Collaboration in Victorian radiation therapy

Abstract In 2009, Ballarat Austin Radiation Oncology Centre (BAROC) required a significant upgrade in equipment and software that was planned to span a nine-day period. Many studies have investigated planned and unplanned interruptions to radiotherapy treatment; however, there remains no radiobiological consensus on the impact of interruptions on treatment outcomes across all areas of the body. Therefore, minimising treatment interruptions is important, highlighting that a patient-focused approach in these situations is required.

BAROC approached the Andrew Love Cancer Centre (ALCC) to assist in treating patients during the upgrade. For BAROC patients to be treated during this period there were concerns to be addressed between the two centres, namely; (1) compatibility and beam quality matching of the linear accelerators, (2) agreement between the two centres in terms of the patient record system, billing and medico-legal matters; and (3) staffing. The commitment of the ALCC and BAROC staff to provide the best possible and equitable treatment to their patients was a strong factor that made this collaborative effort possible and a success. This paper aims to describe the unique achievement of the successful collaboration between BAROC and ALCC.

Keywords: collaboration, radiation therapy, Victoria.

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Introduction

Radiation therapy has a high technological dependence and as a result frequent equipment and software upgrades are required. Planned and unplanned interruptions in a radiotherapy department are not uncommon with machine services, equipment upgrades and breakdowns; however, a department that is rendered non-functional is less common. From a review of the literature, it appears that there are no clear guidelines for radiation therapy departments to manage these situations in Victoria, Australia or internationally. So what is the correct action plan if a radiotherapy department becomes non-functional? Do other departments help and if so, what process is followed to ensure all patients receive their prescribed radiation therapy treatment in an equitable fashion? In these situations, it is important to maintain a patient focus above all.

Figure 1: Presents the eight Integrated Cancer Services in Victoria, along with the location of the Andrew Love Cancer Centre (green), Ballarat Austin Radiation Oncology Centre (red) and the Austin Health (purple). Permission was granted by the Department of Health, Victoria to modify these figures for publication.[1]

Table 1: Summary of radiation therapy departments in Victoria.

Integrated cancer service (ICS)		Radiation therapy department
Metropolitan ICS	North Eastern	The Austin Health – Heidelberg Repatriation Hospital
		PMCC – Box Hill
		ROV – Footscray
		ROV – Ringwood
		ROV – Epping
	Southern Melbourne	The Alfred Health – WBCC
		PMCC – Moorabbin
		ROV – Frankston
	Western and Central Melbourne	PMCC – East Melbourne
		PMCC – Epworth
		ROV – East Melbourne
		ROV – Footscray
Regional ICS	Barwon South West	The Geelong Hospital – ALCC
	Grampians	BAROC – SMU
	Loddon Mallee	PMCC – Bendigo – SMU
	Hume	ROV – Wodonga
	Gippsland	The Alfred Health – Traralgon

ICS = Integrated Cancer Service; PMCC = The Peter MacCallum Cancer Centre; ROV = Radiation Oncology Victoria; WBCC = William Buckland Radiotherapy Centre; ALCC = Andrew Love Cancer Centre; BAROC = Ballarat Austin Radiation Oncology Centre; SMU = Single Machine Unit
(based on Department of Human Services 2007[2])

In 2009, the management team at the Ballarat Austin Radiation Oncology Centre (BAROC) approached the Andrew Love Cancer Centre (ALCC) to assist in treating patients to facilitate an upgrade in equipment and Information Technology (IT) infrastructure. The BAROC upgrade was to improve access to services and was assisted by the Victorian Department of Health with a grant of $700,000. The ALCC and BAROC management teams were faced with many questions when considering this collaboration. This paper highlights some of the key structural features of radiation therapy in Victoria, Australia; the physics implications of transferring patients between departments and the logistics of the transfer. This paper provides an insight into this unique, but successful endeavour between BAROC and the ALCC.

Radiation therapy in Victoria, Australia

Currently, radiation therapy across Victoria is based on eight Integrated Cancer Services (ICS), shown in Figure 1.[1] In 2009, there were nine public and seven private departments across Victoria, (Table 1).[2] Integrated service delivery was one of the key themes for developing the Victorian radiotherapy framework to ensure the best treatment for all patients and providing support throughout their cancer journey.[2] There are three metropolitan ICS (North Eastern; Southern Melbourne; Western and Central) and five regional ICS (Barwon South West; Grampians; Loddon Mallee; Hume; Gippsland). Regional cancer patients have historically been disadvantaged due to access restrictions to Melbourne;[3] this was partly addressed by the development of a centre at Geelong Hospital (ALCC), which commenced clinical operations in 1992. Furthermore, in 1996, it was recommended by the Australian Health Technology Advisory Committee (AHTAC)[3] that:

