



# South Australian Radiotherapy Service Plan 2014 – 2015

A companion document to the SA Statewide Cancer  
Control Plan 2011-2015

May 2014



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of South Australia

SA Health

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## Foreword

Cancer remains one of the leading causes of morbidity and mortality in South Australia and is the second highest cause of death after cardiovascular disease. One in three South Australians will be diagnosed with cancer at some time during their lives.<sup>1</sup>

Radiotherapy is one of the main treatments for cancer, along with surgery and chemotherapy. Determining the right level of access to radiotherapy services is therefore an important part of cancer service planning.

The latest evidence suggests that in Australia around 48.3%<sup>2</sup> of newly diagnosed cancer patients should undergo radiotherapy at some point during their treatment. This evidence also indicates that, given the profile of new cancer cases in South Australia, radiotherapy is indicated for 47.4% of these cases.

The South Australian Radiotherapy Service Plan 2014-2015 (the Plan) has been developed following one of the principal recommendations of the Australian Health Ministers Advisory Council's Radiation Oncology Jurisdictional Implementation Group that all Australian jurisdictions should have a five year strategic plan for radiotherapy that provides a framework for radiotherapy service delivery.

This Plan is one of two companion documents to the Statewide Cancer Control Plan 2011-2015. It sets out the framework and direction required for South Australia to meet best practice radiotherapy service benchmarks, and provides guidance for the provision of radiotherapy services to ensure equitable access for all South Australians.

It is intended that this Plan will support the statewide and local planning and delivery of radiotherapy services to best meet the needs of people with cancer in South Australia.



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## Introduction

Radiation therapy or radiotherapy<sup>1</sup> is one of the three main treatment modalities for cancer along with surgery and chemotherapy. It is provided within the specialist clinical discipline of Radiation Oncology. As a curative method, radiotherapy may be the primary technique or used in conjunction with other forms of treatment.

Radiotherapy involves the accurate and precise delivery of high dose radiation (from electron beams) to carefully-defined disease sites to destroy cancer cells. It offers benefits in terms of organ preservation, better quality of life, effective palliation of symptoms and higher survival rates in a number of forms of cancer. Radiotherapy is distinguished by the length and course of treatment, usually requiring repeated daily doses (or “fractions”) delivered over a number of weeks at a purpose-built facility using a linear accelerator.

A primary goal for cancer care is to provide optimal care and management for people affected by cancer. This should be delivered within a coordinated, integrated and collaborative framework and be underpinned by evidence-based practice. There is also a need for collaborative and effective working relationships between the private and public sectors, particularly in relation to planning future services, data collection and reporting.

### Aim of the Plan

The aim of the Plan is to identify the future need in South Australia for radiotherapy services, and the infrastructure and equipment required to 2016 to optimally meet this need, as informed by evidence-based benchmarks.

In forecasting demand, the Plan considers:

- > projected cancer cases based on population trends
- > the benchmark target radiotherapy treatment rate of 47.4% for new cancers based on South Australia’s incidence by cancer site
- > other planning parameters, including re-treatment rates, throughput, and quality and patient outcome measures.

### Planning principles

The following principles articulate an appropriate scope for radiotherapy services in South Australia:

1. Radiotherapy services operate within a sound safety and quality agenda to ensure patient and staff safety is maintained and optimal patient outcomes are achieved.
2. Radiotherapy services follow national guidelines where they are available.
3. Radiotherapy is offered to all patients who would benefit from it and is provided to all who choose to receive it.
4. Equitable access to radiotherapy occurs within agreed benchmarks or timeframes.
5. Radiotherapy is part of a continuum of care that includes primary care providers.
6. Radiotherapy is part of a comprehensive and multidisciplinary approach to cancer care.

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<sup>1</sup> Throughout this Plan, radiotherapy is used as the terminology for the overall provision of radiation services. This provides consistency of use and it is the term with which most people are familiar.

7. Radiotherapy services are integrated with a number of linked subspecialty disciplines (for example, surgery, palliative care, rehabilitation) as part of a quality-driven, comprehensive cancer service. This can include on-site or networked support services (for example, pharmacy, psychology).
8. Sites for radiotherapy services have a sufficient level of clinical support services including diagnostic imaging, pathology and nuclear medicine.
9. Appropriate outreach services for rural and remote residents are provided.
10. Appropriate provision is made to ensure regular and appropriate upgrading or replacement of treatment equipment.
11. Services are based upon achieving a balance of increasing geographical access, workforce supply and critical mass, subspecialisation treatment access and increasing treatment rates.
12. Effective collaboration between the public and private radiotherapy sectors is achieved.
13. Service planning includes the capacity to respond to new technologies that improve delivery of radiotherapy and patient outcomes.

The Plan also builds on the vision set out in South Australia's Health Care Plan 2007-16, and links with a series of other statewide health service plans and models of care that focus on meeting the health needs of South Australians.

### **Special planning considerations**

There are three groups who have been identified as requiring special consideration when planning radiotherapy services: paediatric and country patients, and Aboriginal and Torres Strait Islander people.

#### **Paediatric patients**

Treating children and young people with radiotherapy is more resource intensive than treating adults. It requires extra planning, a different room set-up and often the involvement of an anaesthetist. Children require additional monitoring, and appropriate time needs to be allowed for the child to recover from the anaesthetic. As a result, paediatric patients are generally treated early in the day.

#### **Country patients**

Remoteness of residence is recognised as one axis of disadvantage that can contribute to poorer cancer outcomes. A 2003 study based on 1990-94 data from the Cancer Registry of South Australia<sup>3</sup> indicated that one of the determinants of not receiving radiotherapy in the first 12 months following a cancer diagnosis was residing in a country region.

#### **Aboriginal and Torres Strait Islander people**

There are specific challenges for Aboriginal and Torres Strait Islander people and their families and carers in accessing cancer treatment. These are considered extensively in the *Aboriginal and Torres Strait Islander Companion Document to the Statewide Cancer Control Plan (2011-2015)* and *Cancer Care Pathway*.

## Radiotherapy treatment

All types of radiotherapy involve the application of ionising radiation with the aim of delivering a precisely measured dose of radiation to a defined known volume of abnormal tissue with as minimal impact as possible to surrounding healthy tissue. The objectives of radiotherapy are eradication of the tumour, contribution to quality of life for the patient, and prolonged survival with as few side effects as possible.

### Types of radiotherapy

There are two main types of radiotherapy:

- > external beam (high energy), and
- > brachytherapy (radioisotope).

Other forms of radiotherapy include:

- > conformal radiation therapy
- > therapeutic radioisotopes
- > stereotactic radiosurgery
- > proton therapy.

A detailed description is included at Appendix 1.

### Radiation treatment planning

Radiation treatment planning is the process by which a team of radiation oncologists, radiation therapists, medical physicists and medical dosimetrists plan the appropriate external beam radiotherapy or internal brachytherapy treatment technique for a patient.

Treatment planners determine the dose that will deliver sufficient radiation to a tumour while sparing critical organs and minimising the dose to healthy tissue. Radiation treatment planning systems are then used to calculate the required monitor units to deliver this prescribed dose to a specific area in the patient. These calculations depend on beam modifiers that include wedges, specialised collimation, field sizes and tumour depth.

Treatment planning systems include the following:

- > two-dimensional treatment planning systems
- > three-dimensional treatment planning systems
- > virtual simulation using computerised tomography scans.

A detailed description of these is included at Appendix 1.

## Specialised technologies

There are a number of specialised technologies in radiotherapy including the following:

- > stereotactic radiosurgery
- > high dose rate brachytherapy
- > low dose rate brachytherapy
- > gated radiation therapy
- > four-dimensional computerised tomography
- > intensity modulated radiation therapy
- > image guided radiation therapy
- > ultrasonography
- > beacon guided radiotherapy
- > total body irradiation
- > multileaf collimator.

A detailed description of these is included at Appendix 1.

## Emerging radiotherapy technologies and delivery methods

Radiation oncology is an area where new and experimental techniques are quite frequently developed. As evidence becomes available, it is important to consider these in future planning.

The chosen method of radiotherapy delivery is dependent on clinical practice, evidence that there are improved outcomes for patients, and availability of sufficient resources. The aim is to apply the most cost effective delivery method based on available evidence and patient needs.

Improved treatment outcomes may be achieved using a combination of more limited surgery with radiotherapy, chemotherapy and hormonal manipulation. An important trend has seen the use of synchronous chemo-radiotherapy. Some evidence is now available for positive outcomes. The important implication is that radiation services must operate from within a multidisciplinary framework of a comprehensive cancer service.

The following radiotherapy technologies are relatively new and need to be considered in future planning of radiotherapy services:

- > intra-operative radiotherapy
- > combined hypothermia and radiotherapy
- > electronic brachytherapy
- > adaptive radiotherapy
- > intensity modulated arc therapy
- > tomotherapy
- > magnetic resonance imaging linear accelerator
- > alternative treatment strategies.

A detailed description of these emerging technologies is included at Appendix 1.

## Radiotherapy equipment

Unlike surgery and chemotherapy, radiotherapy requires significant initial investment in equipment including linear accelerators and infrastructure such as concrete bunkers to prevent incidental or occupational exposure to radiation. A specialist team-based workforce supports delivery of the therapy.

Standard equipment in modern radiotherapy facilities will include:

- > linear accelerators which have multileaf collimators and independent jaws with intensity modulated radiotherapy capabilities
- > three-dimensional treatment planning systems with intensity modulated radiation therapy capabilities
- > computerised tomography simulators
- > on-line portal imaging with image guided radiation therapy capabilities
- > record and verifying systems with full network connectivity to all treatment and planning infrastructure.

Timely replacement of equipment, including linear accelerators, is required to ensure cost effective treatment delivery. A programmed schedule of radiotherapy asset management is required for replacement of linear accelerators to ensure compliance with the national Radiation Oncology Health Program Grants (ROHPG) Scheme guidelines. Linear accelerators have a notional useful life of ten years (or 82,500 treatments) as recognised under the Radiation Oncology Health Program Grants Scheme.

Replacement and commissioning of linear accelerators is a time consuming process and needs to be factored into the planning strategy for managing radiation services<sup>4</sup>.

For detailed information on the ROHPG Scheme, see Appendix 2.

## Radiotherapy services currently in South Australia

South Australia has two radiotherapy providers: one public and one private; and there are 13 linear accelerators: six public and seven private. A description of radiotherapy equipment in use in South Australia can be found in Appendix 3.

### Public services

Radiotherapy services for public patients are provided at the Royal Adelaide Hospital and the Lyell McEwin Hospital, with assessment, some planning and follow-up available on an outpatient basis at The Queen Elizabeth Hospital, Repatriation General Hospital, Noarlunga Health Service and Modbury Hospital; and at Calvary, Ashford, and Burnside private hospitals. Outreach services are also provided at larger country hospitals including Mt Gambier, Whyalla, Port Lincoln and Broken Hill.

A multidisciplinary integrated approach to cancer care is provided with access to a range of diagnostic and specialist medical and surgical services. These services include allied health services, including clinical psychology, dedicated radiation oncology nursing care, cancer specific dietetic advice, and dedicated social work support. Education and training of staff and substantial research endeavours are integral components of the cancer service.

Services located at the Royal Adelaide Hospital include a radiotherapy service consisting of four linear accelerators with multileaf collimators and electronic portal imaging. A full range of radiation oncology services are provided, including brachytherapy, and supported by diagnostic services such as magnetic resonance imaging, computerised tomography and positron emission tomography.

The radiotherapy service at the Lyell McEwin Hospital now has two linear accelerators in operation to meet increased population growth in the Northern Adelaide Local Health Network.

In the Southern Adelaide Local Health Network, Adelaide Radiotherapy Centre is contracted to provide radiotherapy for all public patients through its campus at Flinders Private Hospital.

The Women's and Children's Hospital provides anaesthetic expertise for younger children undergoing treatment at the Royal Adelaide Hospital. In addition, a medical oncologist from the Royal Adelaide Hospital regularly attends the paediatric oncology advisory committee at the Women's and Children's Hospital.

### Private services

Private radiotherapy in SA is provided by Adelaide Radiotherapy Centre (ARC). ARC has seven linear accelerators, with an eighth scheduled to come on line in 2014-15.

