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Radiotherapy techniques

Broadband teleconsultation: new educational tool for radiation oncology

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The clinical implementation of conformal radiotherapy, e.g. tumour irradiation in 3-dimensions with very tight margins, has resulted in an additional demand for quality assurance. Within the Erasmus MC this was achieved by the inauguration of a monodisciplinary treatment plan viewing board: a daily meeting of radiation oncologists, radiation technologists and medical physicists who's approval of the patients treatment plan is mandatory to initiate the actual treatment. As the Erasmus MC is located in two parts of Rotterdam, serious inefficiency (minimal twice 30 minutes time-loss per person per day) was encountered, caused by the travelling from persons from the auxiliary location to the main departments location. The problem was solved with the installation of a telemedicine connection between both locations making the travelling superfluous. The teleconsulting functionality is obtained by 'middleware technology' which delivers a software level between presentation and the Internet. The telemedicine connection requires 20 Mbit/s. It provides instant projection of the medical images to the participants present in both teleconsulting rooms with maintaining the original high resolution of the shared images. The participants can view themselves, have audio connection and can interactively decide what applications are shared and with whom. Since the successful implementation of the local connection further applications were initiated to provide experts consultations and a so-called 'electronic second opinion outward clinic' to medical professionals in regional hospitals and even to the Netherlands Antilles. Future expansion is directed at the organisation of image guided classrooms.

Telekonsultacje – nowe możliwości kształcenia w zakresie radioterapii

Poważne implikacje kliniczne, związane z trójwymiarowym planowaniem i prowadzeniem radioterapii w obrębie ściśle określonego pola, wiążą się z koniecznością dodatkowego weryfikowania jakości postępowania. Z tego powodu na terenie Erasmus Medical Center w Rotterdamie wprowadzono system codziennego zespołowego weryfikowania planowanego leczenia, które jest warunkiem rozpoczęcia radioterapii. W skład zespołu wchodzą onkolodzy-radioterapeuci, technicy radioterapii i fizycy medyczni. Ponieważ budynki Erasmus Medical Centre znajdują się w dwóch różnych częściach Rotterdamu, zebranie całego zespołu wiązało się ze znacznymi stratami czasu – co najmniej dwa razy po 30 min na osobę w ciągu jednego dnia. Problem ten rozwiązano, instalując łącze telemedyczne pomiędzy ośrodkami i, co za tym idzie, eliminując niepotrzebne przejazdy. Łącze funkcjonuje dzięki „Middleware technology", która zapewnia oprogramowanie umożliwiające przekazanie prezentacji za pomocą Internetu. Samo łącze wymaga przepustowości 20 Mbit/sek. Zapewnia to natychmiastowe wyświetlenie obrazów (z zachowaniem ich bardzo wysokiej rozdzielczości) członkom zespołu znajdującym się w salach telekonsultingowych w dwóch różnych miejscach. Członkowie zespołu widzą te same obrazy i siebie nawzajem, co umożliwia im interaktywne podejmowanie decyzji. Sukces opisanego systemu skłonił nas do rozszerzenia tego typu działalności. Powstał dzięki temu system konsultowania (zwany „electronic second opinion clinic"), dostępny w szpitalach rejonowych, w tym również na terenie Antyli Holenderskich. Planujemy dalszy rozwój tej technologii, wykorzystując ją w systemie szkoleń.

Key words: radiotherapy, teleconsultation, education in medicine
Słowa kluczowe: radioterapia, telekonsultacje, szkolenie w medycynie

Introduction

Patient treatment planning in a modern radiation oncology department has seen dramatic changes in the last two decades. Currently, a general consensus exists that before a patient is treated with radiation, a three-dimensional treatment plan must be generated. In the recent past, treatment plans were often relatively simple and

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were not systematically peer reviewed, potentially leading to unsatisfactory or even faulty results. Radiation therapy is now given in a more conformal way, meaning that the tumour is irradiated with very tight margins in 3D, thereby limiting the dose to the surrounding critical structures. This subsequently should result in a lower incidence of side effects and with those which occur being less severe.