- Radiation oncology be organised through networks, which resulted in the eight ICS.
- Decentralise services to enable better access for patients, which resulted in the national radiotherapy Single Machine Unit (SMU) Trial.[4]

Across the eight ICS are four large public hubs (The Alfred Hospital – Prahran; Austin Health – Heidelberg Repatriation Hospital; Barwon Health – The Geelong Hospital (ALCC) and The Peter MacCallum Cancer Centre – East Melbourne). Of the four hubs, there were three spokes at Ballarat, Bendigo and Traralgon established as part of the SMU trial completed in 2007, supported by Austin Health, Peter MacCallum and The Alfred, respectively.[4]

Health service planning historically focused on centrally located radiotherapy services to optimise the utilisation of equipment and to employ appropriate numbers of health professionals to work.[5] Therefore, the majority of radiotherapy services are located in metropolitan centres in Australia, rather than regional locations. In Victoria, this approach served the population well in terms of the quality of care provided; however, there are disadvantages for rural patients in accessing radiotherapy services.[3]

Radiotherapy treatment is delivered over a course of weeks and can extend to an eight-week period, where patients are required to have treatment once a day from Monday to Friday. Therefore, in regions where there are no radiotherapy services, patients may be required to be away from home for long periods and possibly without an income. A lack of income can have a devastating impact on patients and their families. It has been documented in the media, where families have lost businesses and patients have faced financial crises to receive radiation therapy.[6] It has been indicated that a patient's treatment choice can be affected by the