ARC operates facilities at four sites across metropolitan Adelaide: St Andrew's Hospital in Adelaide, Tennyson Centre (Kurrulta Park) in the inner west, Flinders Private Hospital in the south, and Calvary Central Districts Hospital in the north. They also provide visiting consultation and follow up services to the regional and remote communities of Whyalla, Wallaroo and Murray Bridge.

ARC's radiation oncologists also consult weekly at Calvary North Adelaide Hospital; and in the public sector at The Queen Elizabeth Hospital, Flinders Medical Centre, Royal Adelaide Hospital, Women's and Children's Hospital and the Repatriation General Hospital. Consultation clinics are also held at private hospitals including Ashford Hospital and Calvary Central Districts Hospital.

ARC provides a full range of external beam radiation therapy services, and also offers low dose rate brachytherapy seed procedures for the management of prostate cancer.

Both public and private services provide education and training for the radiation oncology workforce in collaboration with local Universities.

## Planning radiotherapy services for South Australia

Radiotherapy service planning is predicated on the expectation that approximately 45-50% of all people diagnosed with cancer can be cured. For 30-40% of these people, this cure is achieved by radiotherapy, either as a single therapeutic regimen or in combination with other treatment modalities such as surgery and chemotherapy.<sup>5</sup> Radiotherapy is also used for the palliative treatment of some cancer patients and to treat some non-malignant conditions.

This section details the approach to planning for radiotherapy services provided using linear accelerators. The important parameters in planning these services include the expected incidence of cancer in the population for each type of cancer, and the optimal utilisation rate per type of cancer.

### Trends and projections of cancer incidence in South Australia

Cancer remains a leading cause of morbidity and mortality in South Australia. One in three South Australians will be diagnosed with cancer at some time during their lives. About 28% of all deaths in South Australia are due to cancer and more years of life are lost prematurely to cancer than to any other cause.<sup>6</sup>

In South Australia, the most common cancers in men are: prostate, colorectal, lung and melanoma, and in women: breast, colorectal, lung and melanoma.<sup>7</sup>

The estimated percentages of the population affected by cancer by age group are:

- > children and young people aged 0-14 years – less than 0.5% of cancers
- > adolescents and people aged from 15-44 years – 6.5% of cancers
- > people aged 45-64 years – 33.2% of cancers
- > people 65 years and older – 60.0% of all cancers.

As cancer is a disease predominantly affecting older age groups, population growth in these groups in particular is expected to impact on the cancer incidence in SA.

### Population trends

South Australia has a growing population. In 2011, the population was 1.64 million and it is projected to reach 1.74 million by the end of 2016<sup>8</sup>. The largest increases are expected to occur in the Northern Adelaide area as shown in Table 1.

Table 1: Population change from 2011 to 2016

| Geographical areas | 2011 population | Projected 2016 population | Projected population increase 2011 to 2016 |
|--------------------|-----------------|---------------------------|--|
| Northern Adelaide  | 370,043         | 402,657                   | 32,614 (8.81%)                             |
| Central Adelaide*  | 441,497         | 462,825                   | 21,328 (4.83%)                             |
| Southern Adelaide  | 350,225         | 371,867                   | 21,642 (6.18%)                             |
| Country SA         | 477,849         | 505,629                   | 27,780 (5.81%)                             |
| Total              | 1,639,614       | 1,742,978                 | 103,364 (6.30%)                            |

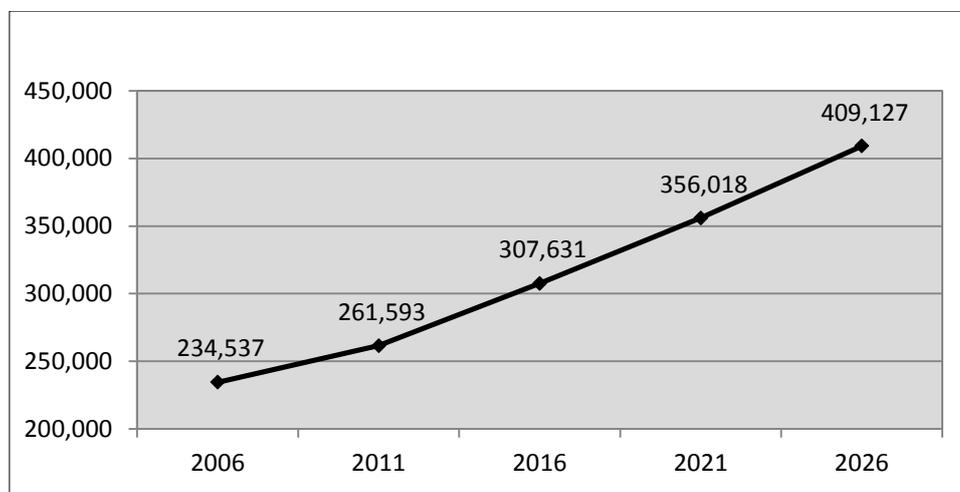
Source: *Rebased Planning SA population estimates (based on rebased ERP 2012)*

\* Women's and Children's Health Network is not included in this table as it is a statewide Health Network and paediatric populations are included in metropolitan and country Local Health Network populations.

It is predicted that whilst population growth will occur across all age groups, most increases will be seen in the age groups at higher risk of cancer.

The number of people aged 65 and over is predicted to continue to increase as shown in Figure 1.

Figure 1: Projected number of South Australians aged 65 and over



Source: Rebased Planning SA population estimates (based on rebased ERP 2012)

The geographical distribution of the older population in South Australia is expected to change in the coming years. The proportion change in projected populations for the 65+ age group indicates the greatest growth will be in the Country Health SA LHN followed by the Northern Adelaide LHN, as shown in Table 2.

Table 2: Percentage change in population projections for 65+ age group

|                   | % in 2006 | % in 2011 | % in 2016 | % Change from 2006 to 2016 |
|-------------------|-----------|-----------|-----------|----------------------------|
| Northern Adelaide | 17.9%     | 18.4%     | 19.2%     | +1.32%                     |
| Central Adelaide  | 31.1%     | 29.1%     | 27.4%     | -3.69%                     |
| Southern Adelaide | 21.4%     | 21.2%     | 21.6%     | +0.22%                     |
| Country SA        | 29.7%     | 31.1%     | 31.8%     | +2.15%                     |
| TOTAL             | 100%      | 100%*     | 100%      |                            |

Source: Rebased Planning SA population estimates (based on rebased ERP 2012)

\* Sum of LHNs may be different to 100% due to rounding

In addition to growth in the older population, the number of children and young people aged between 0-19 years is expected to grow by 10.2%, from around 387,280 in 2006 to 411,855 in 2016, and to 427,475 by 2021. The greatest growth in the number of children and young people is expected in the Northern Adelaide area, where the projected increase from 2011 to 2016 is 6.3%. This increase needs to be taken into consideration when planning paediatric radiotherapy services.

## Trends in cancer incidence and mortality

Cancer incidence and mortality have shown distinct trends over time in South Australia. The incidence rate in men increased by 0.4% per annum between 2005 and 2009, while for women, rates have increased by 0.2% per annum. Mortality rates in men have shown a decline by 0.9% per annum, while for women the rate has declined by 0.8% per annum. Women have approximately 23% lower cancer incidence and mortality than men.

In interpreting trends in total cancer incidence, it should be noted that the number of reported cancer cases increased over the reporting period due to haematopoietic cancers being added to the total cases of cancer statistics. Haematopoietic cancers include lymphomas (non-hodgkin lymphoma and hodgkin disease), leukaemia and myelomas. Of the total people with cancer in 2009, 9.5% (885) had haematopoietic cancer.

Several newly classified lympho-haematopoietic diseases are also now included in cancer statistical reporting. These cancers are not currently treated with radiotherapy, but their inclusion in statistical reporting will have an impact on the total number of cancers, and planning for radiotherapy services will need to take this into account.

Notable emerging developments in the incidence and prevalence of specific cancers include the continued increase in prostate cancer incidence, linked to the corresponding rise in Prostate Specific Antigen (PSA) testing; and the melanoma incidence and mortality remaining static in both sexes. Mortality rates over the last 10-15 years have decreased for males due to a reduction of bowel and lung cancer.

Country Health SA covers almost one million square kilometres, representing approximately 99.8% of the State's geographical area, whilst accommodating almost one third of South Australia's residents<sup>9</sup>. People living with cancer in rural areas have poorer survival rates than those living in major metropolitan centres; and the greater distance a person with cancer lives from a metropolitan centre, the more likely they are to die within five years of diagnosis<sup>10</sup>.

The incidence of some cancers is higher for people in rural and remote areas in part due to lifestyle factors. For example, there is a significantly higher incidence of melanoma (associated with sun exposure) and lung, head and neck, and lip cancers (associated with smoking) compared to people in metropolitan areas<sup>11</sup>.

Aboriginal and Torres Strait Islander people living in South Australia have a similar overall rate of new cancers to the rest of the population, although there is a different distribution of cancer types<sup>12</sup>. The Aboriginal population of South Australia encounters more lethal types of cancer and has much higher rates of cancer-related death. This is partly due to later diagnoses reducing the prospects for cure<sup>13</sup>.

Particular issues to be considered for Aboriginal and Torres Strait Islander cancer patients and their families include unfamiliarity with western health concepts and care, the cultural appropriateness of care, and particular issues around travel, accommodation and isolation from family. These are considered in detail in the *Aboriginal and Torres Strait Islander Companion Document to the Statewide Cancer Control Plan (2011-2015) and Cancer Care Pathway*<sup>14</sup>.

## Projections of cancer incidence in South Australia

The SA Cancer Registry uses linear regression to determine the age-specific and overall projected cancer incidence rates that are used in this Plan (Table 3). These projections are based on the published Australian Bureau of Statistics estimated resident population figures up to 2010 and endorsed population projections for 2011 to 2016. It should be noted that while projected incidence rates are useful in service planning, regular

monitoring of the actual numbers of people diagnosed with cancers should be undertaken and service capacity plans adjusted accordingly. Data in the table from 2007 to 2009 represents *actual* cancer cases and rates, whereas data from 2010 to 2016 are *projected* age-standardised rates of incident cancer cases.

*Table 3: Actual cancer cases and cancer projections using 2010 medium series SA population data*

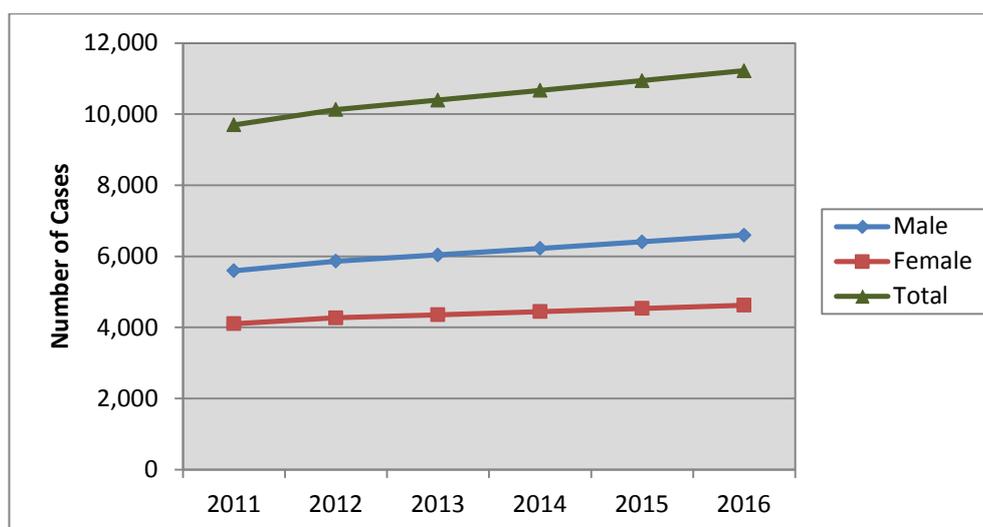
|              | Actual Cases |      |      | Projected Incidence |      |       |       |       |       |       |
|--------------|--------------|------|------|---------------------|------|-------|-------|-------|-------|-------|
|              | 2007         | 2008 | 2009 | 2010                | 2011 | 2012  | 2013  | 2014  | 2015  | 2016  |
| Female Rate* | 397          | 404  | 385  | 391                 | 391  | 392   | 393   | 394   | 395   | 395   |
| Female Cases | 3941         | 4070 | 3948 | 4073                | 4102 | 4268  | 4357  | 4446  | 4535  | 4627  |
| Male Rate*   | 597          | 602  | 595  | 597                 | 600  | 604   | 607   | 611   | 614   | 618   |
| Male Cases   | 5152         | 5296 | 5349 | 5502                | 5597 | 5862  | 6041  | 6222  | 6408  | 6595  |
| Total Cases  | 9093         | 9366 | 9297 | 9575                | 9700 | 10130 | 10397 | 10668 | 10943 | 11222 |

Source: SA Health Epidemiology Branch

\* Aged standardised cancer rate per 100,000 population

It is predicted that by 2016 the incidence of cancer in the SA population will reach over 11,200 cases. The projected trends since 2011 in cancer incidence for SA males, females and overall from Table 3 are depicted in Figure 2.

