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ORIGINAL ARTICLE

Significance of using DICOM communication standard in quality assurance in radiation oncology – an institutional experience

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Summary

Purpose: *The purpose of this article was to highlight the importance of data management systems in radiotherapy.*

Methods: *We performed a database search to review the errors or potential errors in radiotherapy planning and delivery which could be prevented in case of using the DICOM communication system.*

Results: *We registered the following rates of errors: 1) Errors caused by manual rewriting of treatment plan 30%; 2) Errors caused by wrong assignment of the verification system 15%; 3) Errors during the manual rewriting of treatment data to the verification system 15%; 4) Patient identification 5%; 5) Field verification 15% 6) Wedge orientation 10%*

Conclusion: *DICOM communication system may significantly improve the quality assurance in radiotherapy.*

Key words: *DICOM, medical errors, quality assurance, radiotherapy*

Introduction

Digital Imaging and Communications in Medicine (DICOM) is a system used for storing and transferring images and non-image information at the same time across different systems. This enables connecting imaging information among CTs, MRIs or X rays and correlating such images with the identification of a patient or medical information about the images.

For over 100 years, radiotherapy has provided great benefits in cancer patients, and in the last 3 decades many new techniques were integrated into daily clinical practice. The new techniques have rapidly raised the need for new data management systems which would prevent possible mistakes or inconsistencies during treatment and assure high quality patient care. Many physicians and physicists are highlighting the fact that the importance of avoiding technical mistakes during treatment has the same importance level with integrating new techniques of treatment, and even highly conformal techniques with great possibility of dose escalation without proper data management may cause significant harm to the patients [1-3]. Quality assurance has been defined by the Word Health Organization as "all procedures that ensure consistency of the medical prescription, and safe fulfillment of that prescription, as regards to the dose to the target volume, together with minimal dose to normal tissue, minimal exposure to personnel and adequate patient monitoring aimed at determining the end result of the treatment" [4]. The quality assurance processes are involving all levels and steps during treatment delivery, starting with proper patient identification, appropriate decision about the treatment strategy and treatment modality, dose

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prescription, proper combination of patient and treatment plan, or correct dose delivery with appropriate technical equipment. Shortly said, our goal is to deliver the "correct treatment to the correct patient with the correct technique". These quality assurance processes have to keep pace with the rapid development in radiotherapy techniques. All findings during the quality assurance processes should lead to the identification of the cause of such an inconsistency and development of the systems to prevent error repetition. There are suggestions that almost 40% of all workflow steps are intended to prevent errors during treatment delivery [5]. It is also strongly recommended that more time should be devoted to quality assurance processes and particular safety reports on oncology conferences and meetings to enable appropriate discussion among radiotherapy centers, even if it may be inconvenient to disclose own errors or omissions [6,7]. There is a tendency worldwide to present a set of quality indicators which would not only prevent clinical omissions but also would lead to continuous improvement of patient safety and care. Cionini et al. have presented 13 quality assurance indicators which may provide some guidance for centers on how to select and how to use them during daily practice [8].

The purpose of this article was to highlight the need of implementing new data management systems together with new treatment techniques and modalities, since these new techniques are inseparably linked with significant increase of data which are highly vulnerable to human mistakes during the treatment planning and delivery.

Methods

We performed an extensive database search in the Department of Oncology, Teaching Hospital Olomouc, to check for errors or potential errors (potential errors are defined as errors which were detected and corrected during the radiotherapy process) during radiotherapy. We focused on omissions which could be prevented in the case of using simple communication system like DICOM which can combine imaging data and patient treatment information. These errors were arranged according to frequency. We presented only the percentages since unfortunately the total numbers are considered as confidential information by internal rules and therefore are not available for publishing.

Results

After database and safety reports review between 2002 and 2008 (before DICOM implementation to general use in the Radiotherapy Department of Oncology, Teaching Hospital Olomouc), we identified 6 major potential groups of errors caused by missing or incorrect connection of treatment plan information and patient information: 1) Errors caused by manual rewriting of treatment plan (computerized) to treatment protocol (paper version); 2) Errors caused by wrong assignment of the approved version of the treatment protocol (approval documented on paper treatment protocol); 3) Errors during the manual rewriting of treatment data to the verification system; 4) Errors during patient identification – matching the correct plan with the correct patient (omissions due to similar patient name or identification number); 5) Field verification- mistakes caused by matching wrong X- ray films (simulation film and verification film); and 6) Wrong wedge orientation due to mistake in data rewriting.

The following rates of errors were registered: 1) errors caused by manual rewriting of treatment plan 30% ; 2) errors caused by wrong assignment of the approved version of the protocol 15% ; 3) errors during the manual rewriting of treatment data to the verification system 15 %; 4) patient identification 15%; 5) field verification 15%; and 6) wedge orientation 10%. All these errors were highly dependent on matching many different data from different systems and were vulnerable to human error, especially considering the high volume of patients treated on a daily basis and managing this high volume of data was basically not possible before implementing the DICOM system.

Discussion

We focused on the DICOM communication system to search how this system has improved the consistency of the treatment from its introduction into use in 2008 in the Department of Oncology, Faculty of Medicine and Dentistry, Palacky University, Czech Republic. DICOM communication system, combining imaging together with medical information (patient ID, treatment plan, dose of radiotherapy, number of fractions) helps avoid incorrect combination of different information from different systems [9]. There are other formats used for similar purposes, however DICOM system is most widely used in the hospitals. As reported by WHO, 3000 patients were affected by errors during radiotherapy between 1976 and 2007. More specifically, these errors were caused in 25% of the cases by usage of new equipment, in 55% by planning processes, in 9% by information transfer, in 10% by treatment processes, and in 1% in multiple stages during treatment [10,11]. DICOM system has significantly decreased the

number of information transfer errors and improved the consistency of radiotherapy, however this doesn't mean that omissions may not happen during information transfer using DICOM and quality assurance processes need to apply to DICOM system as well. The main problem is what kind of quality assurance checks should be used. There are certain commonly used quality checks such as portal imaging, review of treatment plans by different physicians, cone beam CTs, beam dosimetry, and pretreatment IMRT dosimetry measurement. At the same time we have to consider the time spent for such a quality checks and for this reason we have to carefully select what quality assurance measurements or what combinations of such a measurements should be used. Palta et al. have presented approaches to quality assurance protocols and their applications in daily practice [12,13].

Quality checks measurements to prevent or mitigate errors occurring during radiotherapy are widely used in radiation oncology. Even if widely used there are no clear instructions which steps in the radiotherapy workflow should be assessed during quality assurance process, which quality assurance processes should be used and how these possible quality assurance findings should be managed [14-18].

Conclusion

Quality assurance has a growing importance in current radiation oncology, having the same importance as implementing new techniques. The above described data have clearly shown the importance of data managing systems in the communication among different systems involved in the process and improving safety and reliability of radiation delivery.

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