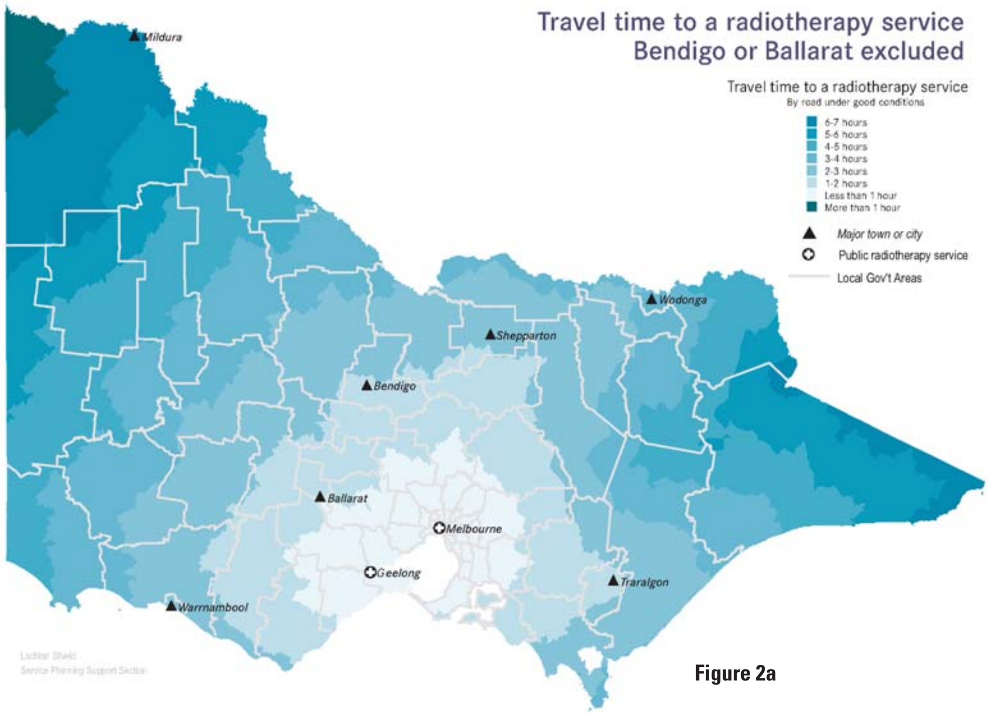

Figure 2a

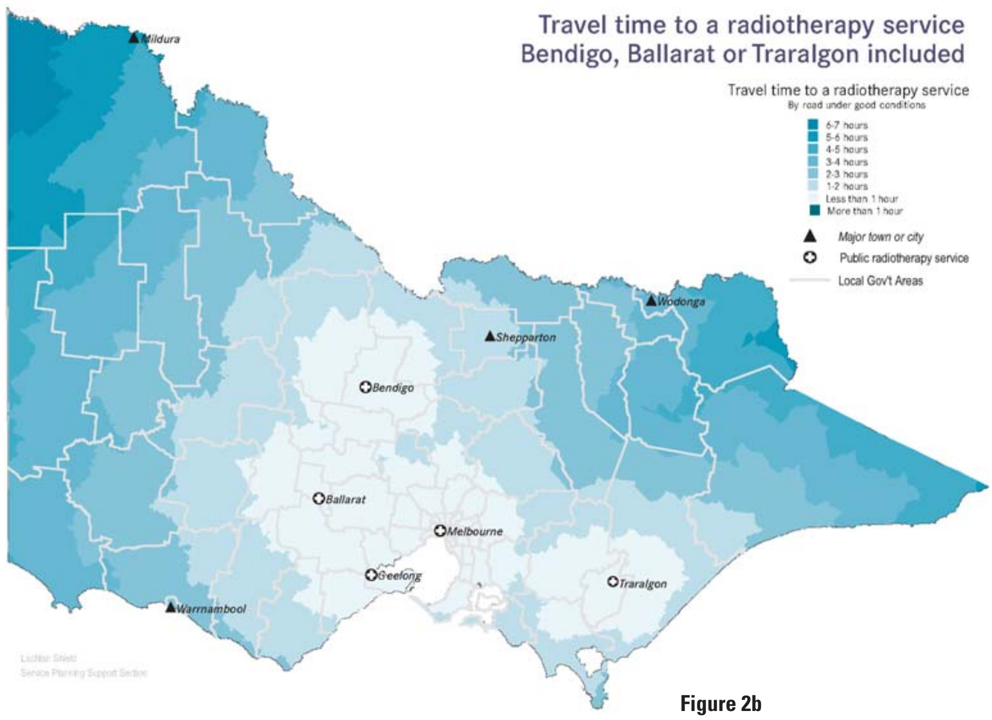

Figure 2b

Figure 2: Access to radiation therapy services in Victoria with and without single machine units (SMUs)

Figure 2a illustrates the travel time to a radiation therapy service in Victoria without the Bendigo or Ballarat departments. **Figure 2b** illustrates the travel time to a radiation therapy service including the Bendigo, Ballarat and Traralgon departments. Permission was granted by the Department of Health, Victoria to reproduce these figures.[4]

Table 2: Comparison of BAROC and ALCC equipment.

Equipment	Andrew Love Cancer Care Centre (ALCC)	Ballarat Austin Radiation Oncology Centre (BAROC)
Linear accelerator	Varian® 2100iX	Varian® 2100C
Treatment planning system	Varian Eclipse®	Elekta CMS Xio®
Imager	EPI aS1000	EPI aS500
Multi-leaf collimators (MLC)	Millenium 120	Millenium 120
Couch-top	Med-Tec carbon fibre	Med-Tec carbon fibre
Co-ordinates nomenclature	IEC 1217	IEC 1217
Record and verify	Aria® version 8.1	Varis® version 7.4

accessibility of treatment services; therefore, impacting on radiotherapy patient's from regional areas more than metropolitan patients.[3] There are some examples where regional patients with cancer may choose more aggressive surgery, thereby negating the need to be away from home and their family for long periods of time.[7] Key factors for regional patients when considering treatment in a centrally located department are issues such as the patient's age; personal support systems; and the financial issues of transport and accommodation.[3] While the government provides some funding assistance for patients who need to travel long distances for their treatment, this is limited to patients living more than 100 kilometres from the radiotherapy department for Victorians,[8] this may vary across other states.[9] While the introduction of SMUs in Ballarat, Bendigo and Traralgon have improved access to radiotherapy for rural patients, there remains a large number of patients that still need to travel long distances to receive the radiation therapy they require, (Figure 2).[4]

Hub and spoke model

A review by the Victorian Department of Human Services recommended that SMU be established using a hub and spoke model with a large metropolitan hub service responsible for managing and operating the regional spoke.[10] The hub and spoke model was recommended as it provided a balance between the advantages and disadvantages of the centralised and de-centralised models.[4] The major benefit of the hub and spoke model was the improved accessibility of treatment for patients in regional Victoria. Additionally, the model required strong professional linkages from the SMU back to the hub to provide quality assurance, referral capabilities, the handling of complex cases, research, development and training; and the reputation to underpin the commercial viability and capacity to attract and deliver quality services to the SMU community.[4] This linkage was to ensure adherence to appropriate clinical standards and to ensure high levels of safety and quality. It was stated in the Evaluation of the National Radiotherapy Single Machine Unit Trial that; *"a range of quality safeguards was built around the hub-and-spoke model to ensure spoke service compliance with the service standards of their hubs"*.[4] A report completed for the Victorian Department of Human Services[10] identified the need for the provision of support in the event of a machine breakdown or planned interruption of service at the SMU.

Ballarat Radiation Oncology Centre (BAROC) and the Austin Health

BAROC located in the mid west of Victoria (Grampians ICS) was established in 2002 and is the regional spoke of Austin Health – Heidelberg Repatriation Hospital (hub) located in the North Eastern Metropolitan ICS. The two sites are separated by a distance of approximately 120 kilometres. Radiation Oncology Victoria (ROV) provided physics staff to commission and service the BAROC equipment, for this reason the equipment at ROV and BAROC were considered to be compatible. The result of commissioning the linear accelerator was based on the work of William Patterson, the chief physicist at ROV. Patterson had previously worked at the ALCC and during that period collected a wealth of commissioning data that showed significant advantages for the matching of linear accelerator parameters. Hence, the ALCC equipment was theoretically compatible with ROV and BAROC.