*Figure 2: Projected incidence of cancer in SA 2011–2016*



Source: SA Health Epidemiology Branch

## Radiotherapy utilisation

Optimal radiotherapy utilisation rates and the proportion of newly diagnosed cancer patients vary between cancer sites. Therefore the overall optimal rate of radiotherapy utilisation for South Australia depends on the incidence of different types of cancer in the South Australian population. The analysis presented here is based on the latest available evidence of the optimal utilisation rates of radiotherapy by cancer site and the cancer incidence by site in South Australia<sup>15</sup>. Based on the current profile of cancer incidence in South Australia, the overall optimal utilisation rate for SA has been estimated at 47.4% of newly diagnosed cases.

It should be remembered that the actual utilisation of radiotherapy is influenced by several factors other than cancer incidence, such as:

### Supply-side factors

- > the availability of radiotherapy services
- > the configuration of services, including the availability of specialist treatment for complex cases, such as head and neck cancers
- > advances in radiation technology, making treatment more effective
- > the impact of screening programs and improvements in diagnostic technology which are increasing the number of people diagnosed with cancer
- > the changing patterns of cancer care and radiotherapy referral practices
- > the hours of operation and productivity in the delivery of radiotherapy services
- > the use of radiotherapy for illnesses other than cancers.

### Demand-side factors

- > acceptance of radiotherapy as a treatment modality by the general community
- > physical access barriers, including transport and opening hours, particularly for those people living in rural areas
- > fears about treatment risks such as exposure to radiation, particularly for Aboriginal and Torres Strait Islander people and communities from culturally and linguistically diverse (CALD) backgrounds.

### Current radiotherapy utilisation

The annual radiotherapy utilisation rate is calculated as follows:

$$\text{Radiotherapy Utilisation (new cases)} = \frac{\text{Total new cases of radiotherapy}}{\text{Total cancer incidence}}$$

where:

Total new cases = number of people treated with radiotherapy per annum; and

Total cancer incidence = number of new cancer cases per annum, excluding non-reportable cancers and other non-malignant conditions for which radiotherapy may be a treatment option.

The data for this calculation are from the Royal Adelaide Hospital Cancer Centre (including Royal Adelaide Hospital and Lyell McEwin Hospital sites), the Adelaide Radiotherapy Centre, and the SA Cancer Registry for the period 2006 to 2009. The number of people treated with radiotherapy per annum in South Australia over this period is shown in Table 4.

Table 4: Number of South Australians treated with radiotherapy from 2006 to 2009

|                                 | 2006            | 2007            | 2008              | 2009              |
|---------------------------------|-----------------|-----------------|-------------------|-------------------|
| Public (RAH)*                   | 1420<br>(38%)   | 1301<br>(36%)   | 1345<br>(38.8%)   | 1384<br>(39.5%)   |
| Private (ARC)                   | 2321<br>(62%)** | 2288<br>(64%)** | 2113<br>(61.2%)** | 2114<br>(60.5%)** |
| Total treatments of new cancers | 3741            | 3589            | 3458              | 3498              |
| Total cancer incidence          | 8592            | 9079            | 9350              | 9297              |
| Radiotherapy utilisation rate   | 43.5%           | 39.5%           | 37%               | 37.6%             |

Source: Royal Adelaide Hospital and Adelaide Radiotherapy Centre

\* Around 2% of patients treated at RAH are from the Northern Territory

\*\* Includes some public patients as SA Health contracts ARC to provide all public radiotherapy services in the Southern Adelaide Local Health Network

A proportion of people are re-treated with radiotherapy, which means that a second course of radiotherapy is provided after an initial course for the same primary diagnosis. Therefore, in estimating the need for radiotherapy services, re-treatment rates must be accounted for. Current re-treatment rates are shown in Table 5. In the four years shown, re-treatment rates have varied between 18% and 36% of cancer patients, with ARC's re-treatment rates considerably higher than those provided by RAH.

*Table 5: Actual number and proportion of cancer patients per annum re-treated\*\* with radiotherapy in South Australia*

|               | 2006      | 2007        | 2008        | 2009        |
|---------------|-----------|-------------|-------------|-------------|
| Public (RAH)  | 261 (18%) | 276 (21.2%) | 282 (20.9%) | 313 (22.6%) |
| Private (ARC) | 674 (29%) | 668 (29%)   | 485 (22.9%) | 769 (36.4%) |
| Total         | 935       | 944         | 767         | 1082        |

\*\* Patients re-treated with radiotherapy as a percentage of new patients receiving radiotherapy per annum

### **Projected need for radiotherapy**

Haematopoietic cancers have been included in the planning for radiotherapy services. Treatment with radiotherapy varies significantly between types of haematopoietic cancer. The latest available research indicates that, at some point during their management, 73% of people with lymphoma, 45% of people with myeloma, and 4% of people with leukaemia should be treated with radiotherapy<sup>16</sup>.

It should be noted that there are some cancer cases that are not included in the SA cancer incidence projections that underpin radiotherapy service planning. They represent a low volume of radiotherapy usage and include non-reportable cancers such as benign tumours, non-melanomatous skin cancer or uncertain malignancies, and other non-malignant conditions for which radiotherapy may be a treatment option.

As shown in Table 4, the actual utilisation rate in SA (37.6%) was considerably lower in 2009 than the optimal rate of 47.4%. To have met the benchmark, an additional 26% of people newly diagnosed with cancer – around 909 people – would have needed to receive radiotherapy treatment.

In Table 5, the South Australian re-treatment rate in 2009 was closer to the commonly accepted 23%, with the Royal Adelaide Hospital Cancer Centre re-treating 22.6% of patients and Adelaide Radiology Centre re-treating 36.4% of patients. However, for planning purposes, the national benchmark re-treatment rate figure of 25% of new cases has been used to account for patients with non-cancer diagnoses who are treated with radiotherapy, noting that these cases represent only small numbers of people requiring radiotherapy in SA.

Estimates of the projected optimal annual radiotherapy utilisation for South Australia are shown in Table 6. The Country Health SA catchment is predicted to have the greatest number of people for whom radiotherapy is clinically indicated (an estimated 1,543 persons by 2016), followed by Central Adelaide (1,412), then Northern Adelaide (1,229) and Southern Adelaide (1,135). Although population projections (see Table 1) suggest that the greatest growth will occur in the Northern Adelaide Local Health Network (8.8%), Country Health SA has a greater ageing population (see Table 2) who are more likely to experience cancer.

Table 6: *Estimated need for radiotherapy*

|                   | 2012                          |              |   |  | 2016                          |              |   |  |
|-------------------|-------------------------------|--------------|---|--|-------------------------------|--------------|---|--|
|                   | Total population <sup>1</sup> | % Total pop. | Projected cancer incidence <sup>2</sup> | Est. no. indicated for RT <sup>3</sup> | Total population <sup>1</sup> | % Total pop. | Projected cancer incidence <sup>2</sup> | Est. no. indicated for RT <sup>3</sup> |
| Northern Adelaide | 375,280                       | 22.7%        | 2,295                                   | 1,088                                  | 402,657                       | 23.1%        | 2,592                                   | 1,229                                  |
| Central Adelaide  | 446,875                       | 27.0%        | 2,733                                   | 1,295                                  | 462,825                       | 26.6%        | 2,980                                   | 1,412                                  |
| Southern Adelaide | 353,243                       | 21.3%        | 2,160                                   | 1,024                                  | 371,867                       | 21.3%        | 2,394                                   | 1,135                                  |
| Country SA        | 480,901                       | 29.0%        | 2,941                                   | 1,394                                  | 505,629                       | 29.0%        | 3,255                                   | 1,543                                  |
| <b>TOTAL</b>      | <b>1,656,299</b>              | <b>100%</b>  | <b>10,129</b>                           | <b>4,801</b>                           | <b>1,742,978</b>              | <b>100%</b>  | <b>11,221</b>                           | <b>5,319</b>                           |

Source:

1. *Rebased Planning SA population estimates (based on rebased ERP 2012)*

2. *SA Cancer Registry*

3. *Review of Radiotherapy Optimal Utilisation Rates, March 2013*

### Linear accelerators

In addition to the number of radiotherapy treatments required for a population, the following planning parameters are commonly used to determine the number of linear accelerators (linacs) needed:

- > treatments (fractions) per course for new cases and re-treats
- > number of patients who can be treated per hour by each linac
- > operating hours per day for each radiotherapy service/linac, and
- > operating days per annum for each radiotherapy service/linac.

### Linear accelerator requirements

In determining the need for linear accelerators in South Australia, the above planning parameters have been analysed for both public and private radiotherapy services. The parameter values reflect current operating practice and require periodic review to ensure that any changes in service operating practices are accounted for.

The higher number of total courses in the private sector compared with the public sector is partly due to the greater number of total operating hours at the Adelaide Radiotherapy Centre as well as the complexity of treatment and variation of case mix between the sectors. The Royal Adelaide Hospital Cancer Service treats more complex patients than Adelaide Radiotherapy Centre, including total body irradiations and stereotactic radiosurgery which take longer than less complex patients and reduce the throughput of patients. Given the difference in the value of these planning parameters across the public and private sectors, an aggregate of overall capacity has been used to determine total South Australian requirements.

The parameter values for South Australia are shown in Table 7.

Table 7: Planning parameters for South Australia

|   | Public | Private | Overall Rate (average) |
|---|--------|---------|------------------------|
| (a) Fractions per course for new patients           | 18.3   | 18.3    | <b>18.3</b>            |
| (b) Fractions per course for re-treats              | 10     | 10      | <b>10</b>              |
| (c) Fractions per hour per linac                    | 3.9    | 4.5     | <b>4.2</b>             |
| (d) Operating hours per linac per day               | 8      | 9       | <b>8.5</b>             |
| (e) Working days per linac per annum                | 244    | 252     | <b>248</b>             |
| (f) Fractions per linac per annum ((c) x (d) x (e)) | 7,613  | 10,206  | <b>8,854</b>           |

The number of linacs projected to be required to achieve the South Australian access benchmark of 47.4% is calculated by dividing the number of total treatments required to achieve this benchmark by the number of fractions that are provided by each linac, as shown in Table 8. A written explanation of the complete methodology is provided in Appendix 5. The calculation indicates that 13 linear accelerators are required across the public and private sectors by 2016.

Table 8: Linear accelerator capacity required to achieve the South Australian evidence-based access benchmark

|   | Benchmark/ Assumption               | 2012         | 2014         | 2016         |
|---|-------------------------------------|--------------|--------------|--------------|
| (a) SA cancer incidence   | See Table 6                         | 10,130       | 10,668       | 11,222       |
| (b) New radiotherapy cases (and courses)*   | 47.4% of new cancer cases           | 4,802        | 5,057        | 5,319        |
| (c) New radiotherapy fractions needed   | 18.3 per course                     | 87,927       | 92,597       | 97,406       |
| (d) Re-treat cases (and courses)  | 25% of new radiotherapy cases       | 1,200        | 1,264        | 1,330        |
| (e) Re-treat radiotherapy fractions needed  | 10 per course                       | 12,004       | 12,642       | 13,298       |
| (f) Total RT fractions (c) + (e)  |                                     | 99,931       | 105,238      | 110,703      |
| (g) Linear accelerators needed to meet access benchmark (f) ÷ fractions per linac | 8,854 fractions per linac (Table 7) | <b>11.29</b> | <b>11.89</b> | <b>12.50</b> |
| <b>Rounded</b>  |                                     | <b>11</b>    | <b>12</b>    | <b>13</b>    |

\* A small number of cases from the Northern Territory has been excluded.

