Pilot Study of a Radiation Oncology Telemedicine Platform

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ABSTRACT

Purpose: A pilot study was undertaken to develop an integrated telemedicine platform for radiation oncology at Memorial Sloan-Kettering Cancer Center (MSKCC) and its regional sites. The platform consisted of a computer system with simultaneous display of multiple live data portals including 1) video-conferencing between physicians, 2) radiology, and 3) radiation treatment-planning system (RTPS). **Methods and Materials:** Two MSKCC regional centers were set up with a widescreen monitor, a dedicated computer, and a web camera with microphone. Each computer ran a Microsoft operating system, utilized video-conferencing software, and connected to the MSKCC Ethernet. This allowed for access to the health information system, radiology (web-based picture archiving and communication systems), RTPS, shared network drives and the internet. **Results:** After 3 months, physicians at two MSKCC sites were successfully able to implement the proposed telemedicine platform. A small sample of cases (prostate, breast, head and neck, and anal cases) were tested. Radiology images, radiation treatment volumes and plans, and portal images were reviewed. Side-by-side comparison of contouring techniques was performed. The platform allowed physicians to remotely review details of cases efficiently. The interactions of the telemedicine platform improved clinical understanding of each case and often resulted in contouring changes. **Conclusion:** From this experience, we feel that telemedicine could have a significant clinical impact on patient care, especially at centers with satellite clinics. The future goal of the system will be the development of a virtual tumor board for radiation oncologists. We envision the simultaneous display of multiple clinical components, including face photo, pathology, tumor images/videos of procedures, radiology, RTPS, and anatomy/contouring databases, on one screen surface.

Keywords: Telemedicine, video-conferencing, virtual tumor board, radiation oncology
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1. INTRODUCTION

Telemedicine is the use of medical information transferred from one location to another via electronic communications to improve patient health. Telemedicine is also associated with telehealth, which encompasses a far wider definition of remote healthcare beyond clinical services. Videoconferencing, image transmission, remote patient monitoring, patient consultations using telecommunications, e-health, and continuing medical education are all considered part of telemedicine and telehealth[1].

Telemedicine is being increasingly used in many areas of medicine including radiology, pathology, and dermatology[2]. Only a limited number of reports exist in the medical literature regarding the use of telemedicine in radiation oncology. The rapidly increasing complexity of radiotherapy due to the advent of innovative techniques (eg, intensity-modulated radiotherapy, image-guided radiotherapy, stereotactic radiosurgery) and imaging modalities demands increasing interaction between radiation oncologists and other specialists. We believe the new technologies in telemedicine can greatly contribute to facilitate such interactions, which in turn will increase the quality of patient care.

Described uses of telemedicine in radiation oncology include quality assurance for review of radiation-treatment portals and radiation dose treatment plans between radiation oncologists[3], collaboration between oncologists and radiologists in target-volume determination[4], patient evaluation for protocol eligibility, and continuing medical education[5]. Real-time patient evaluation via a telemedicine system has also been tested and compared with face-to-face consultation for

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cancer patients[6]. Several major cancer centers have set up telemedicine systems within radiation oncology departments in the U.S., Europe, and Japan.

The Mayo Clinic, for example, communicates with its regional satellite facilities using video-conferencing and remote image display for chart review and routine quality assurance. The Norwegian Radium Hospital has published on the development of a national telemedicine system that includes all radiotherapy satellite units in Norway[7]. In Sweden, telemedicine is being used by radiation oncologists at major academic centers to collaborate on radiation-treatment plans for pediatric cases[8].

With readily available teleconferencing software such as Microsoft NetMeeting and Polycom, telemedicine has become increasingly accessible and widespread. Microsoft NetMeeting, for example, is part of a standard Microsoft Windows package, supports interaction of multiple users, and is capable of audio conferencing. This allows any medical facility that has a PC-based picture archiving and communication systems (PACS), PC-based treatment-planning software, and a PC-based electronic medical record system to set up a telemedicine system to discuss complex cases with input from multiple users. Langmack et al has described how to carry out a remote contouring session between a radiation oncologist and radiologist in different locations using NetMeeting[4]. With the assistance of an Information Technology department, connections can be set up between satellite centers so that multiple off-site medical staff can also participate in the review of complex cases.

We propose an inexpensive platform that assembles readily available hardware and teleconferencing software, such as Microsoft NetMeeting and Polycom, for real-time interactive collaboration across the MSKCC network. We plan to use this technology to develop a telemedicine system for radiation oncology that has broad capabilities and applications.

