Breast cancer is the most common cancer in women worldwide. Slightly more cases in less-developed (883,000 cases) than in more-developed (794,000) regions. Of 184 countries, breast cancer is the most common cancer diagnosis in women in 140 countries (76%) and the most frequent cause of cancer mortality in 101 countries (55%).∗

**ALSO IN THIS ISSUE:**
- First patients treated with Leksell Gamma Knife® Icon™
- India center is country’s first with paperless MOSAIQ® workflow
- Case Study: Monaco® plans for multiple mets and spine SBRT/VMAT
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Several interesting developments to report on in this issue! The first is in the arena of accelerated partial breast irradiation (APBI) via multi-catheter interstitial brachytherapy. I am also pleased to report that our new Leksell Gamma Knife® Icon™ has entered clinical use at Hospital La Timone. Prof. Jean Régis provides details on the first Icon frameless treatments, which show the system’s unique imaging and motion management technologies.

In additional articles, customers are using our solutions in a variety of ways – from improving planning for patients receiving SBRT for multiple brain mets and spine lesions and providing first-time access to advanced radiation therapy, to the use of MOSAIQ to gather the information needed to earn an important oncology accreditation.

If you’re attending this year’s ASTRO meeting, make sure to visit the Elekta exhibit (booth #459) to see first-hand what’s new for Elekta in 2015 and beyond. If you won’t be attending, check out www.elekta.com/gobeyond to stay abreast of our ASTRO activities.

Good reading!

Tomas Puusepp
President and CEO of Elekta
APBI tipping point for breast-conserving therapy

Studies promise to add more evidence that accelerated partial breast irradiation (APBI) using multi-catheter interstitial brachytherapy provides equivalent outcomes versus whole breast irradiation (WBI)

Two American Society for Radiation Oncology (ASTRO) 2015 presentations, representing research groups on both sides of the Atlantic, are expected to add compelling new data that for post-lumpectomy patients, highly focused, short-course multi-catheter APBI is at least as effective as long-course fractionated WBI. In the key parameters of tumor recurrence, disease-free survival, length of treatment, cosmesis, side effects, toxicity and protection of normal tissues, APBI is gaining increasing acceptance as an alternative to WBI.

The ASTRO talks – to be given by Robert Kuske, MD, principle investigator of the United States’ PROMIS (Pooled Registry of Multi-catheter Interstitial Sites) study, and Prof. Dr. Vratislav Strnad, study co-chair of the GEC-ESTRO (Groupe Européen de Curiethérapie-European Society for Therapeutic Radiology and Oncology) phase III APBI trial – will add important confirming data to earlier studies, such as the Hungarian randomized trial1 and the large registry studies of MammoSite®, SAVI and PROMIS.

PROMIS APBI

Supported by an unrestricted grant from Elekta, the PROMIS registry study represents pooled data from five institutions with extensive experience in the delivery of interstitial brachytherapy for APBI. The group collected data from 1992 to 2013 (1,374 patients), retrospectively evaluating long-term outcomes of patients treated with interstitial brachytherapy APBI. PROMIS is one of four large US registry trials evaluating APBI.

Dr. Kuske’s ASTRO 2015 presentation is titled: “Short and Long-term Toxicity and Cosmesis After Interstitial Multi-catheter Brachytherapy for Accelerated Partial Breast Irradiation: A Multi-Institutional Study.”

“We found that the subsequent mastectomy rate is low, as are the fat necrosis and skin telangiectasia rates. The infection rate is acceptable for an invasive procedure,” Dr. Kuske says. “With long-term follow-up and a broad spectrum of patients with both low and high risk features, these data are
especially important, because we included patients that most other APBI studies have excluded.”

At the 2014 meetings of ASTRO and ASCO Breast, PROMIS data were presented on subgroups of patients typically considered “unsuitable” for APBI according to ASTRO guidelines. These include patients younger than 50 years of age, node positive subgroups and biological subtypes such as HER2-enriched and triple negative breast cancers. PROMIS also has outcomes on a large DCIS cohort.

“While a direct comparison with mastectomy or WBI requires a phase III trial, the PROMIS data compare favorably to published results of mastectomy or whole breast irradiation, even though there are many patients in the trial with high risk features,” Dr. Kuske notes. “Despite the heterogeneity in our patients’ tumor biology, the local tumor recurrence rate is in the five to six percent range. PROMIS provides the opportunity for subset analysis, such as triple negative and HER2-enriched tumors treated by interstitial brachytherapy, demonstrating local recurrence of over 10 percent.

“However, we have to ask whether recurrence rates might be over 10 percent as well with WBI or even mastectomy,” he continues. “Our soon-to-be-published ASCO Breast presentation indicates that tumor biology supersedes stage, age and other patient characteristics as risk factors for tumor recurrence.”

Further leveraging PROMIS trial data, an article published online in *Annals of Surgical Oncology* showed that patients treated with APBI had a 10-year actuarial risk of ipsilateral recurrence of 7.6%, regional failure rate of 2.3% and distant metastasis rate of 3.8%. High-grade disease at diagnosis and positive surgical margins were the only significant variables associated with increased risk of local recurrence.2

“These are very important data, because 1,374 patients were treated by APBI with mature follow-up – some patients had brachytherapy 15 years ago – and unlike the SEER and Medicare Claims studies, APBI was performed by experienced users,” Dr. Kuske observes. “Normally, we expect about 0.8% recurrence rate per year of follow-up with WBI. To have 7.6% at 10 years with APBI falls right in line with the best series of WBI with a large number of patients. It’s time for the medical oncology, radiation oncology and breast surgery communities to embrace APBI as an acceptable option in the treatment of early stage breast cancer.”
“With multi-catheter APBI it is possible to sculpture the dose distribution with virtually no restrictions as to the tumor size and shape, the individual anatomy of the female breast or resection margins.”

