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Comprehensive Cancer Center
Radiation Oncology

Automated Real Time Pre-Irradiation Chart Checking Tool

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INTRODUCTION

Radiation therapy process is a very complex set of events involving a large team of experts. As complexity of events increases, so does the number of parameters that need to have their values set properly at the final delivery moment. These parameters often get their values from humans by typing them in by hand. The values are often transferred from one system to another till they reach their final system that control radiation delivery. Each human entry has a non zero probability of making a mistake. Each transfer of data sets has a non zero probability of incorrect transfer of some of the values. It is impossible to manually check all involved and relevant parameters. This checking process calls for automation.

AIM

Pre-irradiation chart checking is one of the essential clinical duties of a medical physicist. It is becoming more and more difficult and laborious when dealing with prevalent complicated treatments such as IMRT or IGRT. Given that all crucial treatment parameters have been recorded in a treatment management system (TMS), it is technically feasible to utilize a software program in the process of chart checking to make it more efficient, accurate and comprehensive. We believe that a supervised automation of certain aspects of the chart checking process will enable more complete and accurate human review of critical radiation therapy parameters and reduce the risk of medical errors related to radiation therapy.

METHOD

We developed a web app that enables a thorough pre-irradiation chart check. At the server side, the program retrieves the medical doctor's prescription and all planned machine parameters from the TMS (at our institution (MOSAIQ)) and check their validity against preset rules. Then the software compares them with the parameters located in the doctor approved treatment plan in TPS.

The server-side program was developed in Python programming language (Django Framework). It gets data from both MOSAIQ database (a MSSQL database) and Eclipse TPS (using a web service developed using ESAPI) via RESTful APIs. The .Net MVC Framework was used for secure and easy access to the MOSAIQ database and ESAPI based web service. The check result is tabulated in a web page at the front-end for physicists' review. Each item can be displayed either as one-line summary or in details. After a review is completed, a summary report is generated and uploaded automatically to MOSAIQ as a record. Because the app is web-based, physicists are not required to install any particular software or tools on their computers.

RESULTS

This app can be accessed using major browsers including IE, Firefox, Chrome, Opera, and Safari, from any computers or mobile devices that are connected to our campus network. During the development, the web app was tested by performing chart checking on a cloning of the database of previously treated patients in order not to affect the live MOSAIQ database that is used daily. After a full test, the app was released and set up on a production server.

The released app has been deployed on a web server in our department and has been tested thoroughly by our physicists. First phase of testing involved a test patient setup in TPS and MOSAIQ database. Each tested parameter value has been sequentially deliberately mismatched by artificially changing their value in TPS or MOSAIQ. The app was ran and the caught mismatch has been documented. After that the a was cross checked against traditional manual chart check results on about 100 patiets in the span of about 2months.

***The app has two parts. First part is a patient dashboard.** It lists every patient that received a RT planning CT scan. For each patient the status of the plan approval process is listed. This is important, because the MD's approval of the prescription is a trigger point enabling the start of the physics initial chart check.. The patient stays on the list till the first fraction is delivered. If anytime during the radiation course either the prescription or treatment plan document or QA document changes in the MOSAIQ database, the patient is listed again on the dashboard requiring physics checks to be performed again.*

***The second part of the app performs the comparison of the expected values with actual values of more than 300 parameters.** The app analyzes the prescription fields and their values and checks if the completed treatment plan satisfies the prescription requirements. Then it checks the parameter values for each treatment field, setup field, CBCT.*