2. METHODS

Two MSKCC regional centers (MSKCC Phelps and MSKCC Basking Ridge) are located approximately 60 miles from each other and are within 35 miles of the MSKCC main campus in New York City. Both regional centers were set up with the following equipment: a widescreen video monitor, a dedicated computer, a web camera, and a headset with microphone (see Figure 1). Each video monitor was installed in a radiation oncologist’s office to ensure patient confidentiality and compliance with HIPAA guidelines.

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Figure 1: Image of telemedicine platform setup

Each computer connects to the MSKCC Ethernet, runs a Microsoft-based operating system (Windows XP), uses available video-conferencing software (eg, Polycom, Microsoft NetMeeting), and runs the MSKCC radiation treatment planning system (RTPS). These different systems all function together over the MSKCC Ethernet backbone, which allows access to the health information system (HIS), radiology (PACS), MSKCC radiation treatment-planning system, multiple shared network drives, and the internet. The MSKCC main campus and each of the MSKCC regional sites (Sleepy Hollow, Commack, Rockville Center, Basking Ridge) are connected to the same Ethernet backbone. Figure 2 depicts the network architecture of the clinical computer network at MSKCC.

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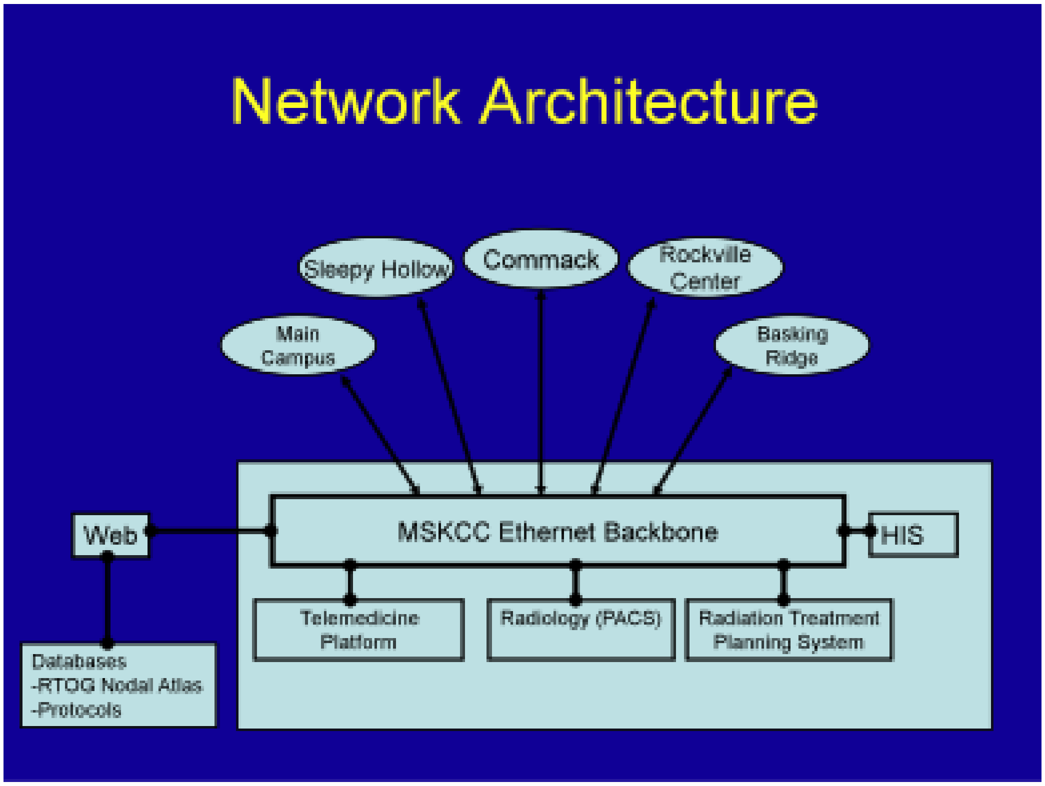

Figure 2: Image depicting network architecture

Two physicians (one at each regional site) utilized Polycom PVX and NetMeeting to perform live videoconferencing. Once a videoconferencing session was initiated, the hosting physician would open the MSKCC radiation treatment-planning system in one window and then share the content of his entire screen. Thereby, a radiation treatment plan opened by the hosting physician could be viewed by both physicians.