Prof. Dr. Vratislav Strnad

GEC-ESTRO APBI

The GEC-ESTRO phase III clinical trial, in particular, is the first international cooperative group to provide Level 1 evidence in a head-to-head comparison of APBI and WBI. Prof. Strnad’s presentation reports five-year mature results regarding local recurrence and survival (VS), in addition to late side effects and cosmesis (CP) of the study titled: “Accelerated Breast Irradiation Using Sole Interstitial Multi-catheter Brachytherapy Versus Whole Breast Irradiation with Boost After Breast-conserving Surgery for Low-risk Invasive and In Situ Carcinoma of the Female Breast, a Randomized, Phase III, Non-Inferiority Trial.”

Patient recruitment for the 16-center APBI trial began in April 2004 and closed in July 2009, accumulating 1,328 patients randomized into two treatment arms: APBI with pulsed dose rate or high dose rate brachytherapy versus external beam whole breast irradiation (50 Gy + 10 Gy boost).

“By January 2015, more than 90 percent of the patients were five years post-APBI or post-WBI, with a median of 6.6 years of post-treatment follow-up,” Prof. Strnad notes. “This enables us to provide a very sophisticated and mature analysis of recurrence rates, efficacy, late side effects and survival rates.”

The results of the GEC-ESTRO APBI trial are expected to reflect the special advantages of interstitial multi-catheter APBI over not only WBI, but also other brachytherapy techniques (i.e., single balloon, single catheter, external beam) as well as intraoperative radiotherapy.

“With multi-catheter APBI it is possible to sculpture the dose distribution with virtually no restrictions as to the tumor size and shape, the individual anatomy of the female breast or resection margins,” Prof. Strnad observes. “In addition, there are no issues
with protection of the skin, heart and lung – APBI provides better protection by at least a factor of four versus other radiation techniques. It’s without any doubt a highly flexible, versatile and reproducible technique that should be considered as a routine therapy for all low-risk breast cancer patients after breast-conserving surgery.”

*The Lancet* has accepted a paper on the APBI results that Prof. Strnad and his colleagues obtained.

**A well-studied technique**

With new favorable results expected to be reported at ASTRO 2015 by both the GEC-ESTRO and PROMIS groups and other important studies – such as an ongoing Phase III RTOG study comparing APBI with WBI – APBI has undergone an unparalleled amount of study, Dr. Kuske remarks.

“APBI will be among the most scientifically tested treatments in the history of medicine,” he says. “There are more APBI patients in prospective clinical trials than all of the trials that moved us away from mastectomy and toward breast conservation.”

**References**


3. RTOG 0413 (NSABP B-39): A Randomized Phase III Study of Conventional Whole Breast Irradiation (WBI) versus Partial Breast Irradiation (PBI) for Women with Stage 0, I or II Breast Cancer. Principal Investigators: Frank Vicini, Julia White, Robert Kuske and Douglas Arthur. •

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**What is APBI?**

APBI is a therapeutic approach that treats only the affected part of the breast. The lumpectomy bed and 1-2 cm of breast tissue beyond the surgical edge are treated with therapeutic doses of ionizing radiation, rather than the whole breast. Because the dose cloud is limited, a higher dose can be delivered in a shorter time – twice a day over four or five days, versus external beam whole breast irradiation, which involves five treatments per week for four to six-and-a-half weeks. Interstitial brachytherapy involves the implantation of multiple thin catheters into the breast, surrounding the tumor site. A high-activity radioactive source is introduced by cables into the catheters. The source then travels sequentially through each cable until the prescribed dose is delivered.

Radiobiologists have calculated that 32 Gy in eight fractions over four days, or 34 Gy in 10 fractions over five days, has similar tumor control probability and late normal tissue effects as the whole breast dose of 50 Gy in 25 fractions.

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**Improved clinical outcomes when using 3D image-guided brachytherapy.**

Clinical outcomes are improved when 3D image-guided brachytherapy (IGBT) is used for the treatment of cervical cancer. Adoption of 3D IGBT for cervical carcinoma is gaining momentum in Southeast Asia and heading north. To receive a PDF of the white paper, send an email to brachytherapy@elekta.com and include “IGBT white paper” in the subject field.
On August 10, doctors at University Hospital La Timone (Marseille, France) used their new Leksell Gamma Knife® Icon™ system to treat a metastasis in the brain of a 71-year-old female patient. This single-session treatment was the first time La Timone physicians had harnessed the system’s advanced motion management and imaging capabilities to enable therapy using mask-based head fixation instead of the traditional rigid stereotactic frame. With Icon, La Timone physicians are predicting a significant increase in the volume of patients suitable for frameless Gamma Knife® radiosurgery. In the days following, doctors treated three additional patients with metastases using the same method. Then, on August 17, the hospital achieved another Icon milestone – its first patient to begin frameless, multi-session (hypofractionated) treatment of a benign tumor.

“This 77-year-old female patient had a cavernous sinus meningioma that was too close to the optic nerve and chiasm to treat with a single high dose – it would have been too high of a dose to avoid threatening these sensitive structures,” says Professor Jean Régis, MD, a neurosurgeon and program director for University Hospital La Timone’s Gamma Knife program, which launched traditional frame-based Gamma Knife radiosurgery treatments with Icon in mid-July. “Therefore, she received a hypofractionated treatment, which divided her therapy into five sessions over five days to decrease the risk of injuring visual pathways.”

Icon features especially important for frameless therapy

When performing frameless Gamma Knife radiosurgery with Icon, it is crucial that patient motion be managed and that the patient’s position can be precisely reproduced in hypofractionated treatments.

Gamma Knife Icon addresses both of these imperatives. Icon provides an integrated cone-beam CT (CBCT) workflow that enables doctors to check the patient’s position against planning images. After a thermoplastic mask is custom-fitted to the patient’s head, an initial CBCT is performed to obtain a
reference image, which is then fused with an MRI image to enable the clinician to develop the plan. The patient is then placed on the treatment couch with the mask.

