Elekta Brachytherapy
Workflow, safety and dosimetric advantages of the Flexitron® brachytherapy afterloading platform

CISSS Montérégie-Centre, Hôpital Charles-LeMoyne
Greenfield Park, Québec, Canada

Maryse Mondat
Medical Physicist
CISSS Montérégie-Centre is an integrated health and social services organization that serves the populations of Longueuil (Greenfield Park, Saint-Hubert), Saint-Lambert, Brossard, Chambly, Saint-Jean-sur-Richelieu and surrounding areas in central Montérégie, Québec, Canada.

Located in Greenfield Park, Hôpital Charles-LeMoyne is the largest hospital center in the Montérégie region. The hospital is an important teaching and research facility, affiliated with the University of Sherbrooke.
Today’s brachytherapy needs

Cancer care is continually evolving. There is a growing number of stakeholders involved in patient management and increasing demands for quality across the continuum of patient care. This impacts every treatment discipline including brachytherapy.

HDR brachytherapy has proven to be effective for a range of different anatomical sites such as the cervix, endometrium, breast, skin and prostate.\textsuperscript{1-5} The efficacy of brachytherapy is well known for two main reasons: the source can be placed inside the tumor for highly targeted treatment; and the rapid fall off of the dose outside the tumor spares organs at risk (OAR). Additional advantages of treating patients with an HDR brachytherapy afterloading platform include radioprotection for staff; short treatment times, allowing patients to be treated in an outpatient setting; and optimization of dwell times, which allows more precise configuration of the dose to the target.

Remote afterloading has developed over several decades. To meet the needs of modern brachytherapy departments, HDR brachytherapy platforms must have certain characteristics, including reliability, good maneuverability, precision in treatment delivery, ease of use and a broad selection of applicators. It’s also important to record user actions on the machine for audit trail and security purposes.

Safety is another important consideration. The majority of HDR brachytherapy accidents reported are due to usage errors, requiring hospitals to take vital preventive measures to reduce such incidents (ICRP Publication 97). Inherent safety checks, workflow simplicity and ease of use are all important features for reducing the possibility of human error.

Hôpital Charles-LeMoyne is home to the Centre intégré de cancérologie de la Montérégie (CICM). This center of excellence offers a wide range of cancer treatment options including surgery, chemotherapy and radiation therapy (external beam and brachytherapy). In 2017, it treated around 2,500 patients using radiation therapy and 315 interstitial brachytherapy treatments.

The brachytherapy suite at Hôpital Charles-LeMoyne has three treatment rooms: one room is for High Dose Rate (HDR) brachytherapy treatment; the second room houses the computed tomography (CT) simulator (on rails); and the third room is adjacent to a magnetic resonance imaging (MRI) machine. The department primarily performs brachytherapy implants for the treatment of gynecological, prostate, breast, skin and head & neck tumors.
Figure 1. Flexitron with the transfer tubes attached to a patient mold for plesiotherapy

The Flexitron® brachytherapy afterloading platform

The Flexitron brachytherapy afterloading platform addresses the demands of modern brachytherapy with an optimized workflow that allows for an easy quality assurance (QA) process. This system incorporates simplified safety measures to increase accuracy and reduce the chance of errors, and it is also expandable to accommodate the changing needs of a busy practice.

Hôpital Charles-LeMoyne has been using the Flexitron platform since the opening of the hospital’s brachytherapy suite in 2012. In March 2017, the platform was upgraded to Flexitron version 3.2.1 (Figure 1).

The position of the shielded source container in the Flexitron makes it very stable. This stability is extremely important to the brachytherapy treatment team at Hôpital Charles-LeMoyne since they are moving the machine between three different treatment rooms. They find the platform to be extremely mobile and easily transported, with the handle making transfer very easy.

This particular platform has 40 channels available for treatment. Treatment planning is performed using Oncentra® Brachy version 4.5.1.

Flexitron enables the team to use a wide variety of brachytherapy applicators including the cervix Rotterdam applicator set; the Fletcher CT/MR applicator set; the Vaginal Cylinder applicator set in titanium; the Vaginal CT/MR Multi Channel applicator set; ProGuide needles; and the CT/MR OncoSmart catheter set, used for breast, head & neck and skin treatments (in customized molds).
The Flexitron workflow at Hôpital Charles-LeMoyne

The treatment communication console (TCC) (Figure 2) and the treatment control panel (TCP) (Figure 3) are located in the control room. The TCC receives the treatment plan in DICOM format from the Oncentra planning station. Once the plan has been approved by the radiation oncologist, the plan is locked and has a unique code. Flexitron requires this code to treat the patient.