A second window running another session of the treatment-planning system could then be opened to view an entirely different patient simultaneously. In this fashion, side-by-side contours and radiation plans could be compared by two physicians at different sites. Other windows could be opened, allowing access to radiology images, anatomy databases and contouring archives. Telemedicine interactions occurred as one-on-one discussions between physicians or as a group discussion between multiple physicians and physicists.

3. RESULTS

After several months, physicians at two MSKCC sites were successfully able to implement the proposed telemedicine platform. A small sample of cases (prostate, breast, head and neck, and anal cases) were tested. Physicians at each site were able to review and discuss radiology images, radiation treatment volumes, treatment plans, and portal images on one screen surface in real time. Side-by-side comparison of contouring techniques was also performed, with simultaneous display of a reference anatomy atlas. Side-by-side treatment-volume comparisons (with two independent treatment-planning sessions open at the same time) were performed live using both Microsoft NetMeeting and Polycom.

The platform allowed physicians to remotely review details of each case efficiently. The interactions of the telemedicine platform improved clinical understanding of each case and often resulted in changes in contouring and ultimately changes in the radiation treatment plan. Shown in Figures 3-6 are screen-capture images of the telemedicine platform comparing treatment volumes for head and neck cancer, prostate cancer, and anal cancer.

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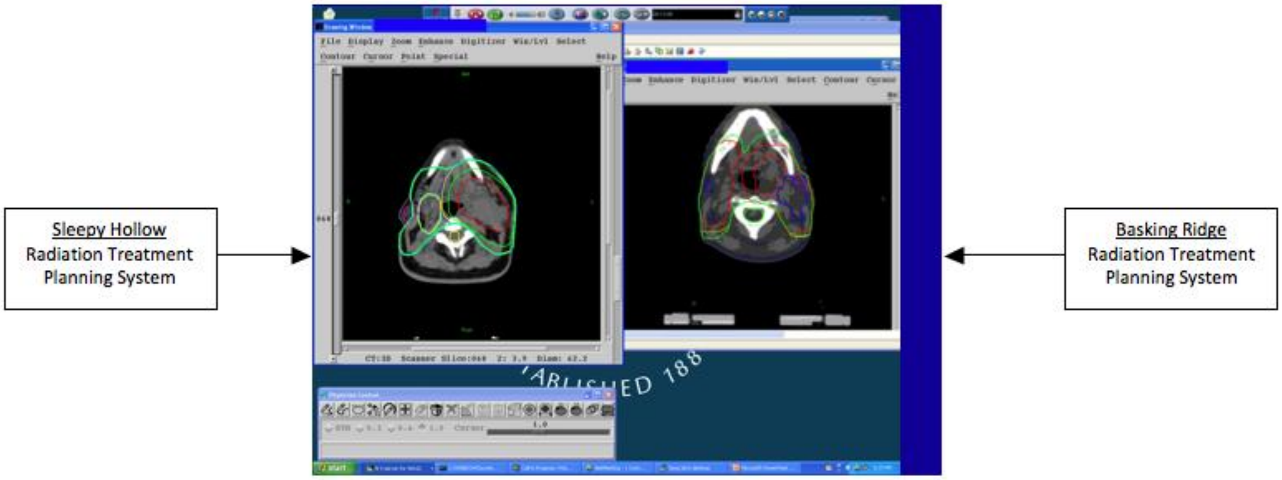

Figure 3. Image showing side-by-side comparison of treatment volumes for head & neck cancer.

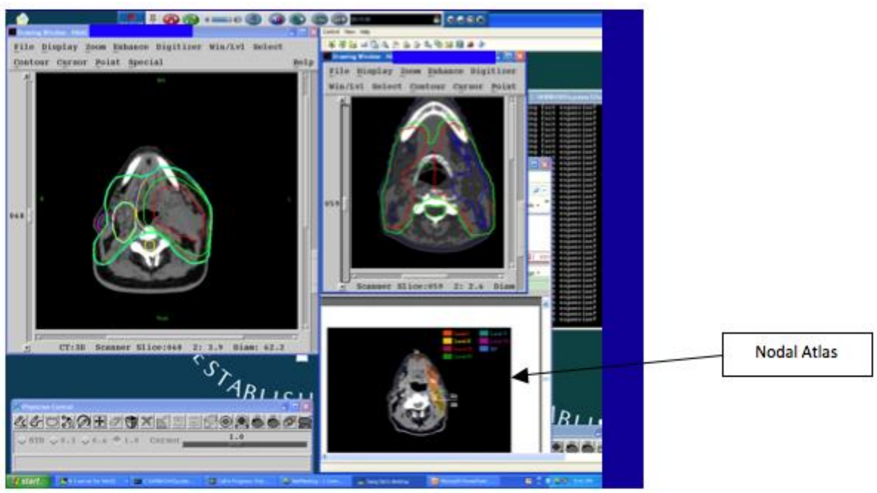

Figure 4. Image showing side-by-side comparison of treatment volumes for head & neck cancer. Nodal atlas shown in separate window.