### Current availability of linear accelerators in South Australia

There are currently 13 linear accelerators (Table 9), which is sufficient to achieve optimal utilisation rates according to the data and methods applied in this plan.

Table 9: Linear Accelerators in South Australia currently

| LHN               |                    | PUBLIC   | PRIVATE  | Total |
|-------------------|--------------------|--|--|-------|
| Central Adelaide  | Current            | RAH: 4 (5 bunkers)   | South Terrace: 2<br>Tennyson Centre: 2             | 8     |
|                   | Additional Planned | New RAH: 1 (1 bunker) by 2016/17   | Nil  | 1     |
| Northern Adelaide | Current            | LMH: 2   | Calvary Central Districts Hospital:1 (2 bunkers)   | 3     |
|                   | Additional Planned |  | Calvary Central Districts Hospital:1 in 2014-15    | 1     |
| Southern Adelaide | Current            | Nil – ARC contracted to provide RT for public patients; or patients can elect to go to RAH | Flinders Private Hospital: 2 (space for 3 bunkers) | 2     |
|                   | Additional Planned | Nil  | TBA  | -     |
| Country SA        | Current            | Nil – some assessment of people only done in country sites                                 | Nil  | -     |
|                   | Additional Planned | Nil  | Nil  | -     |
| TOTAL             | Current            | 6  | 7  | 13    |
|                   | Additional Planned | 1 by 2016-17   | 1 in 2014-15                                       | 2     |

There are no linear accelerators located in the rural regions of SA. Rural patients who elect to be treated as a public patient travel to Adelaide for radiotherapy treatment at either the Royal Adelaide Hospital or the Lyell McEwin Hospital. Rural residents can also access private radiotherapy treatment in Adelaide at ARC. People living in rural South Australia have access to outreach radiation oncology clinics provided at Murray Bridge Soldiers' Hospital, Wallaroo Hospital, Whyalla Hospital, Mt Gambier Hospital and Port Lincoln Hospital.

It should be noted that despite there being sufficient linacs to achieve the optimal utilisation rate in 2009, actual radiotherapy utilisation was below this at 37.6% (Table 4). Greater access could be achieved through increasing the throughput of existing capacity by changing business practices including extending the hours and days of service. This may provide better access for people who live a distance away and for those who are able to continue working whilst receiving therapy. However, it should be noted that extended operating hours would shorten machine replacement timeframes. It is also important that the productivity of existing linacs is optimised through good operational practices.

While another two linacs are planned (one in 2014/15 and one in 2016/17) they are not needed at this point in time to achieve optimal radiotherapy utilisation according to the planning parameters and projections used in this plan. It is therefore recommended that plans to install these additional machines are reviewed as updated data becomes available on utilisation rates, cancer incidence and population growth.

## Planning for new technology

The planning of radiotherapy services must build in the capacity to respond to, evaluate, and incorporate new technologies in radiotherapy service provision. Responsiveness must be balanced against the investments and outcomes achieved with current equipment. There is a range of new and developing technologies within radiotherapy with the potential to impact on service provision including the number of required linear accelerators needed to meet patient need. Additionally the workforce impacts relating to training and maximising efficiency and productivity benefits of new technology need to be considered.

The planning of health infrastructure must take a “forward ready” approach to ensure radiotherapy services are capable of delivering both current and emerging treatment techniques relevant to the 10 year life cycle of linear accelerators.

Future infrastructure requirements include:

- > a linear accelerator that is compatible to deliver current and emerging techniques such as image guided radiation therapy (which utilises both electronic portal imaging and cone beam computerised tomography scans to verify tumour organ position before treatment beam delivery) as well as intensity modulated radiation therapy or volume modulated arc therapy
- > a computerised tomography scanner that allows acquisition of radiotherapy planning computerised tomography scans that can be used for 3-D planning
- > planning software that allows image fusion and design of current and emerging treatment delivery techniques
- > network capability (hardware and information system) that links all these features to allow transfer of data
- > specialist equipment as required for example, brachytherapy treatment unit and planning software; stereotactic planning and treatment delivery resources.

In terms of clinical technique, future planning needs to incorporate software that facilitates virtual simulation, image fusion, conformal or IMRT planning and remote licensing capabilities.

## Radiotherapy service delivery model

The planning of future radiotherapy services reflects directions contained within the SA Health Care Plan 2007-2016. This planning also takes into consideration population growth, current regional structure of health services, and the need for radiotherapy services to be integrated with other cancer services.

The *Statewide Cancer Control Plan 2011-2015* describes a cancer service delivery model aimed at optimising the experience and cancer outcomes for people with cancer, their families and carers. The cancer service delivery model maximises coordination and integration of cancer services to provide accessible, high quality, multidisciplinary, patient-centred cancer services for all South Australians<sup>17</sup>.

In determining the appropriate location and configuration of services, considerations include the relatively small size of the South Australian population, the geographical spread of people across the state, and the high infrastructure costs of establishing and maintaining radiotherapy services. Expansion of services needs to take into account increasing access for people in rural and remote areas, subspecialisation treatment access, the impact of new technologies on utilisation of radiotherapy, increasing treatment rates, maintaining quality outcomes, workforce supply, and maintaining the skills and knowledge of staff.

As part of a quality driven and comprehensive plan, radiotherapy services need to have clear linkages to relevant clinical subspecialties including surgery, oncology, rehabilitation, and palliative care. Although radiotherapy is used in the treatment of some non-malignant conditions, this is limited, and links to related specialty areas that are not considered to be as important from a service delivery perspective.

### Clinically appropriate waiting times

Tumour response to treatment and overall treatment outcome is proportionally dependent on timely access to radiotherapy services. Waiting times that extend beyond published current evidence based guidelines can sway clinical management away from radiotherapy, with resultant choices being less effective in terms of organ presentation, local control, and reducing recurrence rates.

People with cancer requiring routine “radical” treatment are prioritised according to clinical need and care is taken not to clinically disadvantage people by delaying access to treatment. Table 10 provides definitions for best practice and acceptable treatment times. It is noted that these times do not include the waiting time from referral to assessment from a radiation oncologist. It is understood that some very complex care requires a long time in the planning phase and that “nil wait” is unlikely to be achievable.

*Table 10: Definition of best practice and acceptable treatment timeframes*

|  |  |
|--|--|
| Best practice treatment timeframes are defined as: | Radical treatment within 14 days of being ‘ready to treat’<br>Palliative treatment within 2 days of being ‘ready to treat’<br>Emergency treatment within 24 hours of being ‘ready to treat’  |
| Acceptable treatment timeframes are defined as:    | Radical treatment within 28 days of being ‘ready to treat’<br>Palliative treatment within 14 days of being ‘ready to treat’<br>Emergency treatment within 48 hours of being ‘ready to treat’ |

Source: RANZCR. FRO. (2005). *Management of waiting lists for Radiation Therapy. Australia: RANZCR*

## Service accessibility

Radiotherapy treatment services have been located exclusively in metropolitan Adelaide because of the specialist nature of the treatment, establishment and running costs, and availability of the specialist radiotherapy workforce. The geographical spread of South Australia's rural population has discouraged the location of a radiotherapy facility within a country area. However, distance from radiotherapy services should not be a barrier to accessing high quality care. Transport and accommodation support is provided to country patients to facilitate access to metropolitan radiotherapy services. (For further details, see Appendix 6.)

Access to public radiotherapy services is based on the following principles:

- > Royal Adelaide Hospital (RAH) provides radiotherapy for people living in CALHN and all South Australians who require high complexity radiotherapy. It is estimated that 10% of all radiotherapy falls into this high complexity radiotherapy category
- > all children and young people needing radiotherapy are treated at the RAH
- > people living in the Northern Adelaide Local Health Network (NALHN) are treated at Lyell McEwin Hospital (LMH), unless the complexity and type of radiotherapy warrants treatment at RAH
- > people living in the SALHN have access to the private service at the Flinders Private Hospital and may choose to attend RAH or may be referred to the RAH if the complexity and type of treatment warrants it
- > people living in Country Health SA can choose to be treated at the RAH, LMH or Flinders Private Hospital
- > people from areas outside of SA (e.g. Northern Territory, Broken Hill and Mildura) will be treated at the RAH
- > subsidised accommodation is available for country patients attending for cancer treatment who live in eligible areas under the Patient Assisted Travel Scheme (PATS).

Follow-up is provided at some Country Health SA sites; and Country Health SA will explore the potential to provide radiation oncology assessment. Expansion of videoconferencing and telehealth capability will facilitate the process. Tele-medicine may prove valuable in overcoming the workforce barriers to providing appropriate outreach services.

Adelaide Radiotherapy Centre will continue to provide the bulk of general private radiotherapy services for public patients in the Southern Adelaide Local Health Network (SALHN), including some specialised services, and support the education and training of specialist radiotherapy staff.

Continued collaboration between the public and private sectors will deliver the best possible radiotherapy services for South Australians and assist in achieving the goal that all South Australians will have access to high quality radiotherapy services in a timely manner. Collaboration will particularly focus on a range of workforce areas including staff training, staff supervision and mentoring, and recruitment and retention strategies to ensure a sustainable workforce. The collaborative partnership opportunities will continue to be explored as expansion of radiotherapy services progresses.

Table 11: Radiotherapy service delivery model

| TITLE                                  | NATURE OF SERVICES   | SERVICE DELIVERY SITES   |
|--|--|--|
| <b>Speciality Services</b>             |  |  |
| Statewide Cancer Service (public)      | <ul style="list-style-type: none"> <li>&gt; Provides a statewide radiotherapy service</li> <li>&gt; Provides outreach radiation oncology services to cancer services within Local Health Networks in metropolitan and rural areas e.g. TQEH, RGH, NHS, Modbury and country general hospitals</li> <li>&gt; Links with private cancer services</li> <li>&gt; Provides all radiotherapy needs for paediatric cancer patients</li> </ul>  | Royal Adelaide Hospital, Lyell McEwin Hospital   |
| Adelaide Radiotherapy Centre (private) | <ul style="list-style-type: none"> <li>&gt; Provides outreach clinics in public cancer services</li> <li>&gt; Provides radiotherapy for privately referred people with cancer</li> <li>&gt; Provides some radiotherapy services for public patients in the SALHN</li> <li>&gt; Links with cancer services at RAH, TQEH, FMC, WCH</li> <li>&gt; Provides limited paediatric services</li> </ul>   | St Andrew's Hospital, Flinders Private Hospital, Tennyson Centre (Kurralta Park), Calvary Central Districts Hospital   |
| <b>General Cancer Services</b>         |  |  |
| Local Health Network Cancer Services   | <p>Metropolitan LHNs:</p> <ul style="list-style-type: none"> <li>&gt; Develop comprehensive cancer services in major hospitals, including surgery and chemotherapy</li> <li>&gt; Ensure appropriate referral and access to radiotherapy services</li> <li>&gt; Ensure collaborative links with other cancer service delivery points in smaller metropolitan and country hospitals, and the primary health care setting</li> <li>&gt; Country Health SA LHN:</li> <li>&gt; Radiation oncology consultation available in the Country General Hospitals and Port Pirie</li> </ul> | <p><b>CALHN</b> (including RAH, TQEH)</p> <p><b>SALHN</b> (FMC, RGH, NHS)</p> <p><b>NALHN</b> (LMH, Modbury, Gawler)</p> <p><b>Women's &amp; Children's Health Service</b> (statewide)</p> |

The radiotherapy footprint being included in current facility planning for the new Royal Adelaide Hospital (new RAH) is for six bunkers and a separate suite for brachytherapy. The linear accelerators currently located at the RAH will be moved to the new hospital. The brachytherapy suite should include a brachytherapy bunker, a separate entrance, shared theatre room and associated space for physics. One bunker within the service at the new RAH should be allocated for the commissioning and decommissioning of machines and for potential expansion into new technology as the opportunity arises. Footprint space for new technologies should also be considered such as proton therapy, which allows much greater specificity in dose distribution and is increasingly becoming a more affordable option.

### **Service integration**

The radiotherapy service delivery model aims to achieve the following standards in relation to service integration:

- > the treatment components of cancer care are co-ordinated so there are structured relationships with specialised radiotherapy services, and consultation is enhanced via outreach services and telehealth
- > cancer treatment regimens, including supportive care needs, are planned by a multidisciplinary team which include radiotherapy clinicians
- > clinical practice guidelines are consistently applied in all cancer services and, where appropriate, incorporate assessment for radiotherapy treatment
- > patients and their carers are supported by subsidised travel and accommodation for radiotherapy treatment.