“Because the patient is never precisely in the same position as in these first scans, you acquire a new CBCT scan,” Prof. Régis explains. “In a few seconds, the GammaPlan software automatically adapts the plan to the new position of the patient’s head and displays the dose distribution before and after this automated recalculation. This allows the physician to identify any discrepancies between the initial plan and the recalculated plan according to the new patient position. It’s important to reiterate that this is a plan correction, not a physical correction of the patient’s position. So far, the differences in the plan – before and after adaptation to the patient’s latest position – have been clinically insignificant, so we haven’t rejected any of the adapted plans.”

During treatment, patient motion is managed through the high-definition motion management system, which monitors the patient’s head position via infrared tracking of markers.

“If the patient coughs or moves her head and that motion exceeds a safety threshold, the system automatically stops delivering the radiation,” he observes. “This is a critical feature for patient safety in these frameless treatments. The on-the-fly intrafraction, automated adaptation of the planning to patient position is a new and interesting capability of Icon.”

At press time, Hospital La Timone had used Leksell Gamma Knife Icon to treat a total of 79 patients using either frame-based or frameless methods.

To learn more about Leksell Gamma Knife Icon, visit careforthebrain.com.
Gamma Knife® radiosurgery: 1991-2014

Steady growth for an established therapy

The introduction of Elekta’s sixth generation intracranial radiosurgery system, Leksell Gamma Knife® Icon™ is testament to the technology’s position as an enduring, effective and evolving treatment modality. Two years after its establishment in 1989, the Leksell Gamma Knife Society began tracking patient treatment numbers and indications based on the reporting of Gamma Knife sites worldwide and was able to include all patients treated before 1991 on a cumulative basis. The statistics paint a picture of a therapy that continues to make year-on-year gains in patients treated among four major indication groups: benign and malignant tumors and functional and vascular disorders.

Figure 1. The number of patients treated with Gamma Knife technology worldwide increases year-on-year. With approximately 75,000 patients treated annually, the number of patients treated will reach one million before the end of 2016. (68-100% of centers reporting)

Figure 2. Average number of Leksell Gamma Knife Perfexion treatments per region and center 2014: 293 (95% of centers reporting)
Figure 3. Leksell Gamma Knife evidence base compared to linac platforms (peer-reviewed papers reporting ≥ 30 patients through March 2015).

Source: PubMed. Includes AVMs, meningiomas, metastatic Tumors, pituitary tumors, trigeminal neuralgia, vestibular schwannoma, essential tremor, glioma papers reporting 30 or more patients. Single-session SRS only. Linac papers may include some SRT patients.

Figure 4. Installed in over 40 countries, the use of Leksell Gamma Knife in 2014 was widespread throughout the world. (95% of centers reporting)

Figure 5. The case mix for Gamma Knife radiosurgery in 2014 varied widely by region.

Additional 2014 worldwide Gamma Knife stats (95% of centers reporting):

- Arteriovenous malformations represented 74% of all vascular disorders treated with Gamma Knife
- Trigeminal neuralgia represented 87% of all functional disorders treated with Gamma Knife
- Among benign tumors treated with Gamma Knife radiosurgery, 44% of patients had a meningioma and 26% had a vestibular schwannomas
- Metastatic tumors represented 91% of patients who were treated for malignant tumor(s)
- Fractionated Gamma Knife treatments (with the Leksell frame or with Extend™) were performed in approximately 612 patients. Of those patients treated in a fractionated paradigm, 59% of patients had benign tumors, approximately 34% of patients had malignant tumors and 6.5% of patients were treated for vascular disorders

Data and graphics (except Figure 3) are courtesy of the Leksell Gamma Knife Society.
For two years, health care providers at Fortis Memorial Research Institute (FMRI), in Gurgaon (Haryana) had tolerated their often confusing paper-based radiation therapy workflow. Although they had been using MOSAIQ® Desktop (v2.3) to record and verify treatments since 2012, every other aspect of the practice depended on the manual processing of a piece of paper – everything from scheduling and tracking the patient through the treatment process to the creation and filing of many different patient-related documents. In addition to the inefficiencies and greater chance for human error associated with an exclusively paper-driven environment, the department was steadily losing space to the accumulation of physical RT charts. The 2014 upgrade to MOSAIQ® Oncology Information System (OIS) version 2.5 has streamlined FMRI’s workflow dramatically, resulting in better safety, efficiency and communication.

A paperless vision
Since the inception of the FMRI department of radiation oncology in 2012, staff had been cataloguing their patients’ RT charts in two-ring binders and shelving them in cabinets. Although neatly tabbed into five sections, each patient chart contains 40 to 50 pages of documents. The rows of chart binders take up space even today.

However, it had been a long-held vision of Bidhu Mohanti, MD, Head and Director of FMRI’s Department of Radiation Oncology, to create a completely paperless department. His vision – supported by the department’s oncologists, medical physicists, therapists, radiation oncology India center leaves paper-based workflow behind

FMRI is country’s first radiotherapy department to adopt fully electronic workflow with MOSAIQ®
nurses and administration, and the arrival of MOSAIQ v 2.5 and Elekta training support – led to a dramatic transformation in a department that is witnessing rapid growth.

In the fourth week of October 2014, FMRI converted from MOSAIQ Desktop (v 2.3) to MOSAIQ (v 2.5) and upgraded its 12 MOSAIQ workstations to Windows 64-bit version and installed MOSAIQ on them. The department also purchased a printer-scanner to convert and upload paper documents into MOSAIQ.

“Although the conversion was successful, there were significant challenges throughout the process,” Dr. Mohanti acknowledges. “Many of the staff voiced strong concerns whether it was feasible at all. In addition, getting everyone trained on MOSAIQ was a serious hurdle, because not all had attended the training classes.

“Even with instruction, it took time for others to catch up with the new workflow and to understand how to use all the MOSAIQ features,” he continues. “These challenges created a very hectic environment in the department in the first several days.”

Despite these difficulties, FMRI staff began to appreciate the value of their new MOSAIQ workflow.

An electronic mirror image of the paper chart

The customizability of MOSAIQ enabled FMRI staff to create an electronic RT chart that mirrored the physical RT chart in terms of the original tabbed sections.

