Multi-modality tumor tracking application versus manual PACS methods

A time study for Response Evaluation Criteria in Solid Tumors (RECIST)

Introduction

Medical Imaging has had an increasingly important role in the oncology care cycle and, particularly in monitoring the response to standard and new cancer treatments. After a treatment has been initiated imaging can provide timely, quantitative biomarkers that facilitate improved treatment decisions.

The Response Evaluation Criteria in Solid Tumors (RECIST), as well as the World Health Organization (WHO) criteria, provide standard imaging end-points that can be used to assess the response and effectiveness of a wide-range of solid tumor treatments. RECIST 1.1 provides a quantitative measure – the percent change in tumor burden in a follow-up exam in comparison with baseline study. This percentage, combined with other clinical factors, leads to treatment response classification into one of four categories ranging from complete response to progressive disease.

The improved use of quantitative information in medical imaging is the mission of the Radiological Society of North America's (RSNA's) Quantitative Imaging Biomarkers Alliance (QIBA). The QIBA addresses potential challenges with quantification such as the time required for measuring, calculating and reporting the interval changes in lesions.

Tumor size in terms of diameter is often measured manually on PACS systems and dictated in medical records with a reference to the comparison date. Although this standard was designed to be simple, the desire to implement RECIST with manual PACS or similar methods is often offset by the amount of time that would be required in a busy radiology or oncology department.[1] With PACS methods, locating and measuring lesions in a follow-up exam (corresponding to baseline lesions referenced by series and slice number) can be time consuming – and computing the sum of the "target" tumor diameters and percentage change in tumor burden is often calculated using a spreadsheet or a hand-held calculator.

In an automated approach, the Multi-Modality Tumor Tracking (MMTT) application (Philips Healthcare, IntelliSpace Portal) provides features and tools to decrease the time required to implement RECIST, as well as other standard and emerging response criteria.

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sense **and** simplicity
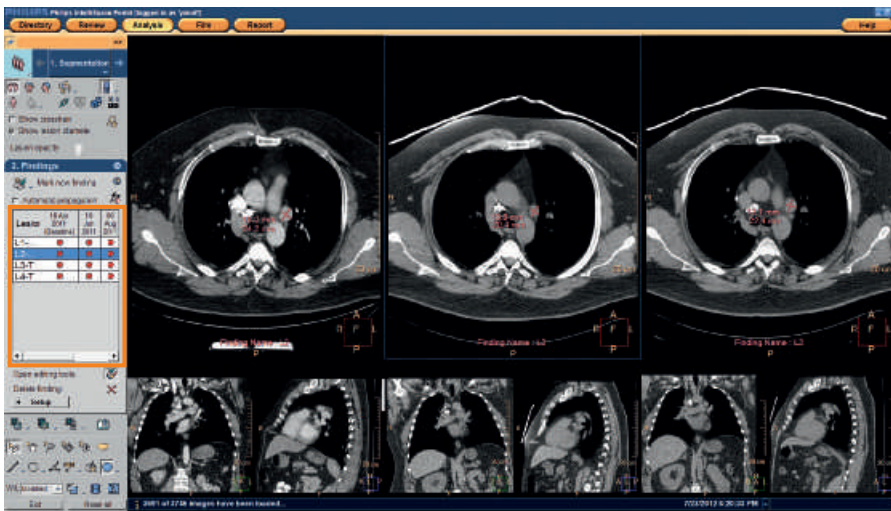
Figure 1: The measurement stage of the MMTT application decreases the time required for follow-up RECIST measurements relative to PACS methods.

Figure 2: The application automatically displays a user-configurable summary of quantitative results including a Cartesian graph of longitudinal tumor response measurements.

MMTT application

Baseline imaging exam

1. The baseline image series is automatically sent to the IntelliSpace Portal Server.

2. Target lesions are selected by the radiologist, measured with segmentation tools, and the results are stored with the image series. With the "Smart ROI," the lesion volume as well as the maximum and minimum diameters can be measured semi-automatically.

Follow-up exams

3. The follow-up image series is automatically sent to the IntelliSpace Portal Server.

4. The baseline and follow-up image series – including previously saved quantitative results – are simultaneously loaded into the MMTT application.

5. The baseline and follow-up data set(s) are semi-automatically registered. The view ports are linked so that longitudinal measurements can be performed side-by-side for temporal comparison.

6. Target lesions are quickly located in linked view ports by clicking an indexed lesion list (Figure 1, highlighted box) and measured with semi-automated tools such as the "Smart ROI."

7. The quantitative RECIST criteria – based on percent change in lesion diameter – is calculated by the MMTT application in the Results screen. A Cartesian graph shows the quantitative response criteria over time.

8. A report is generated with a summary of quantitative results and screen shots of the lesions to assist with the treatment response categorization.

Table 1

Time saving study

A retrospective study was conducted for paired comparisons in the time required for RECIST by Multi-modality Tumor Tracking Application and PACS methods. Four cases (2 females, 2 males; total number of lesions was 15) with baseline and follow-up CT examinations were randomly selected.

> The St. Francis cancer foundation offers more than 50 clinical trials led by entities such as the National Cancer Institute, according to Cynthia Stoner, CCRP, the Lead Data Coordinator at St. Francis Oncology Department and Cancer Research Foundation.

The "target" lesions of the baseline examinations were first evaluated by Dr. Andrew J. Mullinix a radiologist at Franciscan Saint Francis Medical Center, Indianapolis and Moorseville, Indiana. The baseline results were indexed and stored with the image series.

The follow-up RECIST measurements were performed by two independent operators. Each operator measured the follow-up lesion in each study with MMTT and, after a one week interval, with PACS.