### **Uptake of new technologies**

Although the equipment required for Intensity Modulated Radiotherapy (IMRT) is available, there are limitations restricting access to this treatment procedure. The radiotherapy workforce needs to be appropriately skilled in using IMRT. This procedure also takes longer than standard radiotherapy. At present IMRT does not attract a Medicare rebate as it is not approved by the Medical Services Advisory Committee, and this limits its use in private facilities.

## Workforce

The core radiotherapy workforce is comprised of three main groups: radiation therapists who deliver the radiotherapy, radiation oncology medical physicists (ROMPs) who oversee the technical planning and treatment and radiation oncologists, who make decisions about treatment strategies. In addition, nurses and allied health professionals provide essential expertise in supporting people undergoing radiotherapy, while technical support staff including biomedical engineers, are primarily responsible for equipment maintenance. Billing and administration staff also support the delivery of radiotherapy services.

The demand for the radiotherapy workforce is affected not only by the incidence of cancer but by the introduction of more complex technologies requiring more staff time (for both training and service delivery) and sub-specialisation as well as hours of equipment operation.

Factors that influence the supply of the radiotherapy workforce include the supply of newly qualified personnel, participation rates, flexible work arrangements, work practices including the use of time for other purposes, retirements for the existing workforce and relevant government policies.

### Key areas of workforce reform

South Australia has been involved in developing an agreed direction for strengthening the workforce capacity of radiation oncology services in Australia through participation on the National Radiation Oncology Reform Implementation Committee (RORIC). RORIC developed the Workforce Reform Framework November 2011<sup>18</sup> (Framework) to guide and inform the ongoing collaborative efforts of major stakeholders involved in building radiation oncology capacity in Australia over the next five to ten years. The Framework outlined an agreed direction and identified four key areas of workforce reform activity as described below.

#### 1. Workforce planning

The development of the radiotherapy workforce within SA needs to be undertaken using national plans and frameworks as guiding resources. However, it is recognised that work is needed to improve the evidence base that supports national radiotherapy workforce planning.

There is broad consensus that workforce planning and service development must be linked with infrastructure planning for radiotherapy facilities. The National Strategic Plan for Radiation Oncology<sup>19</sup> suggests two possible methods:

1. plan workforce numbers around each linear accelerator and its output in terms of the number of staff needed per hour of linear accelerator operation, and
2. use a population-based model to define workforce need.

However, as long as the number of linear accelerators is based on population need for radiotherapy, these two methods should yield consistent results.

As noted by the RORIC Workforce Reform Framework there are a range of views and workplace practices that make the existing workforce benchmarks contestable, including the differences in practices between public and private sector facilities. Furthermore, the current workforce benchmarks lack clear definitions and evidence that has been widely peer reviewed and may be out of date. In particular, the projected workforce requirements in the document *Planning for the Best: Tripartite National Strategic Plan for Radiation*

*Oncology 2012 – 2022*, June 2012<sup>20</sup> and The Allen Consulting Group 'Projecting the radiation oncology workforce' report (see Appendix 7) were based on the previous (higher) target utilisation rate for SA of 52.3%. Reportedly, many private radiotherapy facilities consider existing benchmarks too high and note that they fail to account for complexities in case mix.

The following table summarises workforce benchmarks recommended by the professional bodies of the three main radiotherapy workforce groups compared with full time equivalent (FTE) staffing levels in SA's public radiotherapy services in 2013. The benchmarks are based on the latest information about cancer incidence in SA and the number of linear accelerators currently in the system, which according to the calculations within this document is sufficient to provide the optimal rates of radiotherapy to cancer patients in SA to 2016.

Table 12: Existing workforce and benchmarks (2013) – SA Public sector only

| Group                                 | Benchmark  | Source (year)  | Benchmark | Actual as at March 2013*  |
|---------------------------------------|--|--|-----------|---------------------------|
| Radiation therapists                  | 1.06 FTE hour per linac hour<br>or<br>10 FTE per linac               | Australian Institute of Radiology (2001)<br>Australian College of Physical Scientists and Engineers in Medicine  | 50        | 54                        |
| Radiation oncologists                 | 1 FTE per 250 new case <sup>2</sup>                                  | Royal Australian and New Zealand College of Radiologists (RANZCR), Faculty of Radiation Oncology, Report on Contemporary Practice: the number of new patients per year, May 2011                                     | 7.6       | 7.9                       |
|                                       | 2 FTE per linac  | Royal Australian and New Zealand College of Radiologists (RANZCR), 2012 (referenced in Allen Consulting Group report 2012)   | 10        | 7.9                       |
| Radiation oncology medical physicists | 1.7 FTE per linac<br>(Brachytherapy physicists estimated separately) | Australian College of Physical Scientists and Engineers in Medicine (ACPSEM) workforce formula 2000<br>Oliver L, Fitchew R, Drew J. Australasian Physical & Engineering Sciences in Medicine Volume 24 Number 1 2001 | 8.5       | 15 <sup>(1),(2),(3)</sup> |

\* Source: Oracle OBIEE data warehouse and the CHRIS5 HRMS database (RAH) as at March 2013, verified with key stakeholders as at August 2013.

Notes:

(1) Ranges from 15 – 17 FTE depending on how many supernumerary staff are employed who are completing their PhD to become a Medical Physicist.

<sup>2</sup> The benchmark used in Canada is 1 FTE for 190 new patients.

- (2) Includes 1 headcount is part-funded (approx. 50%) by the Commonwealth Dept of Health and Ageing in recognition of the critical skills shortage in this discipline. This person is employed at the MeS1 level and is undertaking their PhD to qualify them as a Medical Physicist.
- (3) In addition there are 4 FTE Radiation Engineers and 1 FTE Physics Technical Officer. Engineers have different roles to medical physicists but report to the Manager Medical Physicists. RAH is the State Radiation Oncology provider. Medical Physicists also required to provide services to LMH since commissioning of new Linear Accelerator.

Current staffing numbers were determined in 2008 by the Delaney report (which is now due for a 5-year review). The radiation therapist workforce may need to be reviewed based on new techniques required for the Treatment Suite 2 machine at the LMH.

## **2. Workforce capacity building and skills development**

Effective workforce planning needs to take into account entry, retention and attrition factors, and variability in the levels of each. Improvements can be made in the supply and distribution of appropriately qualified staff by removing barriers to entry and implementing mechanisms to attract appropriately skilled staff, particularly to newly established radiotherapy services. Some of the main identified barriers to entry are listed below.

### Supervision

ROMPs and radiation therapists students require work place supervision. Due to increasing service demand, the ability to undertake supervision of clinical placements presents particular challenges.

### Remuneration

Remuneration has been cited by the ROMPs as a source of contention due to the considerable educational requirements to qualify to work in these roles.

### ROMP training pathway

The education and training pathway to qualify as a ROMP is highly extensive and intensive and may limit the attractiveness of potential candidates, given competing career pathways and associated remuneration.

## **3. Workforce policy, funding and regulation**

The impact of workforce policy, funding and regulation needs to be examined in order to pursue the necessary changes to improve the retention of appropriately qualified and skilled staff, including mature-age workforce. As with all professional groups, the opportunities within current industrial policies to enhance work-life balance and support staff with young families to maintain their working roles should be taken up where possible. This is particularly important in radiotherapy, given the high proportion of women in the workforce.

The *Commonwealth Strengthening Cancer Care Program* includes initiatives to address shortages in the radiation oncology workforce. The RAH – Medical Physics Department has been successful in gaining funding (2009 and 2013) to address the shortage of radiation oncology medical physicists.

The Commonwealth provides payments over the 3.5-year program, contributing to the salary of two ROMP registrar positions and a clinical preceptor position at the Royal Adelaide Hospital Cancer Centre. The State matches approximately 50% of the funding. However there is a risk that these two registrar and one preceptor positions are now temporary appointments as they are funded by short-term initiatives, and, if there is no further Commonwealth funding, this training pathway is at risk.

#### **4. Workforce reform**

Improving the efficiency and effectiveness of the available workforce can be achieved through business process improvements, effective application of new technology, clinical practice improvements and role re-design, such as advanced practice roles and inter-professional training.

Strategies being pursued to build capacity include advanced practice roles which will enable expansion opportunities for training on the job within the clinical practice area of cancer. In order to address a predicted national shortage of radiation oncologists in the next decade, the Department of Health and Ageing advised in January 2013 that it will allow radiation therapists to undergo extra training so they can take over some of the duties previously restricted to specialist radiation oncologists.

In addition, the expansion of inter-professional training is encouraged to not only improve clinical placement capacity but also models the team work required to effectively deliver multidisciplinary management of cancer. A framework for clinical supervision and on the job development of the workforce is being developed.

## Quality and safety

The goals and approaches to quality and safety in radiotherapy services are in line with those of the cancer control quality program. They aim to provide the best possible quality of care for patients in the safest possible environment.

To inform quality and safety programs within radiotherapy services, national Radiation Oncology Practice Standards<sup>3 21</sup> have been developed. There are sixteen standards grouped into three sections which focus on facility management; treatment planning and delivery; and safety and quality management. These standards are incorporated in the South Australian agenda for quality and safety in radiotherapy services, and this agenda includes:

- > technical aspects relating to radiation safety and dose calibration
- > processes that are in place to report and respond to incidents and complaints, and monitor patient satisfaction
- > comparing accesses and clinical outcomes through benchmarking.

### Radiation safety and dose calibration

The success of radiotherapy treatment is dependent on the accuracy of the delivery of specified doses of radiation to selected targets, both in tumours and normal tissues. The margin between tumour control and induced complications is frequently a small one. Therefore the cure rate for a particular treatment protocol relies heavily on the accuracy of the initial calibration of the linear accelerator and its ongoing consistency in delivering the same dose under the same standard conditions.

Dosimetry is used to check that the dose of radiation delivered to the patient is accurate and appropriate. It ensures the risks of accidental dose errors are minimised, leading to the best possible results from treatment.

Various international and Australian studies have highlighted the advantages of conducting a comparison of radiation dose delivery (dosimetric intercomparisons) across multiple radiotherapy centres. These include the identification of systematic errors, as well as an increase in the likelihood of the detection of major treatment delivery errors. The regular, independent, tertiary dosimetric survey of linear accelerators has been identified as a significant enabler in reducing the risk of dosimetry errors occurring.

In February 2011 the Australian Clinical Dosimetry Service (ACDS) was established to provide a national integrated approach to promoting safety and quality in radiotherapy, which is expected to lead to further improvements in radiotherapy treatment outcomes. The ACDS will help to maintain the quality of radiotherapy in Australia and provide a national approach to radiation measurements, making radiotherapy more consistent across the country and safer for patients. SA Health will participate in direction setting and compliance in this area. This service was initially introduced for a three year trial period and is currently being evaluated to assess its function beyond 2014. Both public and private services have participated in this assessment.

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<sup>3</sup> Development and consideration of options for implementation of assessment against the Radiation Oncology Practice Standards is being considered by the Commonwealth

## Reporting and responding to incidents, monitor patient satisfaction and respond to complaints

### Incident reporting

Robust systematic incident reporting systems include the following components:

- > defining the incidents that require reporting
- > defining a clear pathway of reporting
- > encouraging all disciplines in the oncology service to report all incidents (including near misses)
- > defining specific staff for quality assurance
- > increasing staff participation in incident discussions
- > identifying an appropriate communication process to inform all staff about incidents and resolutions.

In SA Health, the Safety Learning System (SLS) is the reporting system for both patient and staff. There are guidelines for reporting incidents and how they are to be managed and investigated and the appropriate action taken. The nominated person responsible for incidents in the area where the incident occurred is automatically notified, and, depending on the level of the incident, other nominated staff members are also advised. The Safety and Quality Unit in the Department for Health and Ageing are advised of all reported incidents across SA Health. The Safety and Quality unit in each LHN monitors and analyses all incidents and near misses which occur in their own network. Action is taken as appropriate.