Earlier an action plan to address machine breakdown issues at BAROC was endorsed by radiation oncologists, physicists and therapists at ROV, BAROC and the Austin Health. This plan designated the ROV – Footscray department to provide treatment back-up for BAROC during treatment interruptions of more than two consecutive days. This breakdown action plan provided details on the number of patients that could be transferred to ROV – Footscray (15–20 patients per day) with the remainder being transferred to the Austin Health. Patient transport issues, along with appointment bookings, staffing, patient privacy, billing and medico-legal issues were outlined in the document. This breakdown action plan was not required in the seven years that BAROC had been operating. The breakdown plan was only intended for unplanned interruptions and was not for the purpose of planned interruptions, such as equipment upgrades.

To improve department efficiency in 2009, BAROC upgraded components of the linear accelerator to include remote couch top ability, Electronic Portal Imaging (EPI) to a Si1000 and a software upgrade from Varis® 7.4 to ARIA® 8.6 (Varian Medical Systems, Palo Alto, CA, USA). Due to the proposal of multiple upgrades simultaneously, the single linear accelerator at Ballarat was unavailable for clinical use for a total of nine days, where five of those days were treatment days. At this time, the full clinical workload at BAROC needed to be transferred. ROV – Footscray (part of the BAROC action plan) did not have the capacity to absorb the entire patient workload of BAROC due to their high patient numbers, with ROV only being able to provide access for BAROC in the early evening. With the travel time between BAROC and ROV combined with the limited evening access, ROV was considered a non-viable option.

With the hub and spoke model, it was proposed that the hub would provide support for the spoke during this upgrade period. In this case,

