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Development of a Curriculum for the Implementation of Stereotactic Radiation Therapy Programs in Middle-Income Countries

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abstract

PURPOSE The aim of this work was to develop a curriculum to be used in the implementation of stereotactic radiation therapy programs in middle-income countries. The curriculum needed to be scalable and flexible to be easily adapted to local situations.

METHODS The curriculum was developed through a partnership between multidisciplinary teams from established clinics in both middle-income and high-income countries. The curriculum development followed a nonlinear progression, allowing greater flexibility throughout the process. A blended learning model was used, combining virtual and in-person interactions.

RESULTS The initial training plan was based on a needs assessment provided by the learners and on the experience of the facilitators with stereotactic radiotherapy. The needs assessment was refined during in-person site visits at each institution which highlighted aspects of the training, such as image guidance workflows and technical specifications, that were not previously emphasized in the curriculum. Both teams found that the in-person visits were important for training purposes, but aspects of the curriculum delivery such as treatment planning and patient selection were well suited to virtual platforms. The training addressed all aspects of the stereotactic program, from patient selection to treatment, and included a review of both technical and clinical workflows.

CONCLUSION The inclusion of contributions from both teams ensured that the curriculum covered the required elements of the stereotactic program implementation, met the needs of the learners, and was relevant to local practices. The nonlinear approach to the curriculum development allowed the flexibility to change the focus as the project progressed. The in-person visits were valuable in conducting a thorough needs assessment.

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INTRODUCTION

Cancer incidence in low- and middle-income countries (LMICs) poses a major health crisis globally.[1-3] Numerous international initiatives have aimed to address aspects of this crisis, including prevention, treatment, and access to care.[4,5] The challenges posed by access to and utilization of radiotherapy have been well documented.[4,6-8] Many of these challenges stem from the relative paucity of available equipment and human resources, leading to access problems for segments of the population.[9,10] In settings where the physical resources exist, a lack of adequate training and sustained support for the staff can lead to limitations in the utilization of the radiotherapy resources.[4,8,11] Numerous organizations have endeavored to establish training guidelines for various medical professionals within the radiation therapy specialty.[12,13]

Efforts to improve access to radiotherapy resources often focus on equipment and technology.[8] However, sustained human resource commitment, including access to initial and continued training, plays an important role in improving the utilization of the equipment. Continuing health professional education is essential for maintaining skills and contributes to the adoption of newer and more complex treatment techniques. The importance of continuing professional development applies to all medical professionals involved in a radiotherapy program such that to truly advance new technologies, the commitment to continuing education initiatives needs to be multidisciplinary. Within the LMIC setting, access to continuing education poses logistical challenges.[8] These include staffing limitations which could impede dedicating time for professional development initiatives, a scarcity of mentors and partner institutions to provide

CONTEXT

Key Objective

Can a generalized approach to training be established to assist with the implementation of stereotactic radiation therapy programs in middle-income countries?

Knowledge Generated

Training curriculum was developed using input from both the learners and facilitators and used a nonlinear approach, ensuring that the content could be adapted to suit the specific needs of the local institution. Training content addressed all aspects of stereotactic radiation therapy, and the training delivery highlighted the value of performing a detailed needs assessment early in the process.

Relevance

A comprehensive training program, using flexible delivery methods, can be used to establish stereotactic treatment programs at other institutions, taking into account local requirements and practices.

collaboration and minimal funding opportunities for training, particularly if the training cannot be provided locally and in their language of origin. Access to continuing education is also hindered in some situations by a lack of institutional and professional support for these activities.[14]

Despite logistical challenges, there have been instances of partnerships aimed at enhancing the clinical training of staff within the radiation oncology setting.[5,15] In many cases, these partnerships were established with very specific goals in mind for the institutions directly involved.[16,17] Having goals that are directly applicable to the local context improves the efficacy of the education initiative.[18] This article describes one such training initiative on the basis of a collaboration between a large academic center with an established radiation therapy program and a clinic in a middle-income country (MIC), wishing to establish a stereotactic radiation therapy program.