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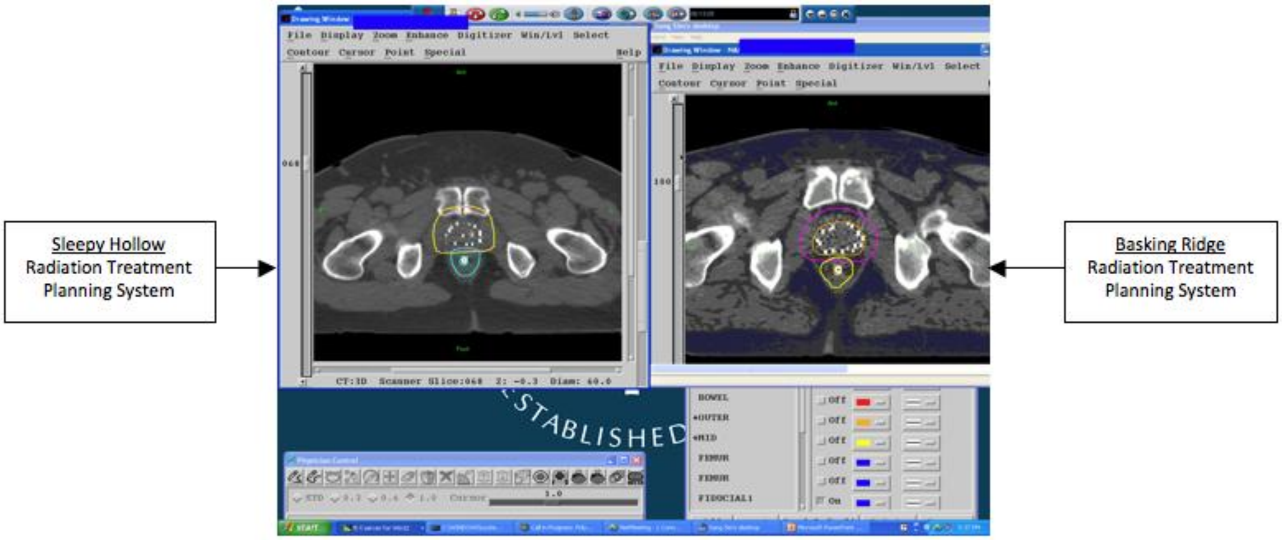

Figure 5. Image showing side-by-side comparison of treatment volumes for prostate cancer.