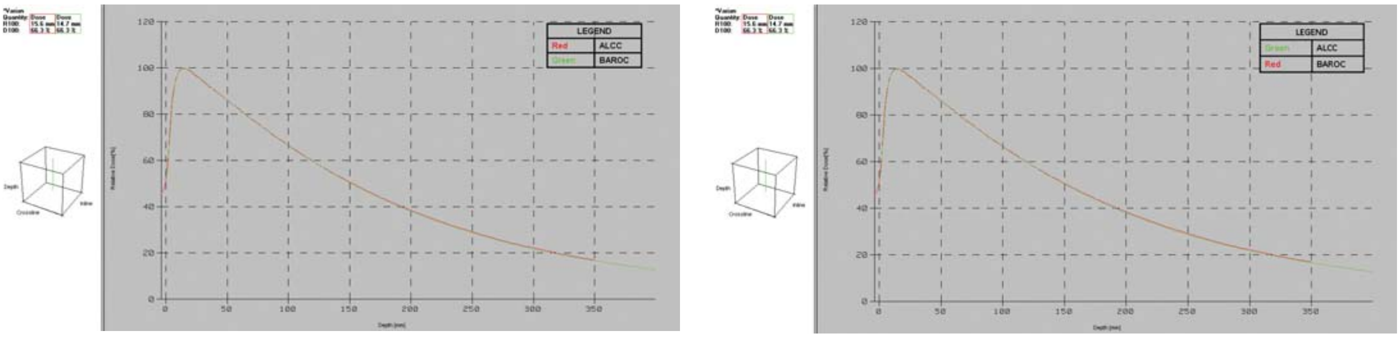

Figure 3a

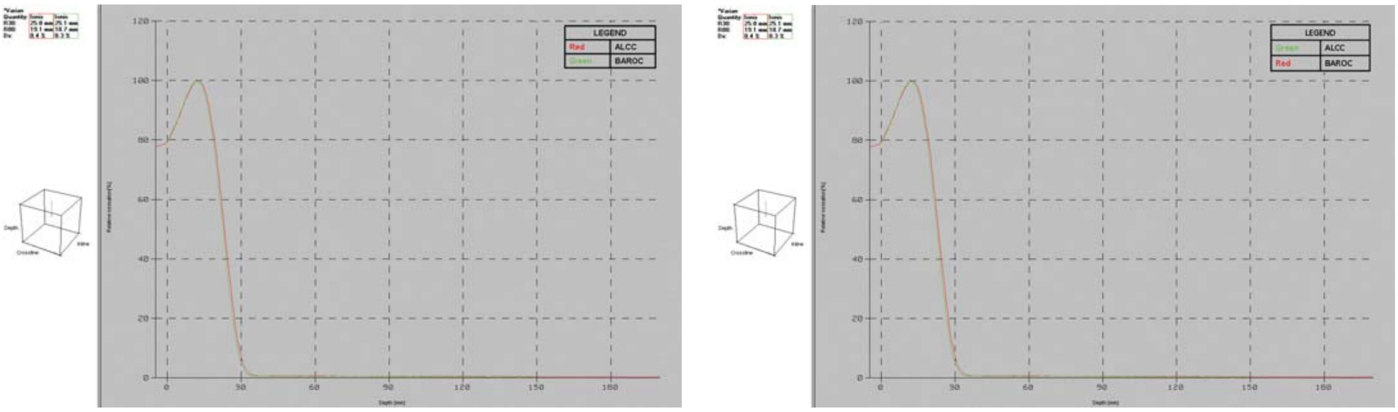

Figure 3b

Figure 3: Comparison of BAROC and ALCC percentage depth dose (PDD) curves for 6 MV and 6 MeV. **Figure 3a** presents a comparison of the BAROC and ALCC 6 MV PDD curves for 10 cm x 10 cm fields. **Figure 3b** presents a comparison of the BAROC and ALCC 6 MeV PDD with 15 cm x 15 cm applicator.

BAROC being the spoke and Austin Health – Heidelberg Repatriation Hospital, the hub, the latter would provide the treatment backup. However, the two centres had incompatible equipment for transferring patients meaning that all patients would need to be replanned for a transfer, and the distance to travel was considered a significant imposition for patients. Austin Health was not able to provide access to the entire patient workload and therefore, was considered non-viable. For these reasons, BAROC was left with the following contingency options:

1 All patients could miss treatment for five days during the upgrade period;
2 Patients could be distributed across multiple Victorian radiotherapy services.
3 Transfer all patients on treatment to a single radiotherapy service, such as the ALCC.

The first option was rejected as this scheme would yield a clinically unacceptable treatment outcome, as shown by many studies[11–34] investigating scheduled and unscheduled interruptions to radiotherapy treatment and how these interruptions are managed.

Option 2 presented issues, such as organisational coordination and geographical challenges. The logistics of a multiple site patient transfer, assessing machine capability, staff and equipment was determined to be challenging and potentially risky for clinical care. This option was also prevented due to the limited information on equipment and calibration factors of radiotherapy services across Victoria.

The third option, which was transferring all patients to the ALCC for treatment was the favourable option as there was some capacity to accommodate the entire patient load, its close proximity to Ballarat and theoretical equipment matching. However, two major technical challenges were recognised in determining if this was a feasible option: whether BAROC's treatment data could be uploaded and delivered on ALCC equipment; and whether the dosimetry of the treatment plans could be delivered within the ICRU dosimetry tolerance of + 7% and - 5% when transferred.[35] There were also transportation issues that needed to be considered, along with the ability of the ALCC to accommodate the BAROC patients into their busy schedule. From a governance perspective, ALCC is a separate entity to BAROC and issues relating to patient records, auxiliary support (nursing and clerical), medico-legal and billing (Medicare, Weighted Allocated Units and Health Program Grants) needed to be clarified.

Andrew Love Cancer Centre (ALCC)

The ALCC is geographically the closest radiotherapy centre to BAROC, with a separation distance of approximately 86 kilometres. Both departments offered similar radiotherapy services in 2009, including conformal external beam radiation therapy and step-and-shoot Intensity Modulated Radiation Therapy (IMRT) using comparable record and verification systems and linear accelerator systems, refer to Table 2 for equipment comparisons between the departments prior to the BAROC upgrade. The treatment planning systems were dissimilar in that BAROC utilise the Elekta CMS XiO® (Elekta, Stockholm, Sweden) treatment

Table 3: Comparison of beam quality from BAROC and ALCC.

Energy	D20/D10 or R50,I (mm)* Ballarat Austin Radiation Oncology Centre (BAROC)	D20/D10 or R50,I (mm) Andrew Love Cancer Care Centre (ALCC)	Difference (% or mm)**
6 MV	0.571	0.571	0.0
6 MeV	22.6	23.2	-0.6
9 MeV	34.6	35.3	-0.7
12 MeV	48.6	49.2	-0.6
16 MeV	64.7	65.1	-0.4
20 MeV	81.9	81.4	0.5

*D_{20}/D_{10} indicates the ratio of absorbed dose at a depth of 20 cm and 10 cm. $R_{50,I}$ indicates the depth at 50 % of the maximum ionisation.
** The ACPSEM tolerances are ± 2 mm for beam energies, flatness of ± 2% for photons and ± 3% for electrons and ± 3% for symmetry.

Table 4: Absorbed dose measurements using dosimetry equipment from BAROC and ALCC.