The aim of this project was to develop a framework that could be used as a model for introducing stereotactic radiation therapy programs to institutions within MICs. The experience of the two collaborating institutions served as a pilot to identify the strengths and weaknesses of the process and informed changes to the program for future implementations. This pilot allowed for the establishment of a structured curriculum with the ability to be adapted to local needs. This built-in adaptability should permit the efficient dissemination of the training to other institutions within the region and contribute to the establishment of a regional network of expertise using advanced treatment techniques.

METHODS

The partnership was established between a large academic center in a high-income country, Canada, and an established cancer center in a middle-income country, Algeria.[9] The Algerian clinic was equipped with three linear accelerators, each equipped with on-board cone beam computed tomography (CT) systems and 6 degrees of freedom treatment couches. Patient treatments were performed using both three-dimensional (3D) conformal techniques and volumetric modulated arc therapy (VMAT) and were planned used an inverse planning treatment planning system. The linear accelerator and treatment planning systems were the same as those used at the partner institution.

The project teams from the two institutions included radiation oncologists, medical physicists, medical dosimetrists, and radiation therapists. The development of the educational program used a cocreation approach, meaning that both the learners and the facilitators contributed to the design of the curriculum.[19] The use of cocreation has been seen to enhance the learning environment and increases the engagement of the learners.[19]

The theoretical basis for the curriculum development was based on Kern's six-Step Framework for Curriculum Development[20] which emphasizes that curriculum development does not occur in sequential fashion. The six steps within the framework include problem identification and general needs assessment, targeted needs assessment, goals and objectives, educational strategies, implementation, and evaluation and feedback.[20] Kern's framework embraces the ideas that curriculum development can begin at any step in the framework, that progress may be made on multiple stages or steps at the same time, and that the progress made at any stage will influence the other steps.[20]

The implementation of the stereotactic program and associated curriculum development used a blended learning model, involving multiple types of educational delivery. The curriculum involved both distance and in-person learning. The distance learning component used case-based studies and group discussions via virtual meeting platforms. The in-person learning included didactic teaching, hands-on experiences, case-based studies, and observerships.

There were two in-person visits, one by the learners to the partner institution and a return visit by the facilitators to the learners' clinic. The visit to the learners' clinic was originally intended to coincide with the launch of the stereotactic

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program; however, delays in the acquisition of some required quality control (QC) equipment meant that the go-live date was delayed, so the focus of this visit shifted to address clinical workflows and techniques used for image guidance. A third in-person visit to support the clinical launch of the stereotactic program was planned but was postponed several times because of COVID-19 pandemic restrictions.

The initial steps of the partnership were to conduct a needs assessment for the learners at the MIC cancer center and to define clear goals for each aspect of the curriculum. This was completed through a series of communications between the two institutions, and the information was provided by the learners in response to questions posed by the facilitators. Both teams had input in defining the goals, on the basis of their individual clinical goals and experiences and informed by published guidelines for the establishment of a stereotactic program.[21]

Feedback on the curriculum content and program implementation was collected from discussions with the participants from both institutions. These discussions took place both in-person and via electronic communications and took place at various times throughout the project. The curriculum content focused on all areas of the stereotactic program, including patient selection, treatment planning, treatment delivery and image guidance, machine quality assurance, and the development of clinical workflows. The effectiveness of the training was evaluated during one-on-one reviews and multidisciplinary group discussions to review aspects of the program. These included assessments of target volumes and evaluation of treatment plans for a selection of patients presented during case reviews. Feedback on the treatment plans, including areas for improvement, was provided to further contribute to the learning. Additionally, staff feedback pertaining to their own confidence in their readiness to move forward was solicited.