Visualisation of the 3D anatomy of the patient is an absolute requirement to enable such demanding radiotherapy treatment planning. Current radiotherapy treatment plans usually consist of a complex summation of multiple radiation beams, which together provide the ability to conform the radiation dose as closely as possible to the tumour. To ensure and control the quality of these complex radiotherapy treatment plans the medical community considers systematic viewing of treatment planning records of vital importance and many centres have installed peer review platforms.

However, the installation of these platforms causes additional pressure on the daily workload of the staff members involved in the process: radiation oncologists, medical physicists and radiation technologists. The additional value of such an activity must be considered as being in an *hostile* environment where the increasing patient load and the growing treatment complexity are already competing for the available time. Therefore this places a further demand on the efficiency of the radiation oncology organisation. In our view adequate data transfer and presentation support plays a vital role in the achieving a solution to these challenges.

Radiotherapy peer review methods

Historical Method

In effect, the need for a systematic peer review as explained above, poses a problem in the Erasmus MC. In line with the general consensus of the radiation oncology community, a so-called *monodisciplinary treatment plan viewing meeting* was initiated many years ago. On a daily basis, radiation oncologists, radiation technologists and clinical physicists meet from 8:00 a.m. to 9:00 a.m. Only after approval of this *tumour board* is the patient's treatment actually scheduled.

Distance Problem for Erasmus MC

The Erasmus MC Radiotherapy Department is situated in two locations: the Erasmus MC Daniel den Hoed Cancer Center and the Erasmus MC Dijkzigt, which together with the Sophia Children's Hospital, constitute the Erasmus MC. The Daniel is located to the south of the river Maas, and the Dijkzigt location is to the north, Figure 1. The distance is less than five kilometres in a straight line, but the travelling time is at least 30 minutes. Also, when traffic congestion is serious, the travel takes even longer. This situation is problematic for the staff of the department since it is a high priority prerequisite that the radiotherapy treatment plans of patients from both locations be discussed on a daily basis. Without this, the highest quality standards cannot be met.

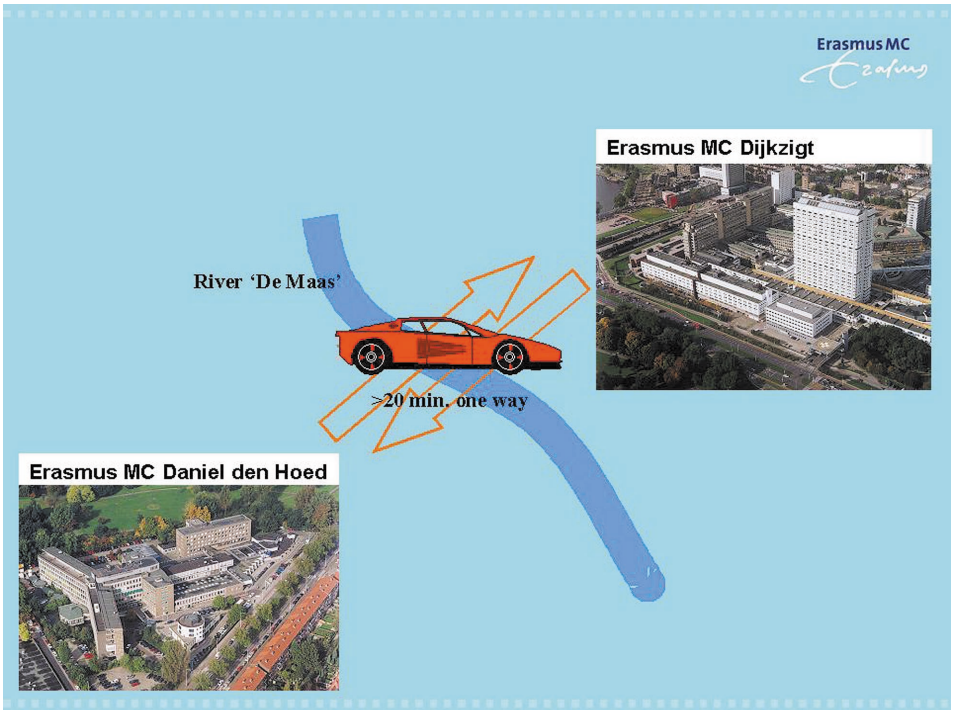

Figure 1. Radiotherapy peer review: the historical situation causing every day a time loss due to mean travelling time of approximately one hour per medical specialist