For each method, the time was recorded to:
- Locate and measure target lesions in the follow-up exam corresponding to those indexed in the baseline exam (Table 1, step 6)
- Compute the sum of the lesion diameters and the total percent change in tumor burden (Table 1, step 7)

> Franciscan Saint Francis Medical Center is a not-for profit, 532-bed tertiary care hospital serving the residents of Southwest Indianapolis.
>
> St. Francis is ranked as one of the nation's "100 Top Hospitals" by a Reuters National benchmark study and is part of the Indiana Health Care system.
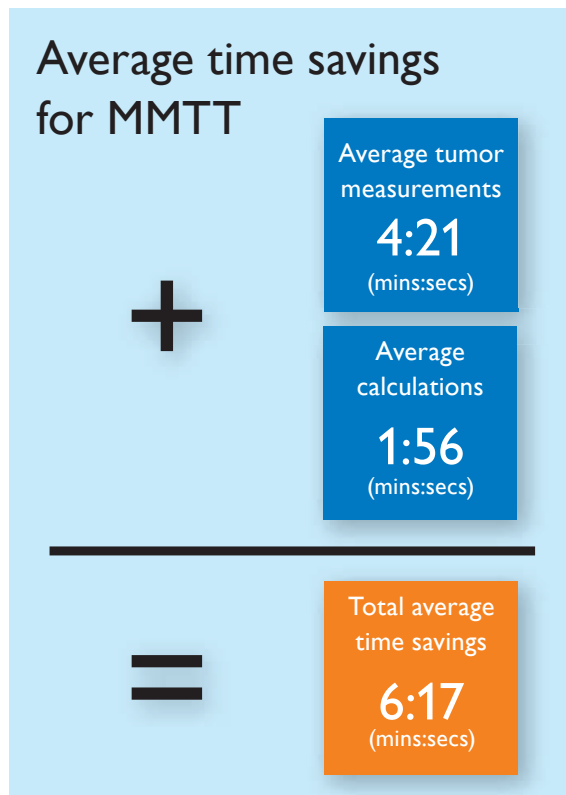
Average time savings

The results of the time study are shown in Table 2. In the measurement stage, the average time savings for MMTT was 4:21 minutes in comparison with PACS. The average time savings with MMTT for the summary calculation of the RECIST criteria was 1:49 minutes. The total average time savings was 6:17 minutes for MMTT relative to the PACS methods.

RECIST criteria timing measurement					
User	Average tumor measurements Time (mins:secs)			Average calculations Time (mins:secs)	
	MMTT	PACS	Diff	MMTT	PACS
1	2:45	7:34	4:49	0:00*	2:03
2	2:32	6:25	3:53	0:00*	1:49
Average time savings			**4:21**		**1:56**
Total average time savings					**6:17**

* MMTT calculations are done in a single click.

Table 2

Average time savings for MMTT

Average tumor measurements
4:21 (mins:secs)

+

Average calculations
1:56 (mins:secs)

=

Total average time savings
**6:17** (mins:secs)

According to J. Louis Rankin, RT (R) (MR) (PET), 3D Lab Technical Coordinator, Imaging Services, Saint Francis, "Once the target lesions of the study have been measured and indexed in the MMTT application, the analysis of the follow-up data sets are more streamlined and exponentially faster." Major time savings resulted from semi-automatic registration of longitudinal datasets, the response criteria calculation, and reporting via the thin client review. Features such as automatic sending of the image series to the IntelliSpace Portal Server were also significant.

The emergence of new image response criteria – such as Choi's, Chesson's, IrRC, and mRECIST – shows the increasing need for quantitative imaging end-points as new cancer therapies are developed. Choi's criteria, for instance, is used to monitor the response of GIST tumors. It extends the RECIST criteria to include a measure of tumor attenuation – which can be performed with the MMTT application.

The time savings of the MMTT application may lead to frequent use of imaging response criteria, facilitating enhanced care management for cancer patients.

Multi-Modality Tumor Tracking

Among other advantages of the MMTT application, PET (Figure 3), SPECT, and MR (Figure 4) studies can be included as longitudinal imaging end-points. Bookmarks of specific MMTT screens and results can be used to facilitate collaboration between Radiology and Oncology departments as the image data is processed toward shared quantitative results.
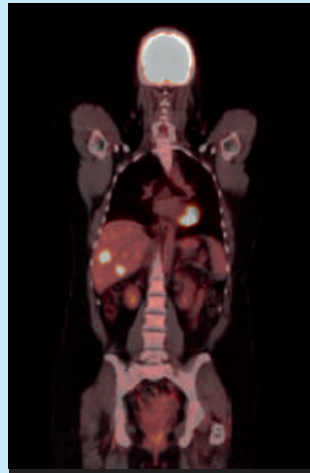
Figure 3: FDG-PET and SPECT are supported in addition to CT and MR for multimodality assessment.
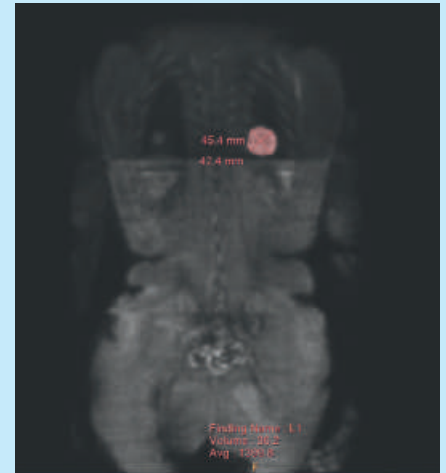
Figure 4: This multi-stack image above shows the measurement tools (shown for MR) that are available for inclusion in RECIST and other response evaluation criteria.

1. The exception can be for sponsored research trials where sufficient objective evidence must be gathered to make valid inferences about the treatment efficacy.

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