Once this was done, staff were no longer required to photocopy and file several paper documents, including billing sheets, vital signs, investigation reports, EORTC-QLC-C30, TPS printouts, morbidity scores and discharge summary. These had amounted to 40-50 pages of documents in the physical RT chart.

“We scan all of these documents and attach them to the patient’s EMR in MOSAIQ,” says Silas George, Chief Technologist. His technologist colleagues, Saneg Krishnankutty and Jeen Sathya add that previously, physicians had to flip through several pages of a patient record to locate a particular report, which made it easy to miss what they were looking for. In MOSAIQ, all the documents are categorized in an electronic pull-down menu.

In an FMRI patient’s RT chart today, there are just two paper consent forms – one for RT treatment course and another for CT
scanning with contrast – and one sheet for recording daily shifts.

Clinical notes
A well-used screen in MOSAIQ is Clinical Notes, which relieves doctors of the necessity to handwrite and file the frequent clinical notes per patient that can come from several different areas and subjects, such as oncology history, radiology, pathology and clinical audit/physics/RTT. These are now entered electronically and categorized in MOSAIQ.

No more chart chasing
In addition to reducing FMRI’s paper documents and enabling access to them in a single, easy-to-navigate application, MOSAIQ eliminated the need to locate RT charts in the department.

“Before MOSAIQ, we had to ‘chase’ the physical RT chart in different locations for every activity concerned with the patient,” recounts radiation oncologist Anusheel Munshi, MD, Additional Director of the department. “But with 12 MOSAIQ workstations, the patient’s EMR is available at every location.”

MOSAIQ home page
The MOSAIQ home page has removed the requirement for staff to walk to a whiteboard in the treatment planning room to check off when they have completed an assigned task.

“The home page is the common space in which the department’s entire workflow is monitored and pending tasks are reviewed,” says Shaleen Agrawal, MD, radiation oncologist. “That saves frequent walks to the treatment planning room, which can be 50 meters away depending on where you are.”

On the home page, it also is obvious when patients have arrived at the hospital, at what time they have been taken inside for treatment and when they complete treatment.

“I used to have only a rough idea when the patient was expected. If I wanted to know, I would have to come out of my room or call someone,” adds radiation oncologist Vikas Roshan, MD. “Now, when patients arrive, they are queued and their progress through the process is visible on my MOSAIQ schedule.”

Weekly chart audit
Having all patient records stored electronically has greatly eased the weekly chart audit of new patients and those who have completed their treatment course. Before MOSAIQ OIS, the audit required transporting physical charts for review.

“If there were 12 news cases and 10 patients completing treatment we had to bring 22 physical RT charts from the linear accelerator console rooms to the conference room,” notes radiation oncologist Sayan Paul, MD. “So we discussed all these files cluttered on the table. Later, these would have to be segregated and brought back to their respective treatment machine. With
MOSAIQ OIS, we just use one workstation and the Patient Worklist Option using appropriate filters.”

**Daily schedules**

Pre-MOSAIQ OIS, daily schedules were done on the two MOSAIQ Desktop sequencers at the linac consoles. However, they were replicated manually in an Excel sheet for distribution to consultant and staff doctors, Patient Review Room, Front Desk and TPS Room. This manual entry in the Excel document was prone to errors.

In addition to the time it took to prepare the Excel sheet, there could be wrong patient ID’s and spelling mistakes in patient names, according to members of the front desk staff and radiotherapy technologists, the latter who had previously been responsible for this daily task. They were able to eliminate this Excel document almost immediately after MOSAIQ go-live.

**Assessments**

All clinical assessments (e.g., vital signs, Temozolomide administration, morbidity scoring) previously done on paper forms are now MOSAIQ electronic assessments complete with graphs to better track trends. In fact, radiation oncology nurses have their own workstation at which they enter the first two assessments listed above.

**eScribe documents**

The availability of eScribe document templates, such as physics calculations, in-vivo dosimetry results and plan requests with dose optimization criteria, also saves time.

Medical physicists Biplab Sarkar and Kanan Jassal relate that they are using this feature for plan requests by radiation oncologists. They note that pre-defined templates are available for different sites with all the dose constraints. Instead of writing the dose constraints and dose objectives on a separate register, oncologists are now using the eScribe feature to put in their requests.

Since the constraints and objectives are already there, they have to do no editing or very little editing before finalizing them and attaching them to the EMR, they observe. Sarkar and Jassal also use eScribe for recording manual calculations, such as electron treatment field calculations. This has improved the documentation process.

**Saving space — FMRI staff scanned and uploaded 8,643 pages of RT chart documents, which translates to over 17 reams of paper or 86.5 cm (~ 3 feet) of storage width saved.**

**On the horizon**

FMRI’s first priority was to get out from under the mountain of paper produced in the radiation therapy workflow. In doing so, the department has greatly enhanced staff productivity, reduced the likelihood of errors and enabled providers to deliver better patient care.

Moving forward, the department’s goals are to more fully exploit MOSAIQ functionality and to use the information electronically catalogued in the OIS to begin mining this data and generating SAP® Crystal Reports®.

“There are already about 200 reports built into MOSAIQ, but to tailor a report with the unique parameters of our workflow, we will need to develop a Crystal Report,” says Tharmar Ganesh, PhD, Chief Physicist. “We expect that in the coming months some of us will receive Crystal Reports training.”

In addition, while FMRI is employing many of the most useful MOSAIQ capabilities, Drs. Mohanti and Ganesh appreciate that the department has only scratched the surface of the OIS’s potential.

“We know there are many centers outside of India that are doing much more with MOSAIQ than what we are doing,” Dr. Mohanti says. “We would like to visit those departments to see how they’re using MOSAIQ in innovative ways. We can learn from them, which will help us take MOSAIQ to an even higher level in our department.”
First high field MR linac installed in U.S.