RESULTS

Needs Assessment

The initial identification of the goals and general needs assessment was based on information provided by the learners regarding their clinical goals for the stereotactic program, as well as on recommendations from the facilitators on the basis of their own experiences in treatments using stereotactic techniques. This cocreation approach drew on the expertise of the facilitators to promote a safe and efficient program implementation while ensuring that the training met the clinical expectations of the learners. The initial assessment asked about availability of equipment and access to training and vendor support and anticipated patient demographics and the experience of the staff. There were also a series of questions related to the existing QC tests. At this stage, the clinical processes related to image guidance and treatment delivery were not discussed. Table 1 summarizes the areas of focus for the needs assessment.

TABLE 1. Areas of Focus for the Needs Assessment

Category	Areas of Focus
Equipment availability	Treatment planning system Treatment equipment, including on board imaging and supporting components (eg, 6 degrees of freedom couch and patient immobilization systems) QA equipment
Staffing	Roles with respect to machine QA, patient-specific QA, treatment plan generation, plan verification, patient selection, contouring, and image guidance Experience and training, including vendor training and current treatment techniques
Patient selection	Typical patient demographics and staging Anticipated anatomical sites for the program
Clinical processes and procedures	Plans of care, contouring guidelines, and image guidance process Machine QA procedures, including tolerances Patient-specific QA procedures and tolerances

NOTE. This was used to establish which aspects of the curriculum required greater emphasis and which ones were already well established at the middle-income country clinic, requiring less of a focus.

Abbreviation: QA, quality assurance.

Differences between the patient populations at the two institutions meant that the goals of one institution did not necessarily apply to the other clinic. The aim of the stereotactic program in the MIC needed to consider the fact that the patient population tended to present with later stage disease, and, therefore, the stereotactic program patient load would not necessarily focus on the same anatomical sites as it would in a North American setting. The primary focus was on metastatic disease and did not emphasize stereotactic treatments for primary lung tumors since these were rarely treated at an early enough stage for stereotactic radiation therapy. Furthermore, differences in clinical staffing models between the two clinics meant that direct application of clinical procedures or published recommendations[21] was not appropriate in all contexts. For example, in the MIC clinic, the medical physicists were responsible for the treatment planning rather than dosimetrists. Differences such as these demonstrated the importance of using a cocreation approach to the curriculum development.

At the time of the first in-person visit, when the learners visited the facilitators' institution, the in-person discussions and observations of practices at the facilitators' clinic identified where the training efforts should be focused.

On-site activities included hands-on treatment planning exercises to assess the readiness of the learners and observations of the machine QC processes in place that were specific to the use of stereotactic techniques. Feedback from these sessions led to the inclusion of additional virtual mentoring sessions related to treatment planning before the program go-live date and after the visit. The teams from both institutions found the in-person visit valuable in advancing the training and expertise as well as in refining the training content to focus on the areas of greatest benefit to the learners.

The use of Kern's six-step framework afforded the opportunity to revisit steps at any point during the curriculum development.[20] A refinement of training requirements took place during the second in-person visit by the facilitators to the learners' institution. This visit revealed that the initial needs assessment had not identified some training gaps related to the use of image guidance for treatments. The initial needs assessment did not ask directly about existing image guidance usage. Feedback from the learners detailed what systems they had at their disposal and what vendor training they had received for the equipment, but in practice, the radiation therapists had limited experience using cone beam CT since this was not routinely used in their practice. The use of daily cone beam imaging is a crucial component to stereotactic radiotherapy treatments, and, therefore, changes were implemented at the time of the in-person visit to the MIC clinic to incorporate this more routinely into their patient treatments. Daily cone beam imaging was added to several existing clinical workflows to ensure that the staff gained the necessary experience with image guidance before the go-live of the stereotactic program.

Feedback from the both teams found the in-person visit to the LMIC clinic extremely useful in more accurately assessing program readiness and the consensus was that for future program implementations, a more targeted needs assessment would be helpful if it occurred earlier in the process. This might include directed questions specific to each aspect of the program implementation and could be conducted in part via surveys and interviews with staff, whether in-person or virtual. In the context of image guidance, in addition to questions specific to equipment availability and training, asking directly about the usage of the equipment would have been helpful in establishing what the additional training needs were. In general, a review of local workflows and processes should be done earlier in the process.