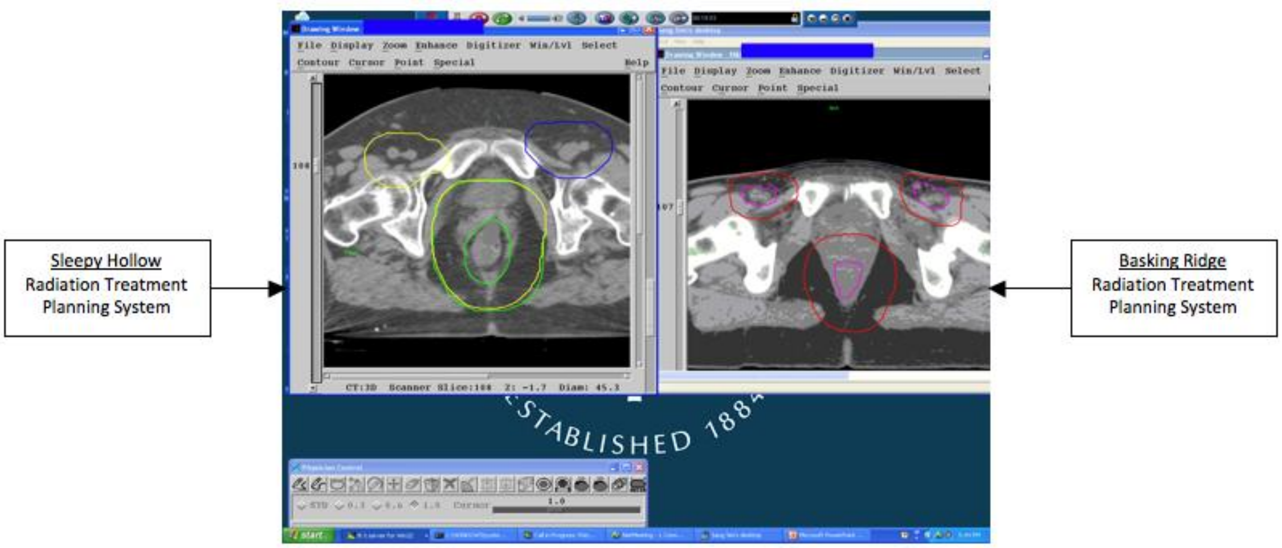

Figure 6. Side-by-side comparison of treatment volumes for anal cancer.

From this experience, we feel that telemedicine could have a significant clinical impact on oncologic care, especially at centers with distant satellite sites. We plan to expand this proof-of-principle and accrue a clinically significant set of data to quantitatively study the advantages of this platform. A future goal of the system will be the development of a virtual tumor board for radiation oncologists. We foresee the ability to display multiple other data portals of clinically relevant information simultaneously, on one screen surface.

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4. DISCUSSION

In the pilot program, the telemedicine platform was limited to physicians at just two regional MSKCC sites. The immediate objective of the telemedicine platform was to allow radiation oncologists and physicists to collaborate more easily on topics such as target-volume definition and review of treatment plans. Telemedicine interactions using the MSKCC radiation treatment-planning system occurred as one-on-one discussions or as a group discussion between multiple colleagues including physicists. The system also has applicability for use in chart rounds, difficult case reviews, morbidity/mortality conferences, and research protocol integration/evaluation. As the system develops and becomes more functional, it will become available to physicians at the Main Campus and the remaining MSKCC regional sites. A telemedicine setup is also planned for each physics department.

We also plan to expand the system to include simultaneous display of clinical components beyond radiation oncology and radiology. We envision the simultaneous display of multiple clinical components (ie, patient face photo, pathology, still images and/or video footage of tumor during procedures, radiology, radiation treatment planning, portal imaging, archives of treatment-plans & anatomy/contouring databases) on one screen surface. We are not currently aware of a platform that assimilates all of these components into one system. The rationale for incorporation of additional components into the telemedicine platform is described below.

Patient Face Photo

A recent abstract by Turner et al [9] evaluated the effects of adding a patient's photograph to the radiographic display. The photographs appeared automatically when radiologists opened the patient file for review. The study concluded that radiologists felt more empathetic to the patients after seeing the photograph and resulted in a more meticulous interpretation. The photographs were also felt to contain clinically relevant information such as suffering or physical signs of disease.

Telepathology

The eventual integration of pathology images into a virtual tumor board will be essential in any detailed clinical discussion. Work at UCLA has involved internet teleconferencing telepathology consultations for lung and heart transplant patients[10]. Referring pathologists acquired real-time video images from biopsies using a light microscope. The consultant pathologists viewed the processed images on a video monitor using a CPU with NetMeeting and directed the referring pathologist during the consultation. The conclusion of the study was that live internet-based teleconferencing was an effective and inexpensive method for conducting a real-time pathology consultation. “Offline” telepathology has also proved to be an efficient and reproducible method of performing histopathology for colorectal polyps[11].

Archived/live video of tumor or procedures

Access to videos or still images of tumor from endoscopies, surgeries, or other procedures (archived or live) would be another important component of a virtual tumor board. The ability to perform live, long-distance teleteaching of endoscopy procedures has been successfully demonstrated in a pilot study performed between Stanford University and two universities in Japan[12]. In this study, high-resolution images and endoscopy videos were transmitted over a special network between institutions. Participants gave high ratings to the usefulness of the videos/images, the commentary from remote and local faculty, and the interactions with remote and local audiences.

Teleradiology using a web-based image viewer

MSKCC, like many other hospitals, has an internal PACS and a PC-based PACS accessible through the intstitutional ethernet. Many hospitals have also made their PACS images available via a web-based image viewer. This has become a popular form of teleradiology, allowing PACS images to be displayed for designated users throughout a medical center or remotely. Utilization of a web-based image viewer is a simple way of providing immediate access to radiology as part of a virtual tumor board.

Databases of anatomy images, contouring atlas

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The use of increasingly sophisticated imaging technology and radiation techniques, requires a detailed understanding of anatomy and CTV targets. Anatomy atlases that describe elective CTV targets have been published for many sites and are available in the medical literature and on various websites. These atlases are extremely useful references for radiation oncologists for contouring, and would be made available in a virtual tumor board.