MD Anderson Cancer Center and Elekta teams have made major progress in 2015 installing the United States’ first high field MRI-guided linear accelerator, presently a non-clinical system. In the early months of the year MD Anderson renovated an existing radiotherapy vault. On August 1, Elekta delivered and installed the radiation therapy system. Later in the month, the system’s super-conducting 1.5 T MR magnet was delivered and integrated within the rotating gantry in one day. When the system installation is complete, Elekta’s commissioning of the system will be performed.

“The installation of the MR linac is going well and an example of the cooperation between MD Anderson and Elekta,” says Stephen Hahn, MD, MD Anderson radiation oncologist. “We expect to start our program of research and performance evaluation in January 2016. The MD Anderson Division of Radiation Oncology is excited about the opportunities that the MR linac project is targeted to provide to our patients. The possibility of soft tissue imaging combined with advanced photon delivery in a linac could allow us to provide improved value for our patients.”

Elekta completed installation of the world’s first high field MRI-guided linear accelerator at University Medical Center Utrecht (Netherlands) at the end of 2014. This system is also currently non-clinical. •
Since University Medical Center Utrecht (UMCU, Utrecht, the Netherlands) first presented the MR linac concept in 2002, research on the feasibility and prospective clinical application of MRI-guided radiation therapy has only accelerated, particularly in the last two years. Researchers at UMCU – a founding member of the Elekta Atlantic Consortium and site of the world’s first high field MR linac installation – has contributed, to date, 37 publications on work that tests and validates the technology.

As more institutions joined the Consortium, additional studies have accumulated exploring virtually every aspect of MRI-guided radiation therapy – from the effects of the magnetic field on the treatment beam and treatment planning, to image interpretation and the ability of the system to track moving targets.

At the 2014 and 2015 meetings of the American Association of Physicists in Medicine (AAPM), UMCU and several Consortium members gave a total of 33 presentations on MRI-guided radiation therapy. The complete Consortium includes UMCU, the University of Texas MD Anderson Cancer Center (Houston, Texas), The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital (Amsterdam, the Netherlands), Sunnybrook Health Sciences Centre (Toronto, Ontario), The Froedtert & Medical College of Wisconsin Cancer Center (Milwaukee, Wisconsin), Royal Marsden Hospital and The Institute of Cancer Research (London), and Manchester Cancer Research Centre/The Christie (Manchester, UK).

“The Consortium’s share of presentations amounted to more than half of the approximately 60 talks on this novel technology at the last two AAPM meetings,” says Marco Luzzara, Research Director – Global Scientific Research. “These were representative of not only the work of our Consortium members at the clinical sites, but also that of Elekta and Philips, which demonstrates the scientific excellence of the Elekta and Philips project teams.”

Several of the 2015 AAPM posters and presentations focused on research aimed at ensuring that Elekta’s MR linac (work-in-progress) will perform correctly in the integrated system.

Highlights included:

- “Operation of an Electron Accelerator on an Integrated MR-Linac System”
  Summary: Researchers modelled the Atlantic waveguide and designed a magnetic shield to ensure the linac was not affected by the MR system’s magnetic field. http://bit.ly/elekta192a

- “Auto-Alignment of 2D Cine Imaging Planes for Real-Time Motion Management During MRI-GRT”
  Summary: Medical College of Wisconsin researchers work to devise a methodology to auto-align 2D cine imaging planes for real-time imaging on MRI guided radiation therapy systems. http://bit.ly/elekta192b

- “Experimental Evaluation of a Commercial GPU-Based Monte Carlo Dose Calculation Algorithm”
  Summary: A study by Sunnybrook Odette Cancer Center and University of Toronto researchers benchmarks a GPU-based Monte Carlo dose calculation algorithm for the MRI linac. http://bit.ly/elekta192c

- “Calculation of KQ for a Variety of Commercially Available Ionization Chambers in the Presence of An External Magnetic Field for MR-Linac Dosimetry”
  Summary: In this study, a University of Texas MD Anderson researcher characterizes different dosimeters in the presence on an external magnetic field. http://bit.ly/elekta192d
Evaluation of Monaco® for planning hypofractionated stereotactic VMAT of multiple brain metastases

By: Young Lee, PhD, Medical Physicist Odette Cancer Centre, Odette Cancer Centre; Arjun Sahgal, MD, Radiation Oncologist; Claudia Leavens, PhD, Medical Physicist; Mark Ruschin, PhD, Medical Physicist

**Patient demographics**

66-year-old female

**Treatment**

HF-SRT
25 Gy delivered in 5 fractions

**Diagnosis**

Primary disease: Lung cancer

Five brain metastases:
- GTV1 – Left Frontal
- GTV2 - Left posterior inferior cerebellar
- GTV3 - Left anterior cerebellar
- GTV4 - Right occipital
- GTV 5 - Right anterior occipital

**Treatment planning and delivery systems**

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**Introduction**

This case study forms part of a larger comparative study to observe differences between Monaco® (version 5.1) and Pinnacle (version 9.2) treatment planning systems (TPS) for the treatment of multiple brain metastases and spine SBRT using volumetric modulated arc therapy (VMAT).

A current debate about the treatment of brain metastases is whether to irradiate the whole brain or to treat each lesion separately. Because it is likely that these patients will present with further brain metastases in the future, it is desirable to maximize dose reduction to the uninvolved brain to enable new metastases to be treated.

In planning the treatment of multiple targets using a single isocenter, hypofractionated (HF) VMAT is technically challenging. The TPSs investigated vary in their optimization and dose calculation algorithms, which may produce substantially different dose distributions. Pinnacle uses a collapsed cone convolution dose calculation and Monaco uses the Monte Carlo dose calculation. This case study sought to
observe the differences in dose distributions
produced by Monaco and Pinnacle for a
challenging five-met HF-VMAT case.
Validation of these results with
measurements will determine the accuracy
of the dose calculation algorithms.