Energy	BAROC (cGy/MU at reference conditions)	ALCC (cGy/MU at reference conditions)	Difference (%)
6MV	0.998	1.005	-0.7
6MeV	0.993	0.998	0.5
9MeV	0.992	0.999	-0.7
12MeV	0.991	0.998	-0.7
16MeV	0.994	1.003	-0.9
20MeV	0.991	0.994	-0.3

planning system (TPS), whereas ALCC utilise the Varian Eclipse® TPS (Varian Medical Systems, Palo Alto, CA, USA). The similarities and differences between the departments were carefully considered and action plans were formulated when determining the logistics of treating BAROC patients on ALCC equipment.

Requirements for transferring patients between departments

Compatibility of treatment units, minimising the need of any major replanning for patient treatments.

BAROC patients could only be treated at ALCC provided the treatment delivered produced the same dose distribution as the treatment planning system. Initial dosimetric comparisons indicated the beam characteristics of the linear accelerators at both centres were similar and the option for using the treatment plans generated at BAROC was considered. Further detailed comparisons were required in order to determine whether additional corrections on the treatment plans were necessary. This involved comparison of the linear accelerator and EPI angle and scaling nomenclature, and dose distribution and correction factors for open beams and beam modifiers (physical and dynamic wedge, tray and couch). Finally, BAROC patient plans were delivered on ALCC equipment using a phantom and dosimetric accuracy comparisons were undertaken. Details of this comparison are outlined in the proceeding paragraphs.

BAROC was equipped with a Varian Clinac® 2100C linear accelerator with aSi500 EPI imager and Millennium 120 Multi-Leaf Collimator (MLC) (Varian Medical Systems, Palo Alto, CA, USA). The ALCC had similar equipment with a Varian Clinac® 2100iX with aSi1000 EPI and Millennium 120 MLC. The radiation energies used for treatment were 6 and 10 megavoltage (MV) photons at BAROC and 6 and 18 MV photons at the ALCC. The electron energies used were the same for both sites.

Initially, a dosimetric inter-comparison on beam characteristics was carried out to determine whether plans created at BAROC using CMS Xio® TPS * (Elekta, Stockholm, Sweden) could be treated on the Varian Clinac® 2100iX treatment machine at the ALCC. These inter-comparisons indicated slight variations between BAROC and ALCC beams and could be attributed to a number of factors, including variation in quality assurance adjustment procedures at each department, methods of beam data acquisition and differences in mechanical and dosimetric alignment at installation.

Beam quality comparisons were carried out on the 6 MV photon, as well as 6, 9, 12, 16 and 20 MeV, to determine if there were differences between beam energies of the two departments. A comparison of the percentage depth dose curves (PDD) was completed for 6 MV and 6 MeV beams, for an example of the results refer to Figure 3. A ratio of absorbed dose at a depth of 20 cm and 10 cm (D_{20}/D_{10}) and depth of 50 per cent maximum ionisation (R_{50}) were carried out for the photon and electron beams respectively, refer to Table 3 for details. There was little, if any difference in the PDD data from the two centres. The maximum differences in D_{20}/D_{10} and R_{50} were zero per cent for the 6 MV photon beam and -0.7 mm for the 9 MeV electron beam. The results were within the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) quality control tolerance values.[36] A comparison of the 6 MV photon and electron beam profiles were carried out at clinically relevant depths, such as 10 cm for 6 MV photon and depth of maximum absorbed dose for electron beams. The maximum differences for these beams were one per cent. The ACPSEM tolerances are ± 2 mm for beam energies, flatness of ± 2% for photons and ± 3% for electrons and ± 3% for symmetry. These initial findings provided an indication that common beams at the two departments could accurately deliver the same beam energies. The reasons for the minor differences between the beam qualities have been discussed in the preceding paragraph.

Comparisons were conducted to determine if the linear accelerators at the ALCC produced the same absorbed dose as the machine at BAROC. Both departments utilise the same absolute dose calibration protocol – International Atomic and Energy Agency Technical Report Series 398,[37] and calibration set-up for their high energy photon and electron beams. Field dosimetry equipment and phantom materials from ALCC and BAROC were used to measure the absolute dose output data from the linear accelerator at ALCC. The maximum difference between the two sets of dosimetry systems was – 0.9%, refer to Table 4, which is within acceptable tolerances of ± 1% for field to local standard dosimeters. No tolerances have been stipulated for field to field dosimeters in national or international recommendations. Based on Table 4 it was determined that the calibration of the ALCC linear accelerator produces the same absorbed dose as the BAROC linear accelerator with differences due to differing dosimetry equipment, adjustment procedures at both centres and daily fluctuations in linear accelerator outputs.

Comparisons between field size factors were conducted for the 6 MV photon beam as well as all electron energies with applicator factors. These comparisons indicated that the linear accelerators at both departments produced open beams for common energies within one per cent.

