Application of statistical process control methods in the retrospective review and design of patient-specific quality assurance processes

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Introduction

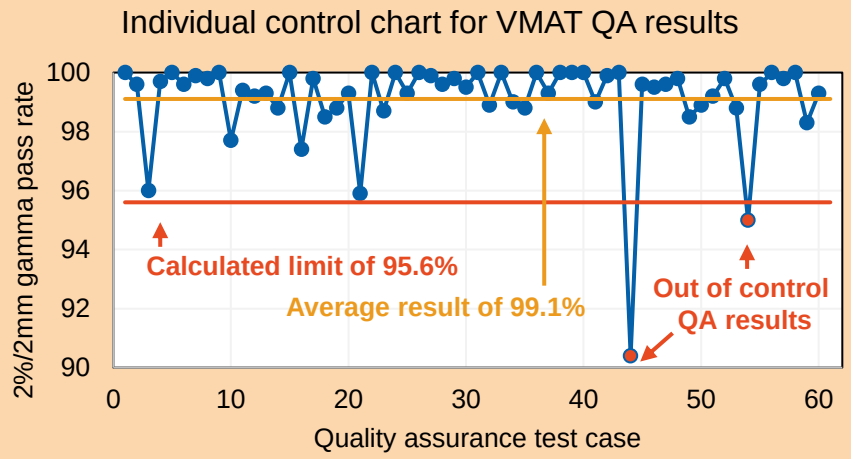
- Radiation oncology physicists spend a lot of time performing and analysing pre-treatment patient-specific QA checks. Given this, we should ensure that our processes are fit for purpose.
- Statistical control methods are suggested best practice for establishing, monitoring and retrospective review of QA processes and results[1]. These include histograms, control charts and control limits.
- Our department used the installation of two new systems (the Varian Edge & Accuray Radixact) as an opportunity to reflect on and plan our future patient-specific QA processes, with control charts.

Background

- Control charts are used to plot individual QA data points or differences between consecutive data (MR, moving range).
- Control limits can be calculated from the QA data:

$$\text{Control limit} = \bar{x} - 2.66\,\overline{MR}$$

- Typically calculated for a build phase, e.g., initial 30 results.
- Control limits are tolerance limits and describe expected system performance. QA results beyond limits are assumed to have an assignable cause. Tolerances are distinct from action limits, which are defined by potential clinical impact.



Methods

Octavius 1500 data collected for 30+ VMAT, Tomo & Radixact plans.

Pass rates calculated for multiple sets of gamma criteria pairs.

Charts, limits, and process performance characterised for calculated data.

Results and plans for ongoing QA discussed in physics team meeting.

Results

- Build phase data was not entirely in control for some data, suggesting that there are assignable causes for QA failure.
- For simplicity and conformity between modalities, tolerance limits of 95% (and action level of 90%) using 2%/2mm gamma criteria were preferred by the physics team for future VMAT composite and Radixact QA evaluations.
- Process performance metrics indicate that our planning, dose calculation, delivery and QA processes should reliably produce plans that are able to meet these tolerance limits.

Modality	Data points	SPC-derived control limit 2%/2mm	3%/2mm	3%/3mm
VMAT (per beam)	61	93.3%	96.9%	99.1%
VMAT (composite)	60	95.6%	98.4%	99.5%
Tomotherapy	30	84.7%	96.0%	99.0%
Radixact	35	98.1%	99.5%	99.8%

Conclusions

- Control charts allow quantitative review of historical QA data and allow departments to determine tolerance limits specific to their planning, treatment and QA processes. This recommended by TG-218[1] as best practice.
- Consider how you record QA data and associated plan and dose information, to facilitate review, and in the future, potentially allow that data to be processed by machine-learning QA prediction tools.
- Specificity and sensitivity testing in detection of simulated errors will be used to identify appropriate action limits.

References

1.Miften M, et al. *Med Phys*. 2018;45:53–83. 10.1002/mp.12810

Disclosures

The authors have nothing to disclose. The study was exempted from ethical review (EX/2021/QRBW/82062).

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Questions? Ask me!