, the correlation between the TDS and remote computer screens was $R = .95$. An example of the remote coverage screen is shown in Figure 2. Physicians noted a subjective minimal delay of the cursor motion compared with 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 ± 6.1 minutes (median: 25.0 minutes). For the 5 remote-physician contoured ART fractions, the average time from registration to treatment delivery was 25.1 ± 7.5 minutes. 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 ± 9.8 minutes (median: 23.5 minutes). The sites analyzed for in-person coverage include 15 pancreas, 4 liver, and 1 lung cases from 10 different patients. A distribution of the adaptive process times is shown in Figure 3.

Discussion

With proper information technology (IT) infrastructure and vendor collaboration, we successfully implemented a novel remote-physician ART coverage practice. There were no hardware or software limitations that prevented implementation in other radiation oncology departments with the MRIdian MR-Linac, and potentially other vendors. This novel remote coverage practice provides flexibility during the COVID-19 pandemic owing to staffing restrictions from illness or reallocation to other departments for clinical care. The practice 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 because 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

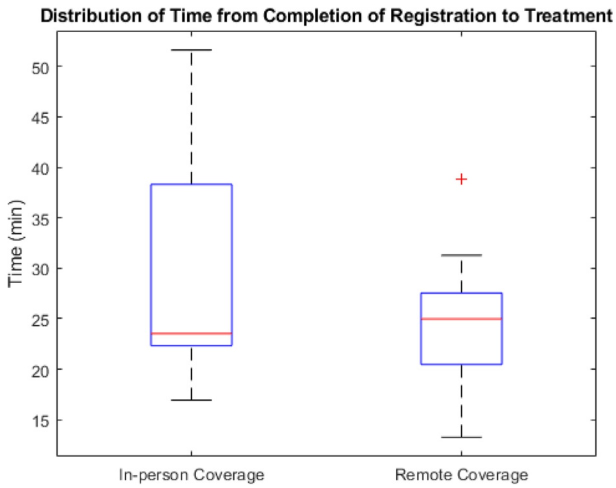

Figure 3 Distribution of adaptive process times with and without remote coverage.

was necessary. A potential hurdle to successful implementation was the added critical physician planning review and approval steps during online ART treatments, which increase the amount of high-risk potential failure modes compared with 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 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 because 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 translates into minimal image quality loss and provides 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, and the remote-physician coverage practice was even less time consuming. The remote coverage practice was implemented after our department instituted policies to decrease patients on treatment, but whether remote-physician coverage was faster or if these times are a result of decreased clinical activity is difficult to determine. Our physicians typically cover multiple radiopharmaceutical procedures, consultations, follow-up visits, and on-treatment visits, in addition to their ART coverage roles. Also, some adaptive cases are more challenging than others and require more time in the adaptive process to achieve an appropriate plan, which would not average out over 14 fractions. Regardless of the need for more data to confirm its timeliness compared with our traditional practice, we eliminated upward of 20 to 30 minutes of physician time physically at the machine; thus, limiting in-person social interactions associated with the risk of COVID-19 transmission.

Of note, 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, continuing to provide high-quality and shortened treatment schedules for radiation oncology patients is a secure and efficient practice. 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 patients' adaptive treatments throughout the course of radiation therapy; thus, limiting cross overage. In a scenario where an institution does not have an APRT, a dosimetrist, physicist, or other physician located in the department can assist in contouring and/or other workflow steps based on established processes. 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 use 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 should not be covered with remote-physician ART. Increased remote coverage experience will help identify these cases. Our institution will also perform a formal failure mode and effects analysis to identify crucial steps and further improve our process. In addition to providing remote coverage, this technology provides a platform for collaboration among subspecialists in our department if they are not available to come to the treatment machine. However, for simultaneous collaboration among multiple users, view-only access may be the best approach. Based on initial experience, our department successfully implemented 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.

Conclusions

At our institution, we were able to implement remote-physician treatment coverage alternatives for adaptive radiation therapy 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 with 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 among our radiation oncology team and patients.

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