In our experience, in planning multiple
targets using VMAT with Pinnacle, we have
observed several planning limitations. To
achieve the desired high dose gradients,
Pinnacle requires a long dose calculation
resulting in a lengthy planning time. The
plan quality also is limited by the
optimization algorithm’s inability to
accurately track the target using the jaws and
MLC leaves as the treatment head moves
around the patient. Specifically, certain leaf
and jaw positions remain open when they
should be closed (Figure 1). Using Monaco,
however, we have found that the MLC leaves
and jaws are better able to track targets
throughout the VMAT arc.

The aim of the study is to determine if
Monaco offers any gains in planning and
treatment times, target conformality and
dose to uninvolved brain. Our hypothesis is
that Monaco will perform better than
Pinnacle when planning multiple brain
metastases and spine SBRT, because of its
ability to track the target effectively using
the jaws and MLC leaves. It should be noted
that the study team has significant
experience in planning with Pinnacle and its
functionality (5-10 years), and limited
experience planning with Monaco (less than
6 months).

If a clinical benefit is proven, this will
justify evaluating the plan quality that can
be achieved using Monaco for other
anatomical sites.

Figure 1. Stereotactic HF-VMAT of multiple brain
metastases. Pinnacle MLC leaves are not
tracking (closing) effectively around the targets,
leading to increased dose to uninvolved brain.

Young Lee, PhD,
Medical Physicist
Odette Cancer Centre
Patient history and diagnosis

The planning CT scans used for the investigation were from a patient with lung cancer and five brain metastases (Figure 2), which were treated at the Odette Cancer Centre using HF-SRT to deliver 25 Gy X 5.

Treatment planning

Retrospective re-planning was performed with both TPSs using an Elekta Agility™ VMAT beam model. The same energy (6 MV) beam, arc geometry and single isocenter (Figure 3) were used for each TPS, so that differences between the systems could be distinguished. A uniform margin of 2 mm was used to create PTVs from GTVs.

VMAT arc arrangement used for each TPS:
- Couch 10°; Gantry 180° to 310° clockwise
- Couch 305°; Gantry 40° to 179° clockwise
- Couch 55°; Gantry 180° to 320° clockwise
- Couch 350°; Gantry 40° to 179° clockwise

Dosimetric objectives for treatment planning:
- Planning target volume (PTV) 100%>98%
- Brainstem maximum dose of 18 Gy
- Optic chiasm maximum dose of 15 Gy
- Optic nerves maximum dose of 15 Gy
- Globes maximum dose of 10 Gy
- Lens maximum dose of 4 Gy
Plans were evaluated based on integral dose to the brain, not including the gross tumor volumes (i.e., BrainMinusGTV), target homogeneity and conformity indices.

**Results**

![Figure 4. A comparison of the dose distribution between the two TPS’s, in axial and sagittal planes.](image)

**Discussion**

We judged both plans to be clinically acceptable. All clinical criteria for organs-at-risk (OAR) constraints were met (Table 1). PTV coverage was greater than 97.5% in all cases except for one PTV that was proximal to the brainstem and resulted in V100% of 82.6% and 90.5 % for Pinnacle and Monaco, respectively.

Dose homogeneity within the target was similar for both systems, with the greatest difference being a 3.5 Gy increase in D2% for Monaco, in PTV1. Conformity indices were also similar but Monaco was marginally lower for four of the five targets.

The BrainMinusGTV dose volume histograms (DVH) were most noticeably different between 5 Gy and 10 Gy (Figure 5), with Pinnacle being 30%-32% higher than Monaco. At lower and higher dose levels, the DVHs crossed and Pinnacle was marginally lower. Overall, the mean dose was slightly lower for Monaco: 453 cGy versus 499 cGy for Pinnacle.

We noted that Monaco provided greater brainstem-shielding than Pinnacle (Figures 4-5), resulting in a mean brainstem dose of 10 Gy and 4 Gy in Pinnacle and Monaco, respectively.

The Windows-based Monaco software is very user-friendly and found to be easier to navigate than Pinnacle for new users. Due to the ability to prioritize IMRT objectives prior to optimization in Monaco, we also found the planning process to be more user-friendly. Through the use of well-structured templates, it is felt that the overall planning process using Monaco may take less time. This finding needs to be validated with a larger study.

The fusion tool in Monaco is easy to use and valuable for deformable image registration, allowing one image to be deformed and matched to another.
Conclusion

Overall, both treatment planning systems produced clinically acceptable dose distributions. Monaco may potentially result in lower normal tissue dose as exhibited by the substantial reduction in DVH between 5-10 Gy for BrainMinusGTV, but this needs to be validated in a larger patient series and findings validated with measurement.

Not considered in the present study were investigations of different beam, arc and isocenter arrangements, nor patient-specific quality assurance, which are necessary for clinical implementation.

As the treatment of multiple metastases expands, the selection of a TPS that can generate multiple target plans quickly, accurately and efficiently is increasingly important to meet clinical and workload needs. Comparisons between the two TPSs continues for single, two, three and four target brain metastases and spine SBRT plans.

References

A multi-party strategic partnership to create a state-of-the-art Caribbean Cancer Control Program has completed its first major project, the construction of a cancer treatment center in the Eastern Caribbean Island of Antigua, at a new medical complex called The Medical Pavilion Antigua. On July 3, just one week after a grand opening event on June 26, The Cancer Centre Eastern Caribbean (TCCEC) treated its first patient, a woman who received palliative radiotherapy for spinal cord compression caused by a metastasis.

“This partnered care collaboration is one in which Global Health Partners, Ltd., my principal private sector organization, assumed a significant role in establishing this service and then offered that service back to the government at a substantial discount, to care for patients who otherwise can’t afford private care,” explains Conville Brown, MD, TCCEC Chairman. "This Antigua center for The Organization of Eastern Caribbean States [OECS] brings state-of-the-art cancer therapy at steeply discounted prices for government patients, and one that residents of the nine countries comprising OECS never had."

In March 2014, TCCEC named Elekta as a member of its newly evolved Quadripartite Partnered Care Model with Elekta as its new industry sector partner.