### Monitoring patient satisfaction and responding to complaints

Within South Australia, consumers have identified current issues experienced by patients in relation to their therapy including delays in treatment, poor access and equity of access to radiotherapy services, ageing equipment, and out of date methodologies as being particular areas of concern to consumers<sup>22</sup>. Specific concerns include:

- > Treatment compliance with best practice clinical guidelines
- > Timeliness of access to radiation oncology:
  - from referral to start of treatment
  - on treatment day – the wait from appointment time to actual treatment
- > Equity of access in relation to:
  - type of cancer
  - rural patients
  - indigenous patients
  - culturally and linguistically diverse patients
  - age groups
  - gender.

An appropriate suite of quality indicators includes the right balance between those indicators that have a specific focus on activity; the efficiency and efficacy of treatments and process; and indicators that address broader system integration including continuity of care, responsiveness, accessibility and the patient experience (with a focus on feedback and satisfaction). Cancer Voices SA<sup>23</sup> identified a series of performance indicators relevant to consumer perspectives including:

- > a South Australian benchmark rate (currently 47.4%) of newly diagnosed cancer patients receiving radiotherapy
- > the number of new patients who commence radiotherapy
- > the percentage of patients treated within best practice clinical guidelines for radiotherapy
- > waiting times for patients
- > the percentage of patients commencing treatment within an accepted standard timeframe
- > the number or percentage of patients who commence and complete radiotherapy treatment in categories where access and equity may be a concern, such as rural, indigenous and culturally and linguistically diverse patients
- > the percentage of patients commencing treatment with satisfactory provision of information and opportunity to ask questions.

The SLS also has a mechanism for customer feedback. A customer complaints officer or SA Health staff members can enter the feedback into the SLS and an email is forwarded to the manager of the exact location in which the notification relates for investigation and a response. There are time standards within which responses to feedback are required.

### **Monitoring access and clinical outcomes**

In order to monitor performance and strive for continuous quality improvement, a standard collection of radiotherapy data is required. The use of relevant and robust indicators to measure and monitor the performance of services is integral to effective health service delivery. Benchmarks and performance indicators that provide useful measures of workload and service performance allow cross-site comparison against best practice guidelines. They can also be used to continuously monitor for quality improvements and help identify bottlenecks or other problems.

The sophisticated and complex machinery required to deliver radiotherapy warrants support from data systems that streamline and document equipment quality assurance procedures. Appropriate quality assurance software must be available to medical physicists (such as ARGUS) to support carriage of their role.

It has been proposed that SA Health and the LHNs progressively work towards:

- > developing and implementing a statewide radiotherapy quality program that includes KPIs
- > establishing a statewide radiotherapy reporting cycle incorporating a national minimum data set and radiotherapy information system
- > establishing IT solutions and support for radiotherapy services; and
- > monitoring and reviewing radiotherapy waiting times.

**National minimum data set**

A recommended radiation oncology minimum data set was developed by the Service Planning Group of the Radiation Oncology Reform Committee (RORIC). As this is yet to be endorsed by the Commonwealth, it has not been implemented nationally.

The main aim of developing the national minimum data set (NMDS) is to enable the reporting of comparable wait times for access to radiotherapy treatment across public and private sectors. National collection of this NMDS would inform the public, health care providers and decision-makers, with the intention of improving patient outcomes. In September 2011 South Australia participated in the Australian Institute of Health and Welfare (AIHW) field test of the draft NMDS.

Currently, work is being undertaken on options for implementing the radiotherapy waiting times data set specification (DSS) including obtaining estimates of costs for a potentially reduced set of data items. The Radiotherapy Waiting Times Working Group is considering a more feasible subset of data for collection, as the full data set is costly to collect. This includes consideration as to whether the information, once collected, should be publicly reported, and what the risks and benefits might be. The DSS is not mandated for collection but is recommended as best practice.

**Aboriginal and Torres Strait Islander cancer management monitoring system**

The South Australian Health and Medical Research Institute (SAHMRI) is participating in the development of an advanced cancer and cancer management monitoring system for Aboriginal and Torres Strait Islander people. This includes provision for data collection on radiotherapy.

## Research

The *Statewide Cancer Control Plan 2011-2015* recognises that research has a vital role in cancer control, from prevention through to end-of-life care<sup>24</sup>. Effective monitoring and evaluation of cancer services depends on sound research evidence. Clinical and other health service leaders are attracted to positions where good opportunities exist for research. It is also recognised that involvement in clinical trials leads to a higher quality of care.

SAHMRI is involved in a number of cancer research initiatives as part of the Beat Cancer Project, which supports the development of high quality cancer research programs in SA. SAHMRI will be running the Central Coordination Unit of the SA Clinical Cancer Registry from July 2013. This unit will collect clinical data on cancers treated in SA major public centres, including cancer types, stages, other prognostic indicators, and treatment. Treatment data will relate to neo-adjuvant and adjuvant radiotherapy, including fractions, doses and target sites. This will enable monitoring of appropriateness of radiotherapy, associations with survival, and further in-depth clinical and translational research.

SAHMRI is also co-funding SA NT DataLink (a high quality data linkage service to support research, policy development, service planning and evaluation). This facility has been used to link colorectal cancer data from the SA population cancer registry, plus staging data, to administrative treatment databases, including data on radiotherapy exposures (fractions, doses, target sites) from public and private radiotherapy centres. The linked dataset has been used to assess appropriateness of care, including radiotherapy, at a population-based level.

Clinical trials are an integrated component of research that supports the delivery of cancer clinical services. Involvement in clinical trials brings benefits in care and outcomes for people with cancer, and contributes to and strengthens new knowledge about cancer treatment options. It is estimated that only 2 to 3% of adults with cancer participate in clinical trials throughout Australia, although up to 20 to 30% may be eligible<sup>25</sup>. Participation in national and international trials of cancer treatment utilising radiotherapy can be increased through improved awareness of clinical trials among people with cancer, as well as improved awareness among members of the radiotherapy team delivering cancer care.

Cancer Voices SA<sup>26</sup> has developed a statement on consumer values on cancer research. It advocates that cancer consumers should be involved in all stages of cancer research. Consumers have a different perspective to bring to determinations about cancer research including practical experiences, particular views on cancer issues and priorities, and ideas about what might work and how.

## Directions at a glance

Priority needs to be given to achieving access to radiotherapy for all those people with a cancer diagnosis who would benefit from it. This will involve a focus on expanding the radiotherapy infrastructure and increasing the workforce, with an increased focus on achieving quality outcomes.

The following table sets out the key directions described within this plan.

| Statewide initiatives                |  |
|--------------------------------------|--|
| 1.1                                  | Develop the role of the Cancer Clinical Network in providing advice on implementation of this Plan   |
| 1.2                                  | Develop and implement a consistent radiotherapy monitoring program   |
| 1.3                                  | Strengthen service partnering arrangements across the state  |
| 1.4                                  | Implement an asset management plan for radiotherapy in SA, including a planned replacement program within SA Health's major equipment program  |
| 1.5                                  | Continue to work toward meeting the nationally endorsed optimal radiotherapy utilisation rates and access benchmark                            |
| Service development initiatives      |  |
| 2.1                                  | Staged increase in number of linear accelerators across the state.   |
| 2.2                                  | Develop radiotherapy capacity in Northern Adelaide Local Health Network  |
| 2.3                                  | Develop cancer services in Local Health Networks that link in with radiotherapy services   |
| 2.4                                  | Develop culturally safe protocols for caring for Aboriginal people in radiotherapy services  |
| 2.5                                  | Develop telehealth and telemedicine initiatives to support outreach radiotherapy services  |
| 2.6                                  | Develop additional accommodation for rural patients and support persons with the Northern Adelaide and Country Health SA Local Health Networks |
| 2.7                                  | Promote PATS amongst GPs and consumers   |
| Collaborative enablers               |  |
| 3.1                                  | Explore public / private partnership opportunities to develop additional radiotherapy capacity in South Australia                              |
| 3.2                                  | Develop an information strategy for radiotherapy   |
| 3.3                                  | Develop and implement an education strategy to improve radiotherapy referrals  |
| Workforce initiatives and enablers   |  |
| 4.1                                  | Develop workforce initiatives that support staff working across multiple sites and in outreach services  |
| 4.2                                  | Develop advance practice roles in the range of radiation oncology disciplines  |
| 4.3                                  | Formalise training programs in the field of radiotherapy   |
| 4.4                                  | Implement strategies to recruit and retain key workforce personnel   |
| Quality, data, reporting initiatives |  |
| 5.1                                  | Develop and implement a statewide radiotherapy quality program that includes KPIs  |
| 5.2                                  | Establish a statewide radiotherapy reporting cycle incorporating a national minimum data set and radiotherapy information system               |
| 5.3                                  | Establish IT solutions and support for radiotherapy services.  |
| 5.4                                  | Monitor and review radiotherapy waiting times  |
| Research and education initiatives   |  |
| 6.1                                  | Develop collaborations in cancer research that incorporate treatment with radiotherapy   |
| 6.2                                  | Establish tertiary training programs in South Australia to support development of the radiotherapy workforce                                   |

## Appendix 1: Radiotherapy treatment and types glossary

### Radiotherapy types

#### External beam radiation

External beam radiation is the most common form of radiotherapy treatment for people with cancer. It is delivered predominantly by a linear accelerator and involves applying a uniform dose of high energy radiation to a tumour site.

Some difficulty can arise when administering radiation as some tumours are constantly moving within the body, for example movement caused by breathing. Hence, the exact location of the tumour may change between the time of scanning and actual treatment. The specificity of the techniques delivered by linear accelerators is enhanced with a multi-leaf collimator. Intensity Modulated Radiation Therapy (IMRT) is dependent on a multileaf collimator. IMRT is a valuable technique to use when a tumour adjoins a critical structure, such as the spinal cord, as it improves the ability to shield out and protect normal tissue from the radiation dose.

Image Guided Radiation Therapy (IGRT) uses two- and three-dimensional images of the person's organs in the treatment position at time of treatment, optimising the accuracy and precision of the radiotherapy and minimising damage to the surrounding tissues.

The insertion of gold seed (fiducial) markers is increasingly being used with IGRT and IMRT. The markers are used as a fixed standard of reference for comparison or measurement every time a patient has radiotherapy. This allows the radiation to be delivered with precision and accuracy which greatly diminishes injury to the surrounding organs and increases the suitability of external beam radiation therapy. For example, the prostate is a mobile organ with its motion dependent on how full the bladder and bowel are. In cases of prostate cancer, the seed markers are inserted into the prostate which allows the linear accelerator to be adjusted to target the prostate. The machine is moved before each treatment to ensure the prostate is targeted and normal tissues are avoided.

#### Brachytherapy

High dose rate (HDR) brachytherapy involves the placement of a high energy radiation source (usually Iridium-192) inside the body near the tumour for a short period of time.

Low dose rate (LDR) brachytherapy, such as seed implantation, places radioactive materials inside the body for extended periods of time.

#### Conformal radiation therapy

Three-dimensional (3D) conformal radiation therapy is a technique where the beams of radiation used in treatment are shaped to match the tumour.

#### Therapeutic radioisotopes

Therapeutic radioisotopes have a limited role in radiotherapy, although new advances in systemic radionuclide therapy have increased the number of treatment options available. They are particularly useful in situations where external beam radiotherapy options have been exhausted and normal tissue tolerance has been reached. Therapeutic radioisotopes are administered by intravenous injection.

An example is the radioisotope Strontium-89, used for the relief of bone pain in people with painful skeletal metastases.

**Stereotactic radiosurgery**

The linear accelerator can also be used in stereotactic radiosurgery. Most commonly used in the treatment of brain tumours, stereotactic radiosurgery does not actually involve surgery, rather is a non-invasive method of delivering a precise dose of intense radiation to a tumour. Stereotactic radiosurgery offers an important alternative for many brain tumours, both benign and malignant, which have traditionally been treated through complicated invasive surgical procedures. This treatment technique can reach virtually any area within the brain, including those that cannot be accessed with conventional surgery.

**Proton therapy**

Proton therapy is a special form of radiation treatment which utilises particles to irradiate diseased tissue. The chief advantage of proton therapy is the ability to precisely localise the radiation dose when compared with other types of radiation therapy. Due to their relatively large mass, protons scatter less easily and hence the treatment and cell damage is focused on the tumour volume with significantly less impairment to the surrounding tissues. Clinically, this means that tumours in unfavourable locations, particularly paediatric patients with brain and solid tumours, maybe treated with theoretically less risk of long term sequelae. It therefore has a unique place in the radiation treatment options.