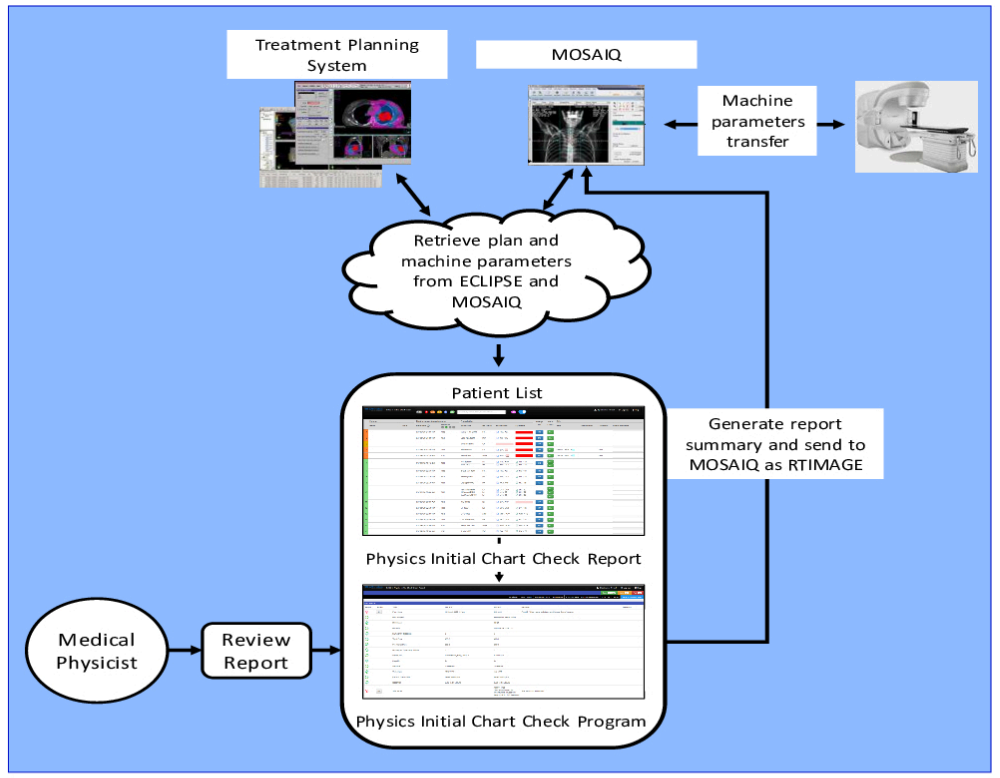

Figure 1: Graphical representation of the automated chart checking workflow

***The following section illustrated the selected parameters we include in the automated checks**:*

***Prescription**: Treatment Site, Laterality, Number of Fractions, Total Dose, Fractional Dose, Dose Specification, Modality, Delivery Machine, Plan technique, Patient Orientation*

***Treatment fields**: Field ID, Field Name, Field Type, Machine, Field Approval status, Tolerance table, Dose per Fx, Gantry Direction, Gantry Angle, Collimator Angle, Couch Angle,*

***Treatment fields continued1:** Collimator X1, X2, Y1, Y2, Energy, Monitor Units, SSD, Number of Control Points & MLC positions for each segment, Isocenter, DRR Image, Time*

***Treatment fields continued2:** Dose Rate, Bolus, Wedge / Applicator*

***Setup Fields**: Field ID, Field Name, Field Type, Machine, Field Approval status, Tolerance table, Source Angle, SSD, Isocenter, DRR Image*

***Schedule Data**: Treatment Calendar #Fx matches prescription #Fx matches patient schedule, Fractionation Pattern*

***MLC Comparison**: Compares MLC's position between TPS and delivery system for each MLC and each segment (control point).*

***Other checks**: Dose calculation grid size, whether heterogeneity corrections used, proper dose calculation algorithm employed, Proper patient positioning device was included in dose calculation, if plan was generated on the correct CT image set, if appropriate dosimetric OAR safety limits have been achieved*

RESULTS CONTINUED

In addition to the above listed checks, if the app detects that the IMRT or VMAT technique was used, it checks if IMRT QA has been performed and if the results have been approved by the MD and physicist or if IMRT QA is scheduled to be performed. Similarly, we search the prescription for SBRT, Electronic Cardiac Device or special imaging indications and the app checks if necessary care plan precautions have been scheduled, such as appropriate monitoring of heart in case of ECD.

The average time spent on one patient's pre-irradiation chart check of technical parameters has been reduced from 15 minutes to less than 10 seconds.

The items checked by the program are more comprehensive than set of items that used to be checked manually by physicists. For example, every single MLC leaf position in a doctor approved plan is compared with the MLC position in TMS for every aperture formed by MLCs (every segment).

Similarly jaw positions for every segment is compared between TPS & TMS.

It is worth noting that **the check is real time** meaning the access to both TMS and TPS is real time.

CONCLUSION

We have successfully developed an automated pre-irradiation patient chart check application for medical physics. This application performs real time comparison of treatment parameters that resulted in an MD approved treatment plan in TPS with delivery parameters waiting in our MOSAIQ system to be delivered onto patients. The application has been shown to be robust, fast, and has greatly improved the efficiency and accuracy of our pre-irradiation chart check workflow. It added additional check that would have been too cumbersome to perform via manual human checks, such as the position of every MLC leaf in every aperture they form. In addition, it greatly enhanced safety aspect of our treatment process. No changes made to prescription, treatment plan or QA plan after physics chart check are left unnoticed and un reviewed anymore.

RELATED AAPM PRESENTATION

The resented work in this poster had a direct influence on the reduction of treatment planning related errors that propagated all the way to the patient. See oral presentation in session SU-E-TRACK 3-2 at this AAPM meeting by M. Lin titled "Error Reduction by Synergizing Event Reporting and Automation".

CONTACT INFORMATION

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