In summary, we would like to integrate more traditional forms of telemedicine with radiation treatment planning and some of the above-described concepts, to create a virtual tumor board for radiation oncologists. A proposed screen format for such a virtual tumor board is shown in Figure 7.

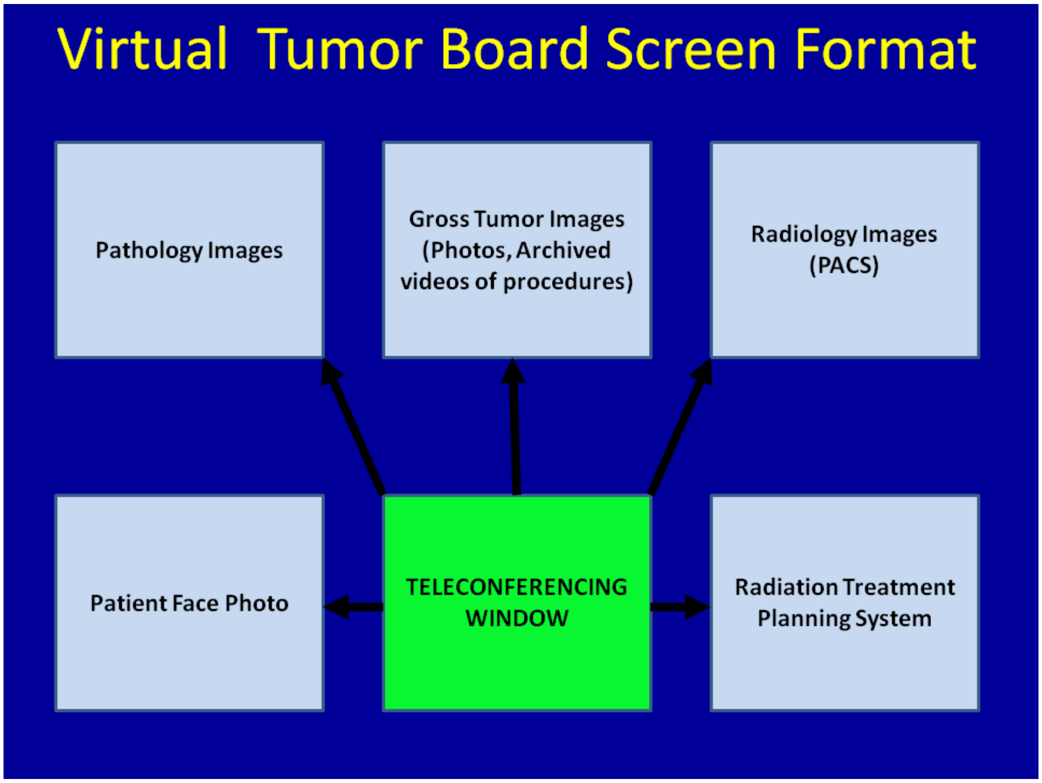

Figure 7. Virtual Tumor Board Screen Format

By simultaneously displaying each clinical component, physicians and physicists at remote sites can review/discuss clinical scenarios in a highly sophisticated manner. Specially formatted screens could be created for each disease category, to accommodate disease-specific information. Figures 8-10 are screen capture images of a *partially* functional, virtual tumor board format for various tumor sites (head and neck cancer, prostate cancer, breast cancer). These images show the incorporation of the patient's face photo, pathology, radiology, radiation treatment planning, and a telepresence window on one screen surface.

