Automatic treatment planning: Improving quality and safety in radiotherapy planning

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Purpose/Objectives

- Using a database of prior patient dose and shape relationships allows for the prediction of dose on future patients.
- Automatic planning improves the speed of treatment planning by providing a good initial plan for the dosimetrist to start from
- Database driven solutions improve quality by predicting the lowest known achievable critical structure dose from prior patients
- Safety is improved by showing suggesting solutions that are more realistic
- Toxicity and other planning data can be recorded to improve plan selection

Materials/Methods

- Prior planning information is stored in an Microsoft SQL Server relational database.
- To provide consistent structure naming in the database, a software tool is used to rename structure names to a standardized naming scheme.

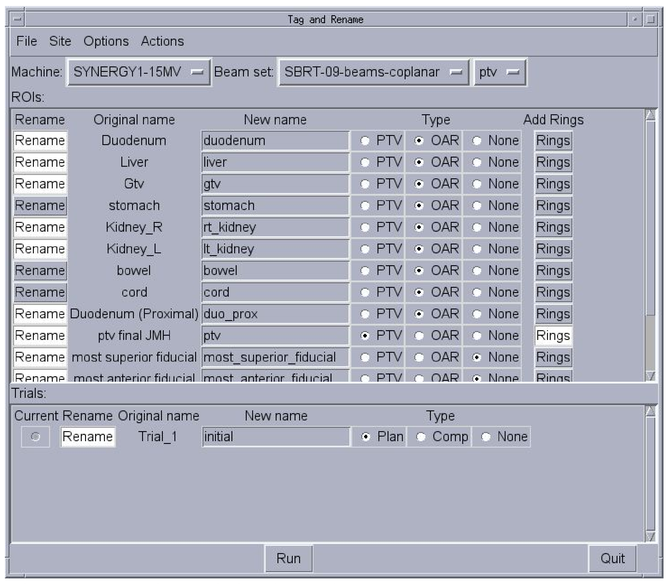

Figure 1: Renaming and planning tool

- Structure names are automatically mapped to standard names.
- Structures are grouped into PTV, OAR and None
  - PTVs and OARs are added to database
  - Structures marked as None are ignored
- User is alerted to any missing structures

Materials/Methods (cont.)

- Automatic planning option allows for complete generation of plans
  - Adds ring structures
  - Combines common OARs
  - Defines isocenter and pre-defined beam sets
  - Sets a prescription based upon the selected plan type
  - Selects a dose grid that covers all relevant structures
  - Software verifies required structures are present Overlap Volume Histograms are computed for each PTV-OAR combination

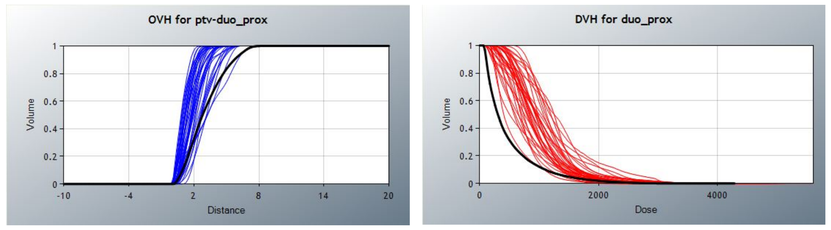

Figure 2: Overlap Volume Histograms represent relative volume of overlap of the OAR with the target as a function of expansion distance of the target. They can be read as Y% of the OAR is within X cm of the target. All patients with OVH curves left of the black line are harder to plan. The black DVH represents the same plan.