A comparison was carried out on Enhanced Dynamic Wedge (EDW) and hard wedges. It was determined that the EDW dose distribution was compatible at both departments, within ACPSEM tolerances. Minor variations between the two departments were due to differing linear arrays. Comparisons between the hard wedge profiles produced a larger difference than expected, approaching ACPSEM tolerance of ± 2%, this was due to the utilisation of differing screw or locknuts on the wedges (personal communication Varian 2009). It was then determined that BAROC hard wedges should be used on BAROC patients at the ALCC during the transfer.

Assessments were carried out on the couch, collimator and gantry angles and scaling nomenclature. Both departments follow International Energy Commission 1217;[38] therefore, nomenclature conversions were not required on the patient plan. Transmission factors for the carbon fibre couch top were compared, showing a 1.5% difference, this was deemed negligible.

The last physics tests involved BAROC clinical plans being delivered using the ALCC linear accelerator, where dosimetric comparisons were carried out in order to determine whether the delivered dose distribution was comparable to those generated by the CMS Xio® planning system. It was decided that if IMRT comparisons were acceptable then it was unnecessary to repeat the comparisons for 3D conformal radiation therapy (3DCRT). This was based on IMRT fields utilising smaller fields than 3DCRT to create beam modulation and steep dose gradients to produce an optimal plan, thus posing a greater dosimetric challenge than 3DCRT. Four IMRT cases (two head and neck and two prostate cancer patients) planned on the CMS Xio® system were delivered on an ALCC linear accelerator and fluence map measurements were carried out and compared with those from the CMS® planning system. The ALCC results were within the acceptable tolerance of greater than or equal to ninety per cent pass rate for head and neck cases and greater than or equal to 95% for prostate cased for IMRT fluence map comparisons using gamma analysis.[39]

From the rigorous physics testing described, patients planned on the BAROC planning system could be treated on the ALCC linear accelerator. The results were based on Australian[36] and international[37] standards and were acceptable across a range of measurements including dosimetric comparison for open, enhanced dynamic wedged and IMRT beams.

Transfer of patient treatment data

A number of discussions were held between the two departments and Varian Medical Systems Australasia to determine how to effectively and safely import BAROC patient treatment data to the ALCC treatment machine. Outcomes from these meetings resulted in the creation of a new user login for BAROC staff on ALCC treatment console with rights to operate the accelerator in Digital Imaging and Communications in Medicine (DICOM) mode. Patient DICOM treatment plans from Ballarat were exported from ® 7.4 and then uploaded onto the ALCC treatment console. The DICOM data from BAROC was tested at ALCC to ensure all patient parameters and details were correct. This exercise indicated that patient information, identification photos, imager position details, structure outlines and field apertures were not exported. This proved to be a limitation in the DICOM export from Varis® 7.4. to ARIA® 8.1. The testing highlighted the difficulty of performing online corrections without anatomy structure outlines or field apertures; therefore all patient plans were re-exported from BAROC on day two of the transfer after the ARIA® upgrade to version 8.6 had been completed. The DICOM export in version 8.6 solved the missing structures and improved efficiency in the online corrections assessment process.

There were two options for BAROC patients originally planned with 10 MV photon; these were replanning them with 18 MV or 6 MV. The option of replanned with 18 MV would have required the full commissioning of 18 MV on the BAROC planning system, which was viewed as impractical. It was decided that the simplest solution for BAROC patients planned on 10 MV photons was to replan their treatment using 6 MV photons. All patients with 10 MV photons were replanned and radiation oncologist approval was obtained to ensure that no clinically significant impact would result from five fractions delivered at 6 MV.

Access and training

Initially, it was proposed that BAROC patients would be treated out of standard business hours (8 am–5 pm) at ALCC; however, this was viewed by Barwon Health as not ideal for BAROC patients. The plan was revised so that one of the ALCC linear accelerators was made available at noon for electron treatments, followed by a second linear accelerator being available at 1pm. For ALCC this involved accommodating the afternoon workload of patients on another linear accelerator. This was managed with no ALCC staff needing to work extended hours, therefore, minimising the impact or disruption at ALCC. BAROC strategically reduced their clinical workload from the high 40s to 33 patients with a cross section of cases. The patient workload was reduced by finishing as many treatment courses as possible the week prior to the upgrade with bi-daily treatments and not commencing new cases until after the upgrade week. The BAROC patients were treated between noon and 8.00 pm by BAROC staff, so that the last patient could return to Ballarat by 9.00 pm.

The BAROC staff were orientated to ALCC department processes, layout and operation of the linear accelerator prior to the upgrade week. The two centres had equipment from the same vendor; however, the newer linear accelerator at ALCC was operating in the ARIA® environment and had remote couch top, therefore some minor orientation was required for the BAROC radiation therapists. This proved to be an excellent training process for the BAROC staff on returning to their upgraded equipment and software the following week.