Curriculum

Table 2 lists the major components of the curriculum: clinical indications for stereotactic treatments, patient preparation, treatment planning, treatment delivery, and machine quality assurance. The MIC clinic was an established clinic with significant experience in planning and delivery of VMAT treatments, so the focus for each aspect of the curriculum was on issues specific to stereotactic radiation therapy.

The clinical indications included discussions of patient selection and prescription decisions. Aspects of target delineation, organ at-risk contouring, and treatment planning goals and techniques were covered in the patient preparation and treatment planning sessions. There were some introductory didactic sessions, and the facilitators shared existing clinical care plans for a variety of anatomical sites which outlined local practices for targeting, imaging, dose tolerances, and planning techniques. Given the already strong experience with inverse planning and modulated treatments, the focus of the treatment planning sessions was on developing hands-on planning experience for stereotactic plans, with feedback provided during case review sessions. These sessions were conducted primarily virtually and consisted of one-on-one sessions between the dosimetrist and those involved in planning at the MIC clinic, as well as multidisciplinary case review sessions.

The treatment delivery content focused primarily on the image guidance techniques since the center was already routinely using VMAT treatments. Technical aspects of the image guidance, such as cone beam CT settings were reviewed, as were the clinical workflows. The clinical team

TABLE 2. Major Components of the Curriculum, as Determined Using a Cocreation Approach and Refined at Multiple Stages of the Development

Topic	Didactic Session(s)	In-Person Observership	Hands-on Session	Case Review	Discussions
Clinical indications and patient selection	x			x	x
Patient preparation and target delineation	x	x	x	x	
Clinical processes, procedures, and workflows	x	x			x
Treatment planning	x	x	x	x	
Treatment delivery, including image guidance techniques	x	x			x
Machine quality assurance	x	x		x	x
Implementation plan	x	x			x

NOTE. The method of curriculum delivery used is also indicated, showing the blended learning approach taken to the curriculum development. All components of the curriculum were at times delivered during in-person and during virtual sessions.

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had received vendor training on the cone beam system, but it was not currently in routine use. Daily cone beam CT was added to existing workflows so that the staff could gain the necessary experience with the process before the program launch. Scan settings were adjusted from the manufacturer defaults to use faster acquisition times, improving image registration workflows and increasing efficiency.

The machine quality assurance training included a review of the available equipment and of the machine quality assurance tests already in place. The existing quality assurance (QA) program was very comprehensive, and most tests specific to stereotactic treatments were already in place at the start of the partnership. Tolerances for tests such as machine and table isocentric rotations were adjusted to be suitable for stereotactic treatments in accordance with published guidelines[21] as well as on the basis of the experience of the facilitators in terms of what was achievable on the treatment units. The only additional piece of equipment needed for transitioning to stereotactic treatments was a 3D QA phantom intended for patient-specific quality assurance. Acquisition of this phantom proved to be one of the delaying factors in the program launch since there were multiple delays in the receipt of this equipment. Once received, the clinical team at the MIC clinic was able to very quickly put it into service and was able to establish patient-specific quality assurance workflows. Processes and pass/fail criteria for this QA formed part of the discussions between the medical physics groups.

Most aspects of the curriculum were delivered both in-person and virtually, depending on the stage of the program development. For many of the components of the curriculum, including the didactic sessions, the case reviews and the hands-on sessions for the treatment planning are easily adapted for either in-person or virtual learning. This makes the curriculum adaptable to future implementation projects.