The use of proton therapy is gaining status internationally, however its cost relative to other forms of radiotherapy has prohibited its uptake. No fully clinical facilities exist in the southern hemisphere. As unit costs and footprint size become more competitive, this form of therapy is likely to gain greater interest.

SA has put a proposal to the Federal Government, as part of the funding case for SAHMRI-2, to house a proton therapy clinical and research centre in the SAHMRI-2 building, to provide Proton Therapy for all Australians, as well as research capacity.

**Radiation treatment planning****Two-dimensional treatment planning systems**

Current two-dimensional (2-D) treatment planning uses an X-Ray simulator to mimic the functions and motions of a radiotherapy treatment unit and a diagnostic X-ray tube to simulate the radiation properties of the treatment beam. The simulator allows the beam direction and treatment fields to be determined to encompass the target volume and spare normal structures excessive radiation. A 2-D computer treatment planning system is used for calculation of dose distributions for X-rays and electron treatment beams. It is of note that planning computers need to be updated every five years.

**Three-dimensional treatment planning systems**

A three-dimensional system more clearly verifies tumour volume and allows more accurate calculation of dose distribution within the treatment volume. Such systems are essential for planning treatments using stereotactic radiosurgery and conformal radiotherapy.

**Virtual simulation using computerised tomography scans**

A number of two-dimensional computerised tomography (CT) cuts are taken and the image manipulated by computerised technology to form either a three-dimensional reconstruction of the region of interest or, alternatively, a digitally reconstructed

radiograph which can be processed to become available as a radiographic view. This process requires the CT to be fitted with a flat top that duplicates the treatment tops on the linear accelerators.

## Specialised technologies in radiotherapy

### Stereotactic radiosurgery

Stereotactic radiosurgery involves the closed skull destruction of a defined intracranial target with a single high dose of ionising radiation. It is intended to deliver a clinically significant dose of radiation within a small three-dimensional intracranial target while minimising exposure to surrounding tissues.

Initially used to treat small arterio-venous malformations in areas unsuitable for surgical ablation, other indications have now arisen. These include management of pituitary tumours, meningiomas, acoustic neuromas, ependymomas, medulloblastomas, malignant gliomas, craniopharyngiomas, paediatric brain tumours and, more latterly, brain metastases. Close proximity to neurosurgical services is essential.

This facility has been available in South Australia since 1993 and is being developed for uses beyond the brain. Modern systems have the capacity to also treat additional sites in the thorax, abdomen and pelvis, which improves the cost effectiveness.

### High dose rate brachytherapy

High dose rate (HDR) brachytherapy is predominately used to deliver boost doses to small tumours while sparing surrounding critical structures and normal tissues. It enables equivalent doses of radiation in just a few minutes by inserting and then removing the radioactive beads.

HDR brachytherapy has additional uses in radical treatment of gynaecological cancers and also in the palliation of obstructing tumours of the oesophagus and bronchus. This modality is operational within the public sector.

### Low dose rate brachytherapy

Low dose rate (LDR) brachytherapy uses sources of low activity over long irradiation periods. The prescribed dose is delivered to the patient during several hours or days.

A special case of LDR brachytherapy is permanent interstitial brachytherapy. When interstitial treatment is applied via LDR brachytherapy, in the majority of the cases the radioisotope is inserted permanently into the tumour. Depending on the tumour volume, isotopes with different half-lives are chosen. Iodine-125 is one of the most used isotopes for permanent implant (particularly for prostate cancer) having a 60 days half-life. The LDR brachytherapy gives a cell survival curve similar to an infinite number of small fractions, and this is ideal for the radiobiology of a slowly proliferating tumour such as prostate cancer.

### Gated radiation therapy

This is a method of delivering a dose to a well-defined area that is mobile within the patient. Mobility may be a function of the respiratory cycle or some other biological cycle. These processes are designed to limit the exposure of the surrounding tissue, for example using an electronically controlled process so that the linear accelerator may only irradiate when certain physiological conditions are met. As replacement linear accelerators are installed in SA over the next two to three years, there will be capacity to include gated radiation therapy as an optional extra should research evidence support its

usage.

### **Four-dimensional computerised tomography**

A significant issue in computerised tomography is the potential for blurring of images due to organ motion. This motion is due to a range of factors such as respiratory, cardiac and gastrointestinal motion. Four-dimensional (4-D) computed tomography correlates computerised tomography to respiration to allow construction of images that minimises the impact of motion-related blurring. This has significant implications not only for diagnostic imaging, but also for radiotherapy planning where organ motion can have a large and undesirable effect on the quality of the radiotherapy plan delivered.

A commonly used concept in 4-D radiotherapy is that of a surrogate for the movement or position of an organ, such as fiducial markers or bony anatomical points.

### **Intensity modulated radiation therapy**

Intensity modulated Radiation therapy (IMRT) is valuable when a tumour is next to critical structures such as the spinal cord. A multileaf collimator is required for IMRT. Accurate delineation of the treatment volume using computerised tomography scanning, MRI and PET scanning and reconstruction using a 3-D planning system are also required. The early results in disease control while sparing critical structures have been impressive in managing head and neck tumours.

### **Image guided radiation therapy**

Image guided radiation therapy (IGRT) uses imaging to aid the radiotherapy process, reduce the irradiated margins and optimise treatment. It targets the tumour prior to or during treatment. Standard IGRT methods use surface and skin markers, portal imaging, electronic portal imaging, fluoroscopy, and conventional and/or cone beam computerised tomography.

In addition, several forms of IGRT are available at present, depending on the imaging technology used. X-rays, magnetic resonance or ultrasound can all be used for image guidance in radiotherapy. Systems can also be based on localisation and tracking of special markers; for example, seeds, coils, infrared markers, clips or electromagnetic beacons.

### **Ultrasonography**

Ultrasonography (US) is becoming a greatly accepted and widely implemented tool for image guided radiotherapy. The most common treatment sites employing ultrasounds for image guidance are prostate and gynaecology. In prostate cancer, US is used for daily target localisation before radiotherapy treatment to correct organ motion and setup errors via specialised US-IGRT systems which allow for real-time visualisation of the prostate gland. The localisation and positioning adjustment are usually done within ten minutes, making US-guided IGRT a safe and feasible method for daily target localisation prior to treatment. In addition, the capability of ultrasound to distinguish soft tissue structures and the high specificity in differentiating solid from fluid-filled structures makes it a good candidate for breast imaging. New ultrasound-based systems include an abdominal ultrasound probe, allowing for IGRT for liver and pancreas treatment.

**Beacon guided radiotherapy**

One of the latest technological implementations in IGRT is the Calypso system (Calypso Medical Technologies, Inc. (now incorporated into Varian)) which uses a GPS for the Body technology in order to provide real-time, continuous and accurate information about tumour location during external beam radiotherapy. The localisation system is based on three miniature electromagnetic devices (beacon transponders) which are implanted into the tumour and allow for non-ionizing treatment guidance throughout therapy. The electromagnetic transponders of about 8.5 mm length are able to detect and display organ location and movement with a sub-millimetre localisation accuracy permitting both inter- and intra-fraction patient repositioning with high precision. The electromagnetic array of the main device contains an energy source which is able to excite the transponders and receivers, which detect the individual radiofrequency signals of the transponders for location coordinate identification.

**Total body irradiation**

Total body irradiation (TBI) is systemic radiotherapy treatment in which a relatively small number of widely dispersed/circulating radiosensitive cells are sterilized. It is used as part of the preparative and conditioning schedule for haematopoietic stem cell transplantation used for the treatment or prevention of leukaemia relapse and multiple myeloma. TBI is generally used in conjunction with high-dose cytotoxic drugs to destroy patient's bone marrow and leukaemic cells. Sterilising the lympho-haematopoietic stem cells and lymphoid cells also prevents rejection of donor cells when allogeneic (that is, genetically non-identical) bone marrow transplantation is used. It also creates spaces in bone marrow for donor cells to establish themselves and grow.

**Multileaf collimator**

A multileaf collimator is an important tool in radiotherapy dose delivery. It is a device attached to a linear accelerator that is made up of individual "leaves" of a high atomic numbered material, usually tungsten, which can move independently in and out of the path of a particle beam in order to block it. A multileaf collimator is used to shape radiotherapy treatment beams to match the borders of the tumour being targeted. The multileaf collimator is now widely used in Intensity Modulated Radiation Therapy.

**Emerging radiotherapy technologies and delivery methods****Multiple daily fractions**

In an effort to improve the therapeutic ratio, novel dose fractionation schedules have been developed for different tumour sites. These regimens have included hyper fractionation, accelerated fractionation, and accelerated hyper fractionation schedules. This is not practised in South Australia since similar outcomes can be achieved with once daily fraction radiotherapy with concurrent chemotherapy.

**Intra-operative radiotherapy**

The delivery of radiotherapy to tumours during surgery is still considered experimental and involves a single high dose of radiation at the time of surgery as adjuvant therapy in tumour resection. It is sometimes used during surgery for breast and colon/rectal cancers.

### **Combined hypothermia and radiotherapy**

This form of combined modality therapy is being trialled in the treatment of some deep-seated tumours.

### **Electronic brachytherapy**

Electronic brachytherapy uses miniature electronic X-ray sources (that is, a miniature X-ray tube) instead of radioisotopes. The unit also has user-adjustable dosimetric properties and potentially lessens radiological exposure of staff. At this point in time, it is generally considered an unproven clinical application. There are a range of concerns about its use including the lack of international calibration protocols available, output variability amongst X-ray sources, and the large unit size compared to other forms of ionising radiation.

### **Adaptive radiotherapy**

Adaptive radiotherapy involves changing the radiation treatment plan delivered to a patient during a treatment session to account for temporal changes in anatomy (for example, tumour shrinkage, weight loss or internal motion) or changes in tumour biology/function (such as hypoxia).

Cone beam computerised tomography units attached to modern linear accelerators acquire scans that can localise the position of a tumour in 3-D and register changes in tumour and patient anatomy during treatment. This assists in minimising adverse effects on healthy tissues by guiding the treatment beam or by modifying/adapting the treatment plan (for example, dose distribution, margins, number of fractions) based on the current patient anatomy.

Cone beam computerised tomography imaging is expected to yield better tumour control but increases clinical workload and short-term treatment costs.

### **Intensity modulated arc therapy**

Next generation arc therapy techniques have established new standards in radiation planning and delivery, both in the view of technical advancements and clinical radiobiology. Intensity modulated arc therapy (IMAT) is a dynamic treatment achieved with a single 360 degree rotation of the gantry around the patient (similar to tomotherapy) which simultaneously changes the rotation speed of the gantry, the dose rate, and the shape of the treatment field conformal to the tumour volume, using multileaf collimators.

The uninterrupted rotation of the gantry during treatment, together with the simultaneous aperture changes, considerably decreases overall treatment time as compared to conventional Intensity Modulated Radiation Therapy, therefore improving patient throughput. Besides reducing treatment time, the radiobiological advantages include dose reduction without compromising target coverage, and reducing the impact on surrounding organs.

### **Tomotherapy**

Tomotherapy is a type of radiotherapy in which the radiation is delivered 'slice-by-slice', differing from other forms of external beam radiation therapy in which the entire tumour volume is irradiated at one time. It integrates mega-voltage helical fan-beam computerised tomography and radiation treatment unit (linear accelerator) into a single device. The unit is similar in appearance to a conventional computerised tomography scanner. As the patient couch travels through the gantry, a rotating ring-mounted mega-voltage source delivers a helical beam pattern. This unique helical delivery pattern minimises normal tissue irradiation. A specially designed 64-leaf binary multileaf collimator shapes the treatment beam to yield a desired dose distribution. The unit can deliver highly conformal dose patterns as well as modulated (non-uniform) radiation intensities, as used in Intensity Modulated Radiation Therapy.

### **Magnetic resonance imaging linac**

A linear accelerator with an integrated magnetic resonance imaging (MRI) unit to provide 3-D imaging during treatment represents the latest development in the area of hybrid machines for Image Guided Radiation Therapy and adaptive radiotherapy. The advantage of this system is that MRI can provide real-time image guidance with high resolution soft tissue-based, online position verification and monitoring during radiation treatment. MRI provides good soft tissue visualisation as well as cine-imaging at a rate sufficient to track all motion – even breathing-related movements – in real time. By integrating high-quality MRI with modern accelerator technology, tissue can be tracked online and beams can be guided to their moving and deforming targets potentially with sub-millimetre precision.