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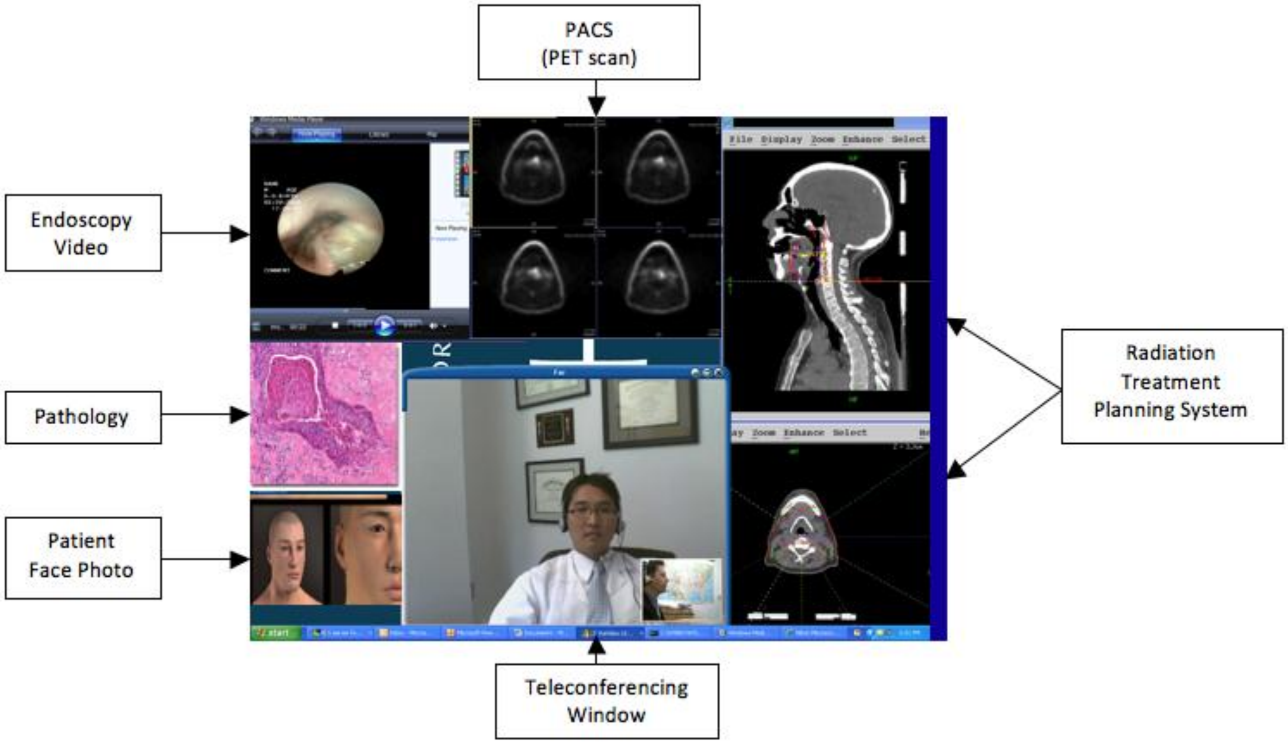