As a partner in the Caribbean Cancer Control Program, Elekta contributed to the Antigua center its MOSAIQ’ Oncology Information System, which will enable TCCEC to electronically link all nine OECS countries together and with its parent company in The Cancer Centre Bahamas (TCCB). TCCEC has acquired Elekta’s Infinity™ linear accelerator, an advanced radiotherapy system capable of image-guided radiation therapy, VMAT, SRS and SBRT.

Access is everything. 95% of all radiotherapy equipment in the world is available to only 20% of the world’s population.

Source: International Atomic Energy Agency (IAEA)

Grand opening draws hundreds

Between 400 and 500 people attended the June 26 grand opening of the Antigua center. Guests of Dr. Tom McGowan, Managing Director, and Dr. Conville Brown, TCCEC Chairman, were included in the government sector headed by His Excellency Sir Clare Roberts (Deputy Governor General of Antigua and Barbuda); the Hon. Gaston Browne (Prime Minister of Antigua and Barbuda); the Hon. Dr. Baldwin Spencer (former Prime Minister, Antigua and Barbuda); the Rt. Hon. Perry Gladstone Christie (Prime Minister of The Commonwealth of The Bahamas and Sitting Chair for CARICOM Heads of Government); the Hon. Molwyn Joseph (Minister of Health for Antigua and Barbuda); the Hon. Dr. M. Perry Gomez (Minister of Health for The Commonwealth of The Bahamas); and Ambassador Bernard Percival (Chairman of Mount St. John’s Medical Centre Board of Directors and Government Equity Partner). Several members of Parliament and the Senate, members of the judiciary and diplomatic corps, and civil servants also attended.
Elekta: reporting from around the world
ATLANTA, GEORGIA, USA

BMX athlete shares his Gamma Knife treatment story

In September, Elekta hosted a cancer survivorship event at Elekta’s Atlanta LINC training center. A highlight of the event was Professional BMX athlete, Josh Perry, who recounted his 2012 treatment of a brain tumor with Leksell Gamma Knife. “I was thankfully given a second chance at life,” Josh says. “With that chance, I wanted to live the life I dreamed of while helping others to do the same and to become as healthy as possible. I also wanted to show others I’m no different than them – in the sense that we all possess the power to overcome adversity in our lives. I am living proof that anyone can achieve their goals when they put their minds to it, nourish their body, and think positively.”

CAPE TOWN, SOUTH AFRICA

South Africa Education and Training center opens

Elekta is investing substantially in Africa, specifically with its Elekta Cape Town Training Centre opening in South Africa. Here, clinicians will learn about the use of linear accelerators, oncology information systems and treatment planning systems. “Currently, this type of training requires visits of overseas technical and applications specialists to South Africa and other African countries,” says Erik Leksell, Managing Director, Sub-Saharan Africa. “With this training facility, we expect to educate about 600 clinical staff and 200 administrative staff over five to ten years.”

LEYWARDEN, NETHERLANDS

Dutch hospital acquires 1,000th Agility™ multileaf collimator

In June, Radiotherapy Institute Friesland accepted delivery of a new Elekta Synergy™ linear accelerator, equipped with Elekta’s 1,000th Agility MLC. “Two of our five linacs are already equipped with Agility,” says Annerie Slot, MD, radiation oncologist and executive director at RIF. “We value the narrow 0.5 cm width of the Agility leaves, which is especially beneficial in shaping the radiation beams for small targets in stereotactic treatments. The high leaf speed also enables us to deliver VMAT in a shorter time, particularly in the stereotactic treatments we deliver.”

NEW SOUTH WALES, AUSTRALIA

Technology upgrade at Mid North Coast Cancer Institute

A program to upgrade radiation therapy equipment at Mid North Coast Cancer Institute centres at is underway. Installations have commenced at the Coffs Harbour and Port Macquarie sites, with the installation at Lismore planned for early 2016. The program will see each of NCCI’s six Elekta Synergy linear accelerators upgraded with Agility multileaf collimators, as well as XVI R5.0 feature upgrades and Monaco 5 treatment planning. “NCCI has always had a strong desire to maintain the latest technology,” says Shaun Seery, Managing Director, Australia and New Zealand. “This program not only upgrades each of their sites with industry-leading technology, but ensures Northern NSW patients have access to world-class radiotherapy devices.”

CRAWLEY, ENGLAND

Elekta celebrates fourth consecutive Queen’s Award

Elekta was awarded its fourth Queen’s Award in as many years. The Queen’s Awards for Enterprise are the UK’s highest accolade for business success and are announced every year on the Queen’s birthday. “This was a very proud day for Elekta and all of our colleagues and suppliers who work tirelessly to discover new ways to fight cancer,” says Todd Powell, Executive Vice President, Comprehensive Oncology Solutions. “It is a great compliment to us all to be awarded with this prize and to be recognized for Elekta’s leading role in innovation.”
OSAKA, JAPAN

JASTRO radiotherapy seminar for students and residents
On July 4, Elekta sponsored the JASTRO radiotherapy seminar in Osaka. Twenty-nine radiation oncologists were on hand to train 24 medical students and residents on EBRT and brachytherapy using Elekta’s Monaco® treatment planning system and brachytherapy applicators. The seminar included a lecture on the history and future of radiotherapy, hands-on training for EBRT planning and GYN brachytherapy. After the event, Prof. Yasumasa Nishimura, president of JASTRO, concluded that he hoped the seminar proved valuable to radiation oncologists as they continue to gain experience.

PARIS, FRANCE

Elekta receives Hermes Innovation Award
The European Institute for Creative Strategies and Innovation recently awarded Elekta with the 2015 Hermes Innovation Award in the “improvement of the human condition” category for the quality and continuity of its innovations in cancer treatment. The Hermes Awards honor companies and organizations whose innovative ideas and products help advance society. “We are very honored and delighted to receive this award,” says Kevin Brown, Global Vice President, Scientific Research. “It’s a motivator to continue to drive us to open new frontiers and create improvements in cancer care.”