### **Alternative treatment strategies**

Research and development in the areas of apoptosis (programmed cell death), gene therapy and immunotherapy is being undertaken that might influence future radiation treatment. Predictive assays, the genetic profiling of tumours, is another emerging area that will support targeted radiotherapy treatment.

## Appendix 2: Capital replacement program

The ROHPG Scheme reimburses the cost of expensive eligible radiation oncology equipment to public and private radiotherapy facilities. Medicare Australia makes ROHPG payments to approved providers monthly, based on the number of eligible services claimed in the previous month and the ROHPG rates for each service.

It is a condition of ROHPG funding that payments be used solely for refurbishing or acquiring radiation oncology equipment in the service location.

ROHPG funding is available for a range of equipment including linear accelerators, computerised tomography (CT) interfacing planning computers, simulators and brachytherapy units. The following equipment is eligible for ROHPG funding:

- > CT Interfacing Planning Computer System with 3 or less workstations
- > CT Interfacing Planning Computer System with 4 or more workstations
- > Single Photon Linear Accelerator (SPLA) with Electronic Portal Imaging (EPI) and Multileaf Collimator (MLC)
- > Dual Modality Linear Accelerator (DMLA) with Electronic Portal Imaging (EPI) and Multileaf Collimator (MLC)
- > High Dose Rate (HDR) Brachytherapy
- > Low Dose Rate (LDR) Brachytherapy (or seed brachytherapy)
- > Simulators – without CT, with CT capability and CT machines with simulation capability.

The ROHPG capital balance and reimbursement rate is determined at the time each machine is approved for funding. The capital balance is reduced by the reimbursement amount on a per service basis. Once the capital balance reaches zero, ROHPG is no longer paid. The discontinuation of ROHPG payments does not affect the Medicare Benefit payable for the service.

Radiotherapy machines that are eligible for ROHPG reimbursement and their expected useful life are shown in Table 13.

*Table 13: Eligible radiotherapy machines and expected life*

| Equipment                                  | Expected life (years) | Expected life (services) |
|--|-----------------------|--------------------------|
| Single Photon Linear Accelerators          | 10                    | 82,800                   |
| Dual Modality Linear Accelerators          | 10                    | 82,800                   |
| Simulators                                 | 10                    | 15,000                   |
| CT Planning Computers                      | 5                     | 7,500                    |
| Automatic afterloading Brachytherapy (HDR) | 10                    | 1,500                    |
| Manual Brachytherapy (LDR)                 | 5                     | 200                      |

Information on the national Radiation Oncology Health Program Grants Scheme is available from the [Health Programs Grants website](#).

## Appendix 3: Radiotherapy equipment

### Current radiotherapy equipment in use in South Australia.

| RT Resources:                                   | RAH Cancer Service – Radiotherapy Service |                   | Adelaide Radiotherapy Centre        |                                     |                                     |                           |
|---|---|-------------------|-------------------------------------|-------------------------------------|-------------------------------------|---------------------------|
|   | RAH campus                                | LMH campus        | South Terrace campus                | Tennyson Centre                     | Flinders Private campus             | Calvary Central Districts |
| Linear Accelerator                              | 4   | 2                 | 2                                   | 2                                   | 2                                   | 1                         |
| with MLC  | 4   | 2                 | 2                                   | 2                                   | 2                                   | 1                         |
| with EPI  | 4   | 2                 | 2                                   | 2                                   | 2                                   | 1                         |
| Record & Verify system                          | Varian / ARIA 8.8                         | Varian / ARIA 8.8 | Mosaiq V4.2                         | Mosaiq V4.22                        | Mosaiq V4.2                         | Mosaiq V4.2               |
| Cone Beam CT/OBI for IGRT                       | 2   | 2                 | 1                                   | 2                                   | 2                                   | 1                         |
| compatible with Cone Beam CT/OBI                | 1   | 2                 | 2                                   | 2                                   | 2                                   | 1                         |
| IMRT beam capability                            | 3   | 2                 | 2                                   | 2                                   | 2                                   | 1                         |
| CT Simulator (make/model)                       | 1   | No                | Siemens wide bore CT scanner        | Siemens 6 slice scanner             | Siemens 6 slice scanner             | Siemens 16 slice scanner  |
| Record & Verify System                          | 4   | 2                 | 3                                   | 2                                   | 2                                   | 1                         |
| Electronic oncology record                      | ARIA 8.8                                  | ARIA 8.8          | Mosaiq V4.2                         | Mosaiq V4.2                         | Mosaiq V4.2                         | Mosaiq V4.2               |
| Planning Computer Systems                       | 5   | 2                 | 4                                   | 3                                   | 4                                   | 3                         |
| Planning Computer Systems licences/workstations | 17  | 3                 | Limitless                           | Limitless                           | Limitless                           | Limitless                 |
| LDR Seed Brachytherapy                          | Yes                                       | No                | Yes**<br>VARI Seed Prostate Program | Yes**<br>VARI Seed Prostate Program | Yes**<br>VARI Seed Prostate Program |                           |
| LDR Selectron Brachytherapy Unit                | Yes                                       | No                | No                                  | No                                  | No                                  | No                        |
| HDR Brachytherapy                               | Yes                                       | No                | No                                  | No                                  | No                                  | No                        |
| Superficial X-ray                               | 1   | No                | 1                                   | No                                  | No                                  | No                        |
| Mould Room                                      | Yes                                       | Yes               | Yes                                 | Yes                                 | Yes                                 | Yes                       |
| MRI/PET fusion used for planning tumour types?  | Yes                                       | Yes               | Yes                                 | Yes                                 | Yes                                 | Yes                       |

\*\* LDR Seed Brachytherapy provided by ARC – treatment delivered at Calvary North Adelaide Hospital and the Tennyson Centre day surgery facility.

## Appendix 4: Radiotherapy service planning parameters for SA

| Utilisation Parameters   | RAH  |      |      | ARC           |       |       |                  |       |       |                                  | Average | Used in calculations  |
|--|------|------|------|---------------|-------|-------|------------------|-------|-------|----------------------------------|---------|-----------------------|
|  |      |      |      | South Terrace |       |       | Flinders Private |       |       | Tennyson Centre                  |         |                       |
|  | 2007 | 2008 | 2009 | 2007          | 2008  | 2009  | 2007             | 2008  | 2009  | 2009                             |         |                       |
| Operating hours per day  | 8    | 9    | 9    | 9.6           | 10    | 11    | 8.5              | 10    | 11    | 11.5                             | 8.5     | 8.5                   |
| Attendances/fractions per course                               | 26.7 | 29   | 30   | 21            | 21    | 20.9  | 21               | 20.1  | 19.8  | 20.1                             | 21      | 18.3 new, 10 re-treat |
| Total operational days per year                                | 244  | 247  | 247  | 252           | 251   | 251   | 252              | 251   | 251   | 106<br>(42starts XRT on 27/7/09) | 248     | 248                   |
| Total annual operating hours                                   | 1827 | 2223 | 2223 | 2419          | 2510  | 2761  | 2142             | 2510  | 2761  | 1219                             | 2108    | 2108                  |
| Attendances/fractions per hour per machine                     | 4    | 4    | 4    | 4.5           | 4.5   | 4.5   | 4.5              | 4.5   | 4.5   | 4.5                              | 4.2     | 4.5                   |
| Total courses  | 1971 | 2026 | 2083 | 1720          | 1659  | 1481  | 1236             | 1124  | 1659  | 217                              | -       |                       |
| New courses per machine  | 345  | 410  | 366  | 443           | 415   | 361   | 478              | 429   | 422   | 177                              | -       |                       |
| Re-treatment courses   | 416  | 383  | 434  | 130           | 138   | 132   | 140              | 134   | 163   | 40                               | -       |                       |
| New treatment rate   |      |      |      |               |       |       |                  |       |       |                                  |         | 47.4%                 |
| Re-treatment rate (number of new cases requiring re-treatment) | 21%  | 20%  | 21%  | 22.7%         | 24.9% | 26.7% | 22.7%            | 23.7% | 27.8% | 18%                              | 22.8%   | 25%                   |

## Operational data

RAH: Calendar treatment days per/year = 260

Effective treatment days = 247 days (10 days for physics Q&A & 3 days for servicing)

2007 = 4.5 operating linacs

2008 = 4 operating linacs

2009 = 4.5 operating linacs (LMH opened in May 2009)

## SA actual average throughput per linac

Linac capacity is calculated as:

$$\frac{8.5 \text{ operating hours per day} \times 4.2 \text{ fractions per hour per machine} \times 248 \text{ operational days per year}}{21 \text{ average fractions per course}}$$

These parameters result in an average throughput of 421 total new courses (patients) per linear accelerator per annum. This figure ignores re-treats.

## Appendix 5: Calculation method for linear accelerator requirements

### **Step 1: calculate the number of people who would benefit from radiotherapy per annum (based on best available evidence).**

Multiply the cancer incidence rate by the evidence-based radiotherapy access benchmark (47.4% ) = New cases of radiotherapy.

Multiply the new cases of radiotherapy by the re-treatment rate = Re-treat cases of radiotherapy

### **Step 2: Calculate the number of fractions required per annum.**

Multiply the New cases of radiotherapy) by the number of fractions per new course (18.3) = New radiotherapy fractions

Multiply the Re-treat cases of radiotherapy with the number of fractions per re-treat course (10) =Re-treat radiotherapy fractions .

Add together the New and Re-treat fractions of radiotherapy required per annum = Total RT fractions required per annum

### **Step 3: Calculate the number of linacs needed**

Divide the total RT fractions required per annum by the total fractions delivered per machine per annum (see Table 7) = linacs needed to meet access benchmark.

## Appendix 6: Access support for country patients

Access to radiotherapy for rural and remote patients and their families requires affordable accommodation near radiotherapy services. The current estimation of accommodation demand suggests that approximately 12 new patients per week may require subsidised accommodation. Radiotherapy can be a protracted treatment option and may be rejected because of the requirement to spend time away from home and family.

Out-of-pocket expenses associated with travel and accommodation can add significantly to the overall expenses of people who need to travel greater distances for treatment. This is particularly evident for people who are of limited means prior to diagnosis such as the elderly and socially disadvantaged. A high proportion of country cancer patients accessing radiotherapy are aged 65+ and are likely to require accommodation while undergoing treatment.

The need for an escort to accompany the person undergoing radiotherapy is supported by evidence of the distress associated with being away from home, family and friends for extended periods of time. This is an important issue for all people; however for groups such as Aboriginal and Torres Strait Islander peoples or those from culturally and linguistically diverse backgrounds, the disadvantage is compounded<sup>27</sup>. Appropriate support and accommodation is needed for these groups of people.

The Patient Assisted Travel Scheme (PATS) assists country patients and approved escorts needing access to metropolitan-based radiotherapy treatment. The scheme makes treatment more accessible to rural South Australians by subsidising the cost for travel and accommodation (\$30 per night), when these factors would impose a financial burden and may deter access, and when patients are required to travel over 100kms (each way) to receive specialist medical treatment. Additional marketing of PATS support may be needed to encourage rural patients to seek radiotherapy as a treatment option. General practitioners in rural and remote locations may need additional education regarding PATS and radiotherapy as it applies to Medicare-related services, especially doctors from overseas countries who are new to many aspects of health care provision in Australia.

Currently Greenhill Lodge and Flinders Lodge, as managed by Cancer Council SA, are the only providers of subsidised metropolitan based accommodation dedicated to cancer patients, and both of these facilities are centrally located in Adelaide. Current accommodation capacity at Greenhill Lodge is 47 rooms (122 beds) and Flinders Lodge 66 rooms (138 beds), consisting of single, twin share and some family style accommodation. Accommodation needs for paediatric patients requiring radiotherapy are met by Ronald McDonald House in North Adelaide. The Leukaemia Foundation has received a Federal Government funding grant through the Regional Development Australia Fund (RDAF), which will see the construction of a purpose-built patient accommodation village in Northfield to support regional blood cancer patients and their families.

The specific issues relating to travel and accommodation that face Aboriginal and Torres Strait Islander cancer patients and their families are further considered in the *Aboriginal and Torres Strait Islander Companion Document to the Statewide Cancer Control Plan (2011-2015)* and *Cancer Care Pathway*".

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