Challenges

The progress of the curriculum development and delivery was challenged by difficulties encountered by the MIC clinic in acquiring the necessary QA equipment to support the stereotactic program. Delays in the receipt of the 3D tool for patient-specific QA meant that timelines for both the program launch and the in-person visit by the facilitators were changed multiple times, and the timelines were pushed back by almost 6 months. Although the requirement for this equipment had been identified before the launch of the partnership, it was expected that this equipment would be in place well before the anticipated go-live date. Although there were initially some connectivity difficulties with the virtual communication platforms, these were largely resolved, and significant progress on the project was achieved via virtual meetings. Ultimately, the program implementation was delayed by the onset of the global COVID-19 pandemic. The initial go-live date was put on hold for nearly 2 years because of global pandemic restrictions. During this time, virtual planning sessions and case reviews continued, and plans were put in place to support a virtual go-live. This would be achieved using the same virtual platforms, allowing teams from both sites to review the image guidance during the first patient treatments. Although both teams were confident that the program was ready to launch, the decision was made to wait until the team of facilitators is able to travel to be present for the program launch.

DISCUSSION

A curriculum for the implementation of a stereotactic radiation therapy program in a middle-income country radiation medicine program was developed. All aspects of the stereotactic radiotherapy program within the MIC clinic are ready to support the launch of the program. Staff involved in the program received training and support in all aspects of the program, including patient selection, treatment planning, treatment delivery, image guidance, and machine quality assurance. This training included building hands-on experience, leading to greater familiarity with the procedures and confidence that the tasks could be carried out safely.

The use of a cocreation approach to the curriculum development ensured that it met the needs identified by both the learners and facilitators. It also allowed differences in clinical needs and patient populations and access to resources to be reflected in the curriculum and gave all members of the partnership an opportunity to contribute actively to the program. This approach is essential in future partnerships so that the curriculum can be adjusted to suit the specific goals and needs of an institution. Feedback from both the learners and the facilitators was essential in developing the curriculum and emphasized the importance of the variety of training techniques used, including didactic training sessions, in-person observations, hands-on exercises, virtual case reviews, and discussions.

The flexibility of the curriculum design on the basis of Kern's framework allowed the curriculum development to adapt as different requirements for training were identified. Similarly, the blended learning approach gave flexibility to adapt the program delivery in the face of unforeseen delays and changes to the schedule. Each of these approaches was essential to providing a curriculum that is flexible enough to meet the needs and schedules of different institutions.

The curriculum has been developed with the intention that it can be used in subsequent partnerships between other institutions. In each case, the didactic training modules that have been developed would require adjustments on the basis of institutional needs. The in-person observations and hands-on exercises can be adjusted to suit the specific needs of the learners, although the basic format would remain the same. This process has begun in a second partnership between the facilitators' team and a second clinic in the same MIC.

In-person visits in this case proved invaluable for accurately assessing the needs and gaps in the training. The teams from both institutions agreed that this is a valuable component to the program implementation. However, in the face of delays, unforeseen restrictions or perhaps limitations in funding or personnel availability, adaptation to a virtual format can be achieved through targeted discussions and surveys to determine the program readiness.

Both teams identified the multidisciplinary nature of the teams as a strength of the initiative. This ensured that all aspects of the program were included in the training, from the patient selection through the treatment plan and infrastructure preparation to the treatment delivery.

Some of the challenges encountered over the course of the project included delays in the acquisition of required quality assurance equipment, difficulties with some of the virtual communication platforms, and unforeseen delays because of the global pandemic. Future projects should consider the likelihood of delays in equipment acquisition that could affect the project progression. One of the major challenges faced during the project was that a complete understanding of the training requirements was not appreciated until the facilitators visited the MIC and were able to observe clinical workflows and talk directly with the entire team. Future initiatives would include a more directed needs assessment early in the process with checkpoints in place to assess progress. This would take the form of surveys and interviews addressing specific aspects of the program, particularly in terms of current practice and experience in addition to a review of available equipment and training history. If an in-person visit is not feasible, this could be conducted virtually as a series of targeted questions to assess specific areas of the curriculum. Although this could still be altered as the program progresses, it would permit the training to begin with a more comprehensive view of the needs.

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