The transfer week

BAROC organised two coaches to transport patients between Ballarat and Geelong to minimise expenses for patients and the inconvenience of driving. The two coaches reduced the amount of time patients were away from home. For the comfort of patients, both coaches were fitted with bathroom facilities. Patients who were capable and well enough to transport themselves were encouraged to do so. As there was no onsite medical cover for BAROC patients being treated at ALCC, all patients underwent a triage based physical health assessment daily by the nursing staff prior to their departure from Ballarat. If a patient was deemed too unwell to be transported by coach, they were not treated and assessed on the following day. The Geelong Hospital Emergency Department were notified of the transfer, so they were aware if a BAROC patient required admission. In addition, BAROC radiation oncologists were on-call throughout the transfer period. BAROC inpatients were not treated during the transfer period, either completing their treatment prior to the transfer or commencing treatment after the upgrade.

The BAROC patient treatment data was exported in DICOM format and saved to the ALCC clinac console desktop. Patient data were stored with a separate folder for each patient, identified by patient unit record number. Daily treatment history data and portal images were saved back to the patient's folder in a new sub-folder for each of the five days. Each day at the completion of treatment, the BAROC data was saved back to a compact disk initially, and then to an external hard drive. By using this data transfer system at no point did BAROC patient data enter the ALCC information system and vice versa.

Five BAROC radiation therapists, along with two nursing and one clerical staff were present for the duration of the treatment time at ALCC. Four radiation therapists staffed the ALCC linear accelerator for the entire transfer period for consistency and to minimise the number of BAROC staff requiring training. The radiation therapists were supported by a rotating roster of BAROC senior radiation therapists. The BAROC site manager was present on the first transfer day to familiarise the BAROC radiation therapists with the ALCC department and to ensure everything went to plan. The ALCC head of treatment and the BAROC site manager remained on-call during the transfer period to provide support to BAROC staff.

The BAROC administration staff were supplied with a standalone computer with relevant patient data that was in a read-only format of their database. This information was available to manage the daily machine schedule, patient demographics were at hand, and all electronic documentation, should it be required. As this was a standalone computer, it was not linked with the BAROC or ALCC network and therefore, it could not be written to. A telephone was installed by ALCC to form a dedicated reception point for BAROC, so that the services lines of contact could run separately and patients could contact BAROC staff directly.

All medications and dressing supplies were transported to Geelong by BAROC nurses. BAROC radiation oncologists were available via telephone for the authorisation of any medications for their patients. To ensure that accurate administration of medications, two BAROC clinical nurse specialists were present at the ALCC throughout the transfer period.

No formal billing agreement was made, as both departments fall under the Victorian public health system. There was a nominal amount paid by BAROC to the ALCC for utilities.

The week went well with no significant logistical, medical, patient or staffing issues. There was positive interaction between the BAROC and ALCC staff and this emulated the management approach from both departments. The ALCC radiation therapists were welcoming and provided support to the BAROC staff. The BAROC team were friendly, appreciative and most importantly they were adaptable and effective in their work within the ALCC department. Careful planning and checking of the transfer methods ensured that day one of the transfer progressed smoothly, and resulted in a successful transfer of patients with minimal impact on the patients and staff at BAROC and ALCC. It was evident from the outset of this collaboration that patients were central in the transfer process and this remained throughout.

Post transfer week

BAROC has a long history of online imaging, so one of the key outcomes was to retain the image series of the department. As the images were not written back to the database until after the transfer was completed, all imaging was an online correction process and offline image reviewing was completed on the return to Ballarat the following week. A similar process of DICOM import was utilised to update the BAROC database with the treatment histories and the imaging captured while at ALCC. There was not a single instance of lost data related to the transfer week, and BAROC has been able to maintain its online imaging series intact.

To the authors' knowledge there has not been a documented example of such an extensive patient transfer between health services in the radiation therapy setting. The collaboration between Barwon Health and Austin Health has provided the best outcome for the patients of BAROC by accessing best care, no impact on disease outcomes, all treatment delivery history retained and restored. While significant testing, logistic planning, education and risk mitigation was required prior to this patient transfer, the week went smoothly with positive feedback from all stakeholders and was considered to be a great success.

Conclusion

The successful transfer of patients from BAROC to ALCC in 2009 due to equipment and software upgrade at BAROC was only possible through the collaborative efforts of the ALCC, BAROC and ROV staff and their commitment to providing the best possible and equitable treatment to all patients in Victoria. Despite the two departments being from different health services, BAROC patients were treated in ALCC facilities with minimal organisational, logistical and technical adjustments. This contingency management activity forged a better relationship between BAROC and ALCC. Discussions to strengthen the professional relationship of the two centres through further collaboration in research and professional development have occurred.

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