- Automatic planning tool queries optimization objectives from the database
- Selection from a predefined set of prescriptions defined in configuration files
- The query selects from the patients in the database those which have achieved a target dose greater or equal to the prescription target dose.
- For each structure, the patients which have the same or closer shape relationship between the target and structure is selected. The lowest achievable dose from this group is returned by the query

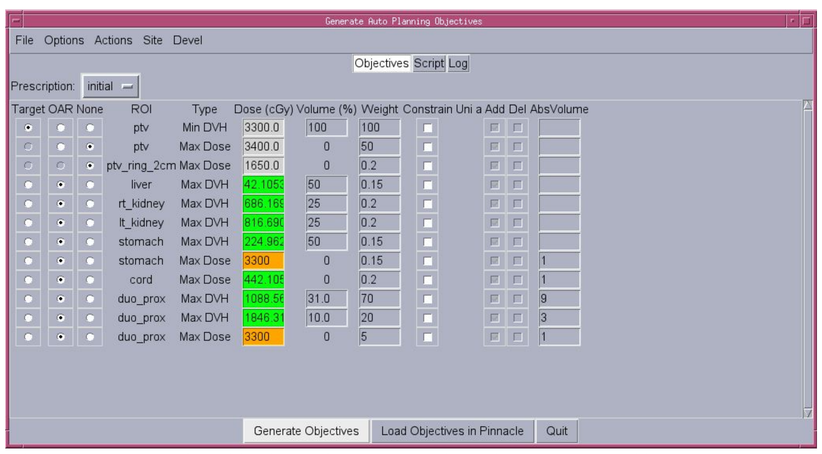

Figure 3: Auto planning objective lookup. Successful lookups are colored in green, unsuccessful lookups in orange. Objectives can be automatically exported to Pinnacle or manually entered into a different planning system.

- Unsuccessful queries are from more difficult cases where there is no shape relationship in the database of equal or closer distance.
- Protocol objectives are defined in a comma separated values file and allow flexibility in defining protocol parameters including upper and lower limits on goals.

- To aid in plan evaluation, a tool to check protocol compliance is used

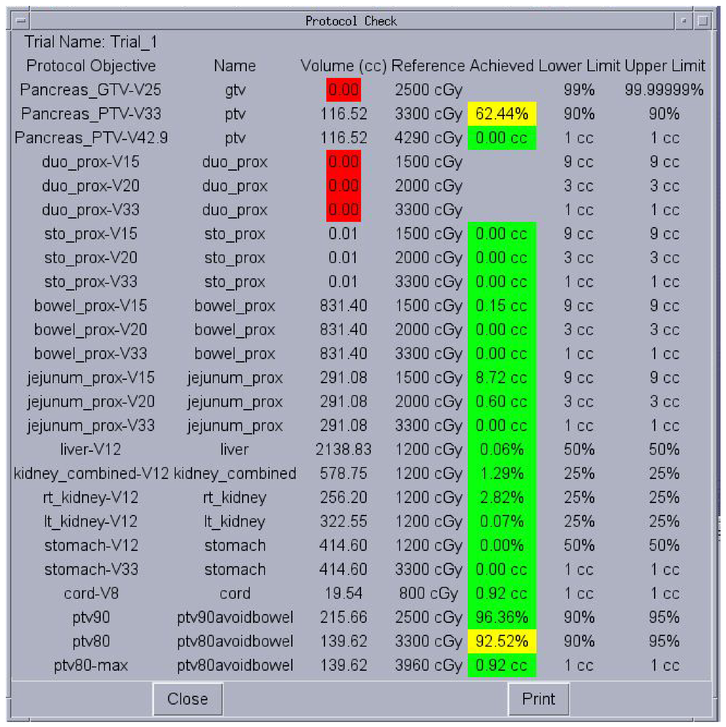

Figure 4: Protocol check interface. Color coded values indicate which objectives are achieved and which are not met. Volumes highlighted red indicate missing structures.

- Plans can be evaluated with a single click from the planning system and the resulting spreadsheet can be included in plan documentation.
- Approved plans are added back to the database to improve the selection for future patients.

Results

- Total additional time added to the planning process is 4 minutes.
- A typical plan optimization requires approximately 5 minutes.
- If at least one round of optimization is saved, use of this tool reduces the total time required for planning
- The automatic planning tool is currently being clinically used for all pancreas SBRT patients at this institution.

Conclusions

- The automatic planning tool allows for faster planning while improving safety and plan quality.
- Using an automatic planning tool allows for less experienced planners to generate high quality plans based upon prior patients.

Acknowledgements

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