Figure 8. Image of virtual tumor board format for head & neck cancer

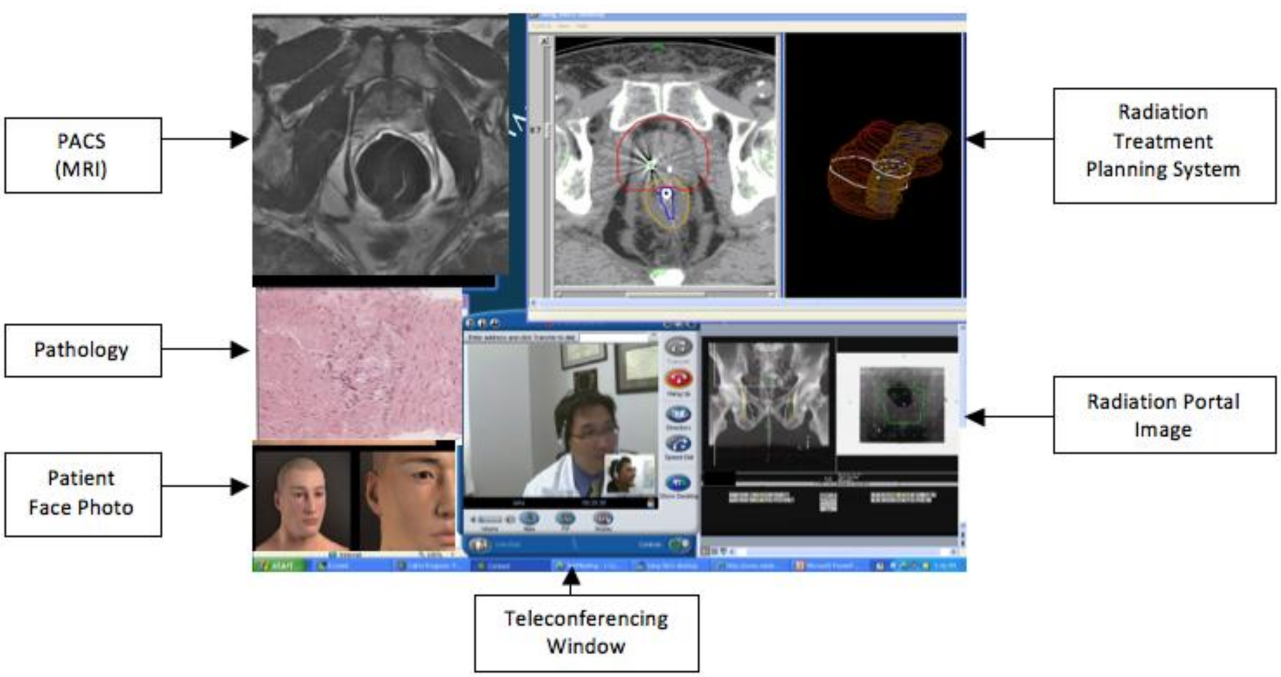

Figure 9. Image of virtual tumor board format for prostate cancer

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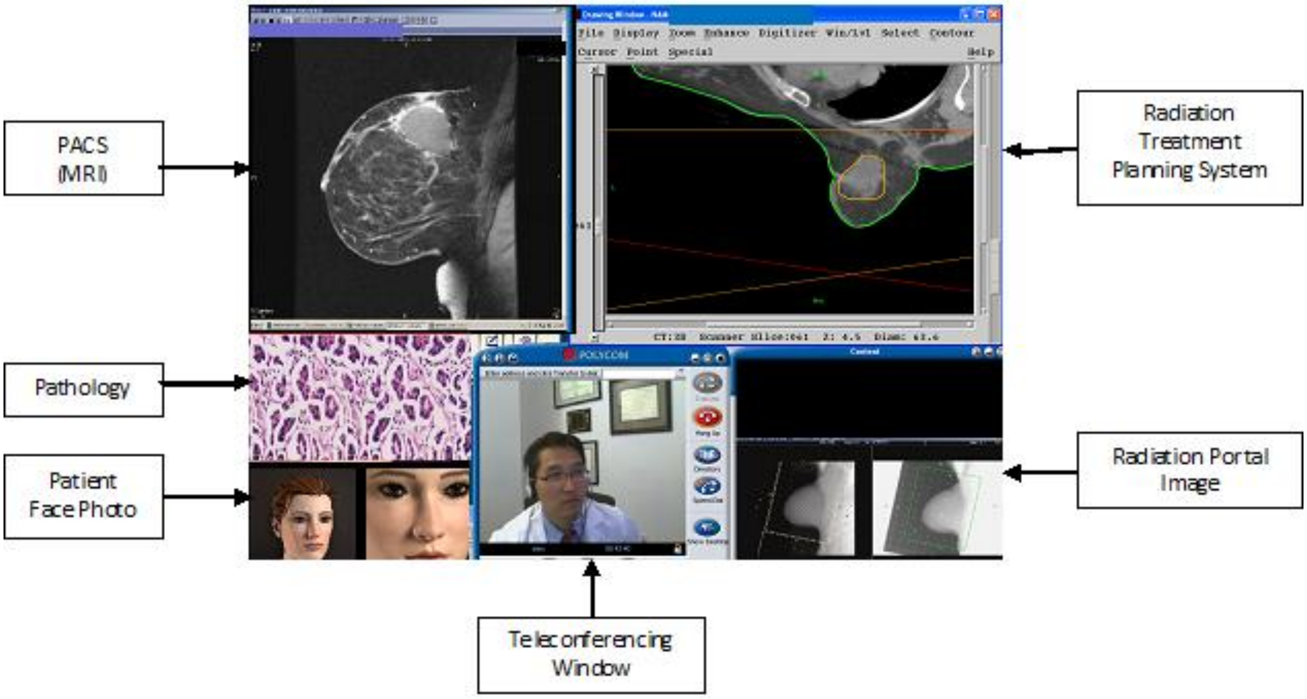

Figure 10. Image of virtual tumor board format for breast cancer

5. CONCLUSION

We have presented an inexpensive, integrated telemedicine platform for radiation oncology using a Microsoft-based operating system and basic video-conferencing software. This allows for simultaneous display and review of radiology images, radiation treatment volumes and plans, and portal images by physicians at remote MSKCC sites. The platform enables physicians and physicists to remotely discuss and interact with details of cases efficiently. We plan to expand this concept to develop a virtual tumor board for radiation oncologists. This will involve the visual display of additional data portals including patient face photo, pathology, gross tumor images/photographs, and archived videos of procedures. The final goal of the radiation oncology telemedicine platform is to foster a higher level of interaction and integrated care by physicians, physicists and staff at MSKCC and its regional sites. We also feel confident that this platform will increase the level of oncologic care for patients, decrease medical errors, and improve clinical outcomes.

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