To prepare a patient plan for treatment, the radiation therapist opens the treatment plan on the TCC, and then proceeds to QA reviews to confirm the correct patient, the correct prescription dose, the correct fraction number, the unique plan code and the source strength. A treatment plan report is generated, detailing this information as well as the treatment time per catheter and the treatment time per dwell position.

Once the radiation therapist has completed these checks, the dwell times are modified (actualized) to take into account the source decay between the time on the treatment plan and the time of the actual treatment. At this point, the TCC generates another report called the pretreatment report, which shows the actualized times per catheter and per dwell position.

Next, the plan is accepted. The Flexitron system can be set so that two authorized people are required to accept the plan. At Hôpital Charles-LeMoyne, this feature is important since two radiation therapists must be present for treatment. After acceptance, the plan is sent to the Flexitron afterloader.

Figure 2.
Treatment communication console (TCC): green upper section—date and time; grey section—patient information, plan information and source information; white section—treatment proceedings; lower yellow section—instructions, treatment state, error detail
Once the Flexitron system has received the plan, the TCP—the console that controls the Flexitron platform—is in control of the treatment. All commands, such as to start an extra check cable run, to initialize the treatment, to interrupt the treatment or to terminate the treatment prematurely, are performed on the touch screen window. The emergency stop button is on the top of the TCP.

Every command on the TCP has to be acknowledged by the therapist who logged on to the TCC. While the treatment is being delivered, Flexitron sends all the information to the TCC. The treatment proceedings can be viewed in detail on the TCC including the remaining dwell time, the remaining total time per catheter and the remaining total time per fraction. The dwell position of the source in the channel in use is shown graphically. Everything is color-coded so it is easy to see the location of the source and whether the catheter or dwell position is completed. The lower section on the TCC display shows instructions for the next step in preparation and the status of the source during treatment (out, in or in transit), as well as any errors. These instructions are also color-coded. Once the treatment is completed, control returns to the TCC.

At this point, the final report (the post-treatment report) is created. This report shows the patient information, the source information, the delivered time to each dwell position, the date and time of every action of the source, the signatures of the staff members who accepted the plan and the staff signatures for every command given during the treatment.

At Hôpital Charles-LeMoyne, the optional extra check cable run (ECCR) is performed before each treatment. This allows a faulty connection between the catheter and the transfer tubes, or a broken catheter to be detected before starting the treatment. Therefore, if re-planning is needed, no partial dose will have been given to the patient. During the ECCR, the treatment room door can be left open, allowing the radiation therapist to see if any unusual friction is detected in a catheter. This is indicated at the bottom of the TCC screen. When the initial ECCR is finished, the TCC display indicates which catheter is faulty and at which position. The radiation therapist can then correct the situation, and Flexitron only rechecks the faulty catheter, which saves time. When the ECCR has been completed, the treatment is started from the TCP.

**Figure 3.** Treatment control panel (TCP) displays the treatment state and communicates with Flexitron through touch screen windows.
The Flexitron quality assurance workflow

The Flexitron QA mode is designed for convenience and ease of use. A QA plan, created directly on the TCC, is not considered a patient plan—so it is possible to deliver and repeat it without having to create a new fraction or a copy of the plan. The dwell times can also be actualized or fixed in QA mode, as instructed.

At Hôpital Charles-LeMoyne, Flexitron QA checks are performed by the radiation therapists every treatment day. This includes radioprotection and Flexitron functionality checks. The source position check ruler (SPCR) is coupled to a pan/tilt zoom network video camera, which is placed over the ruler (Figure 4). The video display is seen on the second screen of the TCC, showing the position of the check cable and of the live source. This allows the position of the source to be checked, without the need for film preparation, and a screen capture provides an electronic record, eliminating the use of film completely.

When a source is exchanged, the position of the check cable and the source cable can be adjusted very precisely using the same setup, with an accuracy of 0.25 mm within a range of 2.0 mm. This can be done by the user without having to call a service engineer on site for making this adjustment. The alignment tool on the TCC allows the actual position on the video to be compared with the TCC template. Adjustment can be made quickly and rechecked easily.

