Expand Clinical Treatment Strategies with Monaco Webinar (3-9-2022)

# Presenters

1. Director of rad onc at an Italian hospital
2. Lead proton physicist at Beaumont Health in MI

# Intro

## *ART* Definition

This webinar is on adaptive radiotherapy (ART). ART was first defined in a 1997 paper as treatment modification using systematic feedback measures. Advantages of ART include local control (higher target dose), lower OAR toxicity, and increased QoL due to more individualized treatment. A 2019 redefined ART to apply it clinically.

## Types of ART

There are three types of ART. In order of increasing sophistication:

1. Anatomy adaptive
2. Dose adaptive
3. Response adaptive

There are also several methods of ART. Least sophisticated (and what our clinic does) is ad-hoc offline re-planning.

# Presentation 1: Automated Contouring and Adaptive Workflow for H&N Tumors

## Overview of ART in the Clinic

The first presenter discussed clinical implementation of ad-hoc offline ART at a clinic with an in-hospital cancer center plus an external proton center. The clinic uses four Elekta linacs, Monaco, and MOSAIQ.

ART better controls ROI shape, volume, and dose by maintaining planned doses to targets and OARs, and decreasing target dose inhomogeneity.

ART is unfortunately not widely used, but it’s mainly used at academic centers, for few treatment sites (most H&N), and via ad-hoc offline re-planning. To drive adoption, we must better establish ART’s clinical benefits.

ART is time consuming, so we should only adapt when we are out of geometric tolerance. But this tolerance is difficult to define, and standardized protocols are insufficiently individualized for specific patients. Example standardized protocols are adapting after a given number of fractions or delivered dose.

Clinical indications for ART are weight loss, changes in nutritional status, and tumor shrinkage. The burning question is, “What is the ideal moment for offline adaptive for an individual patient?”

## Clinic-Specific Workflow

The presenter discussed her clinic’s workflow for ad-hoc offline ART for H&N cases.

The original plan is VMAT. At every fraction, IGRT and CBCT are taken with XVI. If any major qualitative differences are noted between the planning exam and the daily images, the CBCT is exported from XVI to Monaco for quantitative dosimetric evaluation. If the changes from the planning exam to the CBCT are minor, the dose is simply recalculated on the CBCT. Otherwise, the plan is recalculated on a synthetic CT generated from a deformable registration. Dosimetric evaluation involves DVH metrics; the Monaco plan Scorecard, which appears similar to RayStation’s Clinical Goals; and ProKnow cumulative dose evaluation, which appears similar to RayStation’s plan sums. If re-optimization on the new exam still does not create an acceptable plan, the patient is re-planned on a new CT.

The clinic saves time with ABAS for automatic contouring in the original plan. They use multi-atlas contouring with STAPLE.

## Future Research

ART is especially effective when the target is near important OARs. This is obviously true for H&N, but other body sites could also benefit.

Daily CBCTs allow online rather than offline ART; we should move to the former if possible.

Perhaps online ART will lead IGRT to be used for daily evaluation of patient dose instead of just positioning.

How do we adapt the GTV?

ART can be used to refine objectives and constraints.

We need more clinical evidence for ART!

## Q&A

**Q:** What is the average timing for a treatment that needs adaptive therapy?

**A:** The workflow discussed in the presentation takes around two hours.

**Q:** Are CBCTs sufficiently accurate? How do we re-contour the CTV and the GTV on the CBCT?

**A:** The presenter does not change the CTV and GTV.

# Presentation 2: Optimal Proton Arc Plans with Monaco

I don’t know the actual title of the second presenter’s talk as I missed most of it. The presenter’s clinic has research partnerships with their vendors, Elekta and IBA, plus other vendors.

A couple points that I did catch:

* For protons, compared to other TPSs, Monaco requires fewer objectives and constraints for proton arc optimization. Optimization is thus simpler in Monaco.
* Monaco PlanIQ provides a plan quality score. Much of the presentation focuses on the tradeoff between plan quality and delivery efficiency. Typically, the plan quality is higher when plan quality is emphasized.

## Summary

Monaco plan optimization is unique. Biological optimization with planning templates allows a form of auto-planning. Proton arc planning contests and research confirm the tradeoff between plan quality and delivery efficiency.

## Future Research

Clinical application of the research findings

## Q&A

**Q:** Concerning target coverage, proton arc appears to have the advantages of both VMAT and pencil beam scanning. How do we evaluate plan robustness, especially with moving targets such as thorax or abdomen?

**A:** Evaluate robustness using worst-case scenario optimization. Use 4D dynamic dose to evaluate target coverage across all phases. Arc PT allows a 100° beam angle, decreasing uncertainty.

**Q:** Is majority-arc treatment the future of proton therapy?

**A:** Who’s to say, but here are some applicable research findings:

* Traditional proton SBRT yields poor conformality, but proton arc is better.
* Single-fraction proton arc brain SRS of 10–20 Gy for large tumors or metastasis causes less necrosis than treatments with more fractions.
* Proton arc improves delivery efficiency. The presenter’s clinic increased patient throughput by around 30 percent with the adoption of proton arc. This produces obvious financial benefit.
* Of course, proton arc therapy will be more beneficial for certain indications than others.

**Q:** Does proton arc plan evaluation require additional dosimetric data compared to conventional spot scanning?

**A:** No, but beam modeling does require more commissioning parameters, such as gantry rotation. There are also specialized QA devices in development.

**Q:** Are multiple layers of delivery necessary to get the same rotation effect that we get with pencil beam scanning?

**A:** Publications over the last five years have shown better plan quality, delivery efficiency, and other clinical benefits even for single-arc proton therapy. Might dual arc produce better plan quality and robustness? In some cases, but we must remember the tradeoff between plan quality and delivery efficiency.