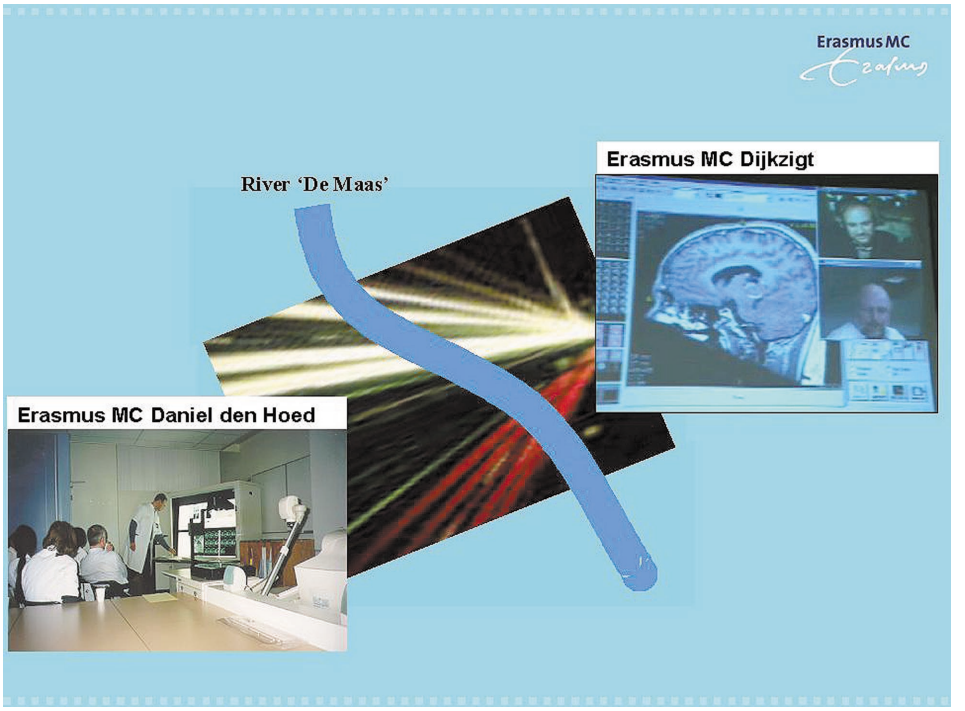

Figure 2. Radiotherapy peer review: the new situation with teleconsulting resulting in a high gain in efficiency

Telemedicine Method

However, a solution by means of telemedicine was envisioned [1] and recently implemented. Since January 2001, the Department of Radiation Oncology of the Erasmus MC has employed a teleconsulting system based on modern Internet technology. The system enables radiation oncologists and other medical specialists to meet their peers on the other side of the river Maas in the city of Rotterdam, Figure 2. This online consultation and peer review eliminates the need to travel and thus provides an important gain in efficiency.

Teleconsulting

Our teleconsulting strategy was also triggered not only by the distance problem for the two centres, but also by an organisational change. Until recently, all treatment plans from the Department of Radiation Oncology were generated in the Daniel den Hoed Cancer Center where most of the linear accelerators, mould rooms, simulation devices and computer planning facilities are situated. However, since 1998 Dijkzigt also accommodates accelerators, allowing the practice of stereotactic radiotherapy.