SAN ANTONIO, TEXAS

Cancer registrar of the year named at NCRA conference
During the National Cancer Registrars Association’s Annual Education Conference, Elekta paid tribute to the 2015 Registrar of the Year, Lelia Edwards. Lelia, who was nominated by her peers, is a cancer registry pioneer in the state of Alabama, with more than 37 years in the cancer registry field. She has served as a CTR for 29 years and is a mentor with NCRA’s mentoring program. “What better honor than recognition from one’s colleagues,” says Heidi Gianella, Manager, Data Product Management. “We at Elekta would like to congratulate Lelia for her tireless efforts and contribution to her registry program.”

SEOUL, KOREA

Samsung Medical Center acquires Asia’s first Leksell Gamma Knife® Icon™
In June, Elekta signed a contract with Samsung Medical Center to deliver the first Leksell Gamma Knife® Icon™ to Asia. “With Leksell Gamma Knife Icon, I can increase treatment efficiency while minimizing toxicity to normal brain tissues,” says Dr. Jung-Il Lee, professor at SMC’s department of neurosurgery. “Icon brings new possibilities to patients with tumors that could not be operated on before.” Professor Lee has treated more than 7,000 patients with Leksell Gamma Knife® since 2002 and will now pioneer the new potential that Icon brings.

STOCKHOLM, SWEDEN

Berghs School of Communication teams up with Elekta
Each year, the students at Berghs School of Communication work on a theme-based thesis project. For 2015, the theme was “Emotions.” Their mission: to improve visibility of Elekta within Sweden and beyond. “The students visited Uppsala Akademiska Hospital to see a patient being treated on our equipment,” says Rachel Thölix, Head of Corporate Brand Management. “They later created pieces of jewelry that were once part of an Elekta linear accelerator. The revenue from sales then went to Cancerfonden, a non-profit organization in Sweden whose primary goal is to raise and distribute money for cancer research.”
If you are attending ASTRO, ASRT or SROA in San Antonio, stop by Elekta booth 459 and discover:

- Advancements in Elekta’s radiosurgery innovations with Versa HD™ and the new Leksell Gamma Knife® Icon™.
- The latest Information-guided cancer care™ solutions from Healthcare Analytics to MOSAIQ® 2.63.
- Technological breakthroughs that push boundaries in healthcare delivery.

Take advantage of free product demonstrations.

MOSAIQ, Monaco®, Leksell Gamma Knife Icon, Versa HD™, XVI5, Flexitron® afterloader, and so much more!

If you are not attending, follow us on our social sites to keep up with breaking news.

Elekta social media – https://www.elekta.com/company/social-media.html
Facebook – https://www.facebook.com/Elekta
Twitter – https://mobile.twitter.com/Elekta
Instagram - https://instagram.com/elekta_/

The only way to push the boundaries is to move beyond them.
In May 2015, Hematology Oncology Associates of Central New York (HOACNY) received full accreditation from the Commission on Cancer as an Oncology Medical Home (OMH), a designation for an oncology-specific model of cancer care delivery with an emphasis on care coordination, patient-centeredness, measuring quality and using resources wisely. A valued MOSAIQ user and beta tester for 14 years, HOACNY was able to harness the powerful analytical and information management functionality of MOSAIQ to compile the vast amount of data required for accreditation.

OMH certification distinguishes HOACNY as one of the nation’s premiere community cancer practices for meeting stringent standards, including innovative patient-centered care and engagement, expanded access to advanced evidence- and team-based care and comprehensive quality improvements to deliver high quality and value to the patient.

“We were part of the OMH pilot project, which included 10 US centers and so far only six clinics have received OMH certification,” says Marsha DeVita, HOACNY’s Chief Clinical Officer. “HOACNY got an A+ rating.”
“We like to think of the OMH model as giving the right oncology care to the right patient at the right time and the right setting, so that we can anticipate problems with the patient and head them off,” DeVita adds. “The goal is to be accessible and available to patients so they don’t get sicker and end up in the hospital needing more resources. A big part of that is the ability to measure quality – things like ER use and hospitalization rate, performance status, survival statistics and patient satisfaction. OMH is really a great model for people who love caring for patients.”

“OMH is really a great model for people who love caring for patients.”

To receive OMH accreditation, HOACNY spent months gathering objective validation measures and generating reports from its MOSAIQ® Oncology Information System to document a comprehensive range of practice and patient care parameters. Examples of these measures include:
- Percentage of chemotherapy patients who receive a treatment plan prior to initiation of chemotherapy
- Number of ER visits per chemotherapy patient per year (validates outcome of effective telephone triage and expanded access)
- Number of hospital admissions per chemotherapy patient per year
- Percentage of patients adhered to NCCN guidelines
- Percentage of patients with stage I or II breast cancer undergoing advanced imaging
- Percentage of patients with stage I or II prostate cancer undergoing advanced imaging
- Percentage of patients with staging documented in chart data field before initiation of chemotherapy treatment
- Percentage of patients with performance status documented in chart before treatment
- Percentage of stage IV patients with advanced care plan discussions documented

According to DeVita, the flexibility of MOSAIQ gave staff abundant flexibility to create customized reports.

“OMH Priorities

- Patient engagement
- Expanded access
- Evidence-based medicine
- Comprehensive team-based care
- Quality improvement
Meet Leksell Gamma Knife® Icon™, the most advanced solution for cranial radiosurgery. Icon enables you to treat any cranial target with confidence – with significantly lower dose to normal tissue than other systems. Frame-based or frameless immobilization, single session or hypofractionation, radiosurgery or ultra-precise microradiosurgery – the choice is yours.

The introduction of Icon brings a number of new innovations. The unique High-Definition Motion Management system enables frameless treatments with industry-leading accuracy. With true stereotactic Cone Beam CT, Online Adaptive DoseControl™ technology and virtual 6D couch, the dose is always delivered exactly where planned.

Born of a profound care for patients with cranial disorders, every detail of Icon has been designed with the patient in mind, and those who treat them.

Leksell Gamma Knife Icon Care for the brain.
We care for life