Another useful QA tool is the source position simulator (SPS). When new transfer tubes or new accessories are received, the SPS allows verification of the transfer tube and applicator length, and confirmation of the first dwell position at the tip end.

Figure 4.
Flexitron setup for daily QA, showing the camera over the drawer containing the source position check ruler (left), the source position check ruler (top right) and the TCC screen (bottom right)
Moving from microSelectron® to Flexitron

Some staff members at Hôpital Charles-LeMoyne had worked with the Nucletron® microSelectron system before using Flexitron. The learning curve for treating using Flexitron was very short for these staff members.

The Flexitron user interface is easy to learn and intuitive, and the workflows for microSelectron and Flexitron are similar. The transfer tubes are specific to Flexitron, but the applicators for both systems are the same, so the physicians and the radiation therapists were already accustomed to the applicator manipulation.

As for microSelectron, Oncentra treatment planning software is used for Flexitron. Apart from the different maximum dwell position and step size, 400 mm and 1 mm for Flexitron respectively, everything else is straightforward. Since the activated dwell position can be chosen to be 3 mm or 5 mm, treatment planning for Flexitron is not much different from microSelectron. The biggest adjustment was that the key switch, which serves to switch from standby to treatment, is on the Flexitron afterloader itself and not at the control desk.

In addition, the check cable and source motion mechanisms on Flexitron are different than those on microSelectron. For every treatment, Flexitron checks if planned channels are free and if a transfer tube is connected. Although this increases the overall treatment time compared to microSelectron, it is a valuable extra security check.
Dosimetric advantages of Flexitron

The Flexitron 1 mm step size provides flexibility in choosing active dwell positions when a treatment plan is created on the Oncentra treatment planning station. Depending on the case, the planner can only activate every third or fifth dwell position. In addition, to minimize dose to OAR locally, the dwell position can be moved by 1 mm away from the possible OAR.

The following example cases were treated at Hôpital Charles-LeMoyne

Prostate case (Figure 5)
For prostate brachytherapy, implantation of the needles is performed using ultrasound guidance. Planning uses CT images, but contouring is performed using MRI T2 images following registration with the CT images. OAR include the rectum, bladder and urethra. When the base of the prostate is very close to the bladder, the last position of the source can be changed by 1 mm or 2 mm. The dose still covers the prostate without overdosing the bladder.

Breast case (Figure 6)
Breast cases are also implanted using ultrasound guidance. A CT scan is then performed and planning is performed on the CT images. MRI T2 images are also used to help localize the surgical bed. As seen in Figure 6, if the cavity is close to the skin at the connector or tip end, having the flexibility to change the activated dwell position by 1–2 mm is important. With Flexitron, the dwell position can be easily adjusted to protect the skin and potentially limit toxicity.

Figure 5. A prostate case, showing the flexibility of the Flexitron step size: green—DIL; red—PTV; yellow—bladder; brown—rectum

Figure 6. A breast case, showing the cavity (green) and the PTV (red)
Cervix case (Figure 7)
Cervix cases are also implanted using ultrasound guidance. Then, MRI T2 and MRI T1 scans are obtained and planning is performed using the MRI images. Figure 7 shows the model applicator (Rotterdam in titanium). The Rotterdam applicator is chosen because it is MRI (1.5 T) compatible and the diameter of the intrauterine tube is small. Also the colpostats are fixed relative to the cervix stopper position.

Figure 7. A cervix case: red—HRCTV; yellow—bladder; brown—rectum

Scalp case (plesiotherapy) (Figure 8)
Plesiotherapy is performed with catheters that are glued to a customized mold. Treatment planning is performed using CT images. The CT images allow dosimetry to take into account any existing space left between some portion of the scalp and the mold.

Figure 8. A scalp (plesiotherapy) case, showing the PTV (green)
Conclusion

In 2017, almost 290 brachytherapy cases were treated at Hôpital Charles-LeMoyne. The Flexitron system has been very reliable throughout that time. The flexible dwell position with Flexitron provides very accurate brachytherapy plans with excellent OAR sparing. Finally, the QA mode is a much-appreciated safety enhancement. These inherent QA checks, combined with the system’s simple and intuitive workflow, ensure that opportunities for user error are minimized.

References


We are healthcare technology innovators, specializing in radiotherapy treatments for cancer and brain disorders.

We help clinicians to improve patients’ lives through our forward-thinking treatment solutions and oncology informatics, creating focus where it matters to achieve better outcomes.