This form of radiotherapy requires even more precision than does conventional radiotherapy. Tumours often suitable for stereotactic treatment are those in brain, head & neck, and melanoma of the eye, and recently tumours of the pancreas and prostate and also liver metastases. For stereotactic irradiation, CT and MR scans for planning purposes are carried out in the Daniel den Hoed Cancer Center, although the treatment planning and the actual treatment take place at Dijkzigt.

Combining the teleconsulting features with EXOMIO[X] is another good example of increasing efficiency and quality obtained by integrating modern technology in the medical environment. Together, teleconsulting and EXOMIO enable the possibility of performing remote delineation and contouring of the target volume with online consulting and verification of the final treatment settings, prior to the dose calculation, Figure 3.

Figure 3. Example of teleconsulting using EXOMIO as virtual simulation tool

[X] EXOMIO is a new CT based virtual simulator system which has been developed at the Institut für Graphische Datenbverabeitung (Fraunhofer IGD) in collaboration with the Department of Radiation Oncology of the Klinikum Offenbach, Germany, and can be obtained from Medical Innovative Technology GmbH, Feldstrasse 26a, D-44867 Bochum, Germany.

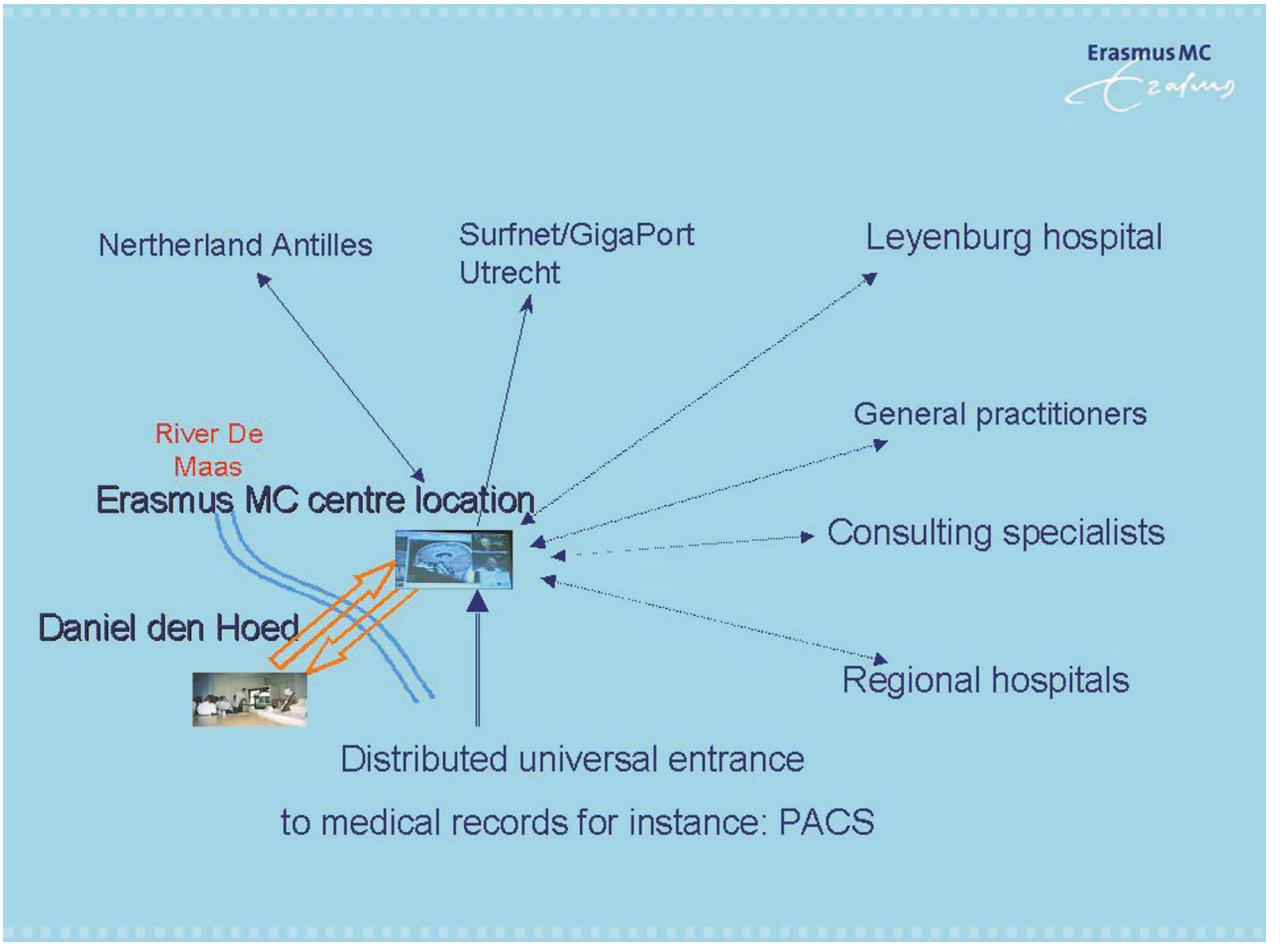

Figure 4. Future strategy for teleconsulting connections and features

The discussion of [stereotactic] radiotherapy treatment plans facilitates the sharing of knowledge and serves educational and research and development purposes. It is though, emphasised that this string of data needed a *transport medium* that is both fast and extremely accurate.

Teleconsulting

Middleware Technology

Many alternatives were considered and eventually a product developed by Lucent Technologies and the Dutch Telematica Institute provided the required functionality. This so-called *middleware technology* delivers a software level between presentation software and the Internet. It supports video conferences in combination with the collaborative use of standard applications from, for example, office packages; as well as presentation software for medical images.

Network Infrastructure

The network infrastructure consists of an ATM/IP connection between the two hospital locations. The middleware and the network infrastructure together provide the required functionality. Cameras can register events at Dijkzigt, send the images instantly and seamlessly to Daniel den Hoed Cancer Center: and *vice versa*.

Beamers at both locations project images of the people present in the teleconsulting room onto the wall, next to the medical images that are visible within the same image of the beamer. Participants in the meetings can view themselves and can also see the participants on the other side of the river Maas. Concurrently, an audio connection is established. This set-up requires 20 Mbit/s. The shared images maintain their original high resolution and the users can decide what applications they want to share and with whom. It is also possible to select material from patient files irrespective of their location, provided that access to the data is available.

The future

In the near future, it should be possible to collaborate even with experts abroad, to give consultations to medical professionals in regional hospitals, or to organise (image guided) virtual classrooms at a distance. In particular, a so-called *electronic second opinion outward clinic* has recently been established between the University Hospital Erasmus Medical Center and the Leyenburg Hospital in The Hague.

An important hallmark in the broadband application is the recent establishment of a teleconsulting unit in the St.Maarten Medical Center in the Netherlands Antilles. With the latter teleconsulting connection, the hospitals in the Netherlands Antilles are able to request a consultation with various highly specialised medical departments in the Erasmus MC without the need for the patient to travel to Rotterdam. Clearly such a service is highly beneficial to the patient: no unnecessary travelling and rapid expert evaluation of their disease and subsequent treatment. It is also highly beneficial to the community as the reduced travelling saves money and inherent to the consulting of experts is the educational benefit of the local medical doctors.

As a GigaPort project, the aim is to generate knowledge on broadband technology for future applications through a high bandwidth network infrastructure. Applications in the medical sector display several features that are well accommodated by a GigaPort network. Security measures are intrinsic to the network technology and high bandwidth can be provided for, including quality of service guarantees. Thus a session may demand the online use of 50 Mbit/s, and unlike the Internet, GigaPort and similar networks can guarantee the allocation of the required 50 Mbit/s. Finally, billing and accounting can be automatically arranged. This is necessary when medical consultation between hospitals takes place on a regular basis.

The project presented in this chapter is just one case of electronic collaboration. The same setting is or could be realised for telepathology, cardiology, general practitioners, nursing staff and management in general. We hope that this project will trigger a cascade in Dutch telemedicine applications.

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