Options for radiation oncology services in the Northern Territory

A report commissioned by the Government of the Northern Territory of Australia

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Contents

Executive summary and recommendations.............................................................. ii

Acknowledgements................................................................................................. vi

1...Introduction...................................................................................................... 1

2...Radiotherapy: background information ............................................................ 3

3...Northern Territory: demography and cancer epidemiology ......................... 12

4...Cancer care in the Northern Territory: current arrangements ...................... 21

5...The options for radiation- oncology services.................................................... 38

6...Preferred option.............................................................................................. 56

References............................................................................................................ 58

Appendix A: How we fulfilled out terms of reference................................. 60

Appendix B: List of consultations........................................................................ 63
Executive summary and recommendations

We were commissioned to examine Northern Territory (NT) cancer patients’ access to and utilisation of radiotherapy services; to assess the requirements for a radiation–oncology service in the NT; to identify and compare options for such a service; and to recommend a preferred service model.

We have found evidence that NT cancer patients’ access to radiotherapy services is restricted by the need to travel interstate, because no radiotherapy facility exists in the NT. The utilisation rate of radiotherapy by NT cancer patients is the lowest of all Australian States and Territories. Many patients who would benefit from radiotherapy do not receive it. Those who elect to travel interstate endure up to eight weeks of domestic disruption at a time when they are facing a major, often life–threatening illness. While the NT Government provides assistance with financial support for travel and accommodation associated with interstate treatment, the support is often inadequate, and the assistance scheme is too inflexible to meet the needs of many patients. The difficulties are particularly acute for Indigenous patients.

The problems associated with patients’ interstate travel for radiotherapy are no reflection on the quality of the radiation–oncology services that they received. NT patients and referring practitioners whom we consulted were unanimous in their praise for the professionalism, competence and compassion of the services. They were particularly appreciative of the radiation–oncology services provided by the Royal Adelaide Hospital (RAH). Clinicians in the Royal Darwin Hospital (RDH) and the Alice Springs Hospital (ASH) have strong, long–standing collegial relationships with RAH clinicians, sustained by outreach services to the NT from Adelaide and by a weekly video–conference between the RDH and the RAH, in which individual patients receive expert multi–disciplinary assessment. However, despite the strength and value of these clinical relationships and referral pathways, no formal service agreement exists to underpin them.

Irrefutable arguments exist to support the establishment of a radiotherapy service in the NT, as part of a new radiation–oncology unit in Darwin, at the RDH. The arguments are based on (i) the need to correct the current problem of access to radiation oncology faced by NT cancer patients, and (ii) the fact that a sufficient caseload exists at present to run a radiation–oncology unit, and will inevitably grow in the coming years.

NT cancer patients living in Central Australia wish to retain the choice of travelling to Adelaide rather than Darwin for radiotherapy. However, the Darwin caseload is likely to be boosted by referrals from northern parts of Western Australia (the Pilbara and Kimberley Health Zones).

The new radiation–oncology unit must take account of the geographical and professional isolation of any Darwin–based specialist service. It must therefore have sufficient back–
up equipment to ensure reliable service delivery, and be staffed with adequate numbers of qualified and experienced personnel to guarantee self-sufficiency. To ensure that a safe and high-quality service is provided for cancer patients in the NT, the new radiation-oncology unit should be developed in conjunction, and retain a strong operational link, with a major established radiation-oncology service elsewhere in Australia. Within the RDH, other medical, surgical, nursing, allied-health, psychosocial support and diagnostic services that are likely to face an increased workload as a result of the establishment of the new radiation-oncology unit should be strengthened.

We estimate that the net cost per patient for radiotherapy treatment in the new radiation-oncology unit will be slightly less than $8,000. This takes account of the cost of procuring and installing equipment and infrastructure, recurrent operating costs, replacement of equipment, and staff remuneration. It does not take account of the construction cost of a building to house the unit, as this is likely to be amortised over decades. It allows for some cost savings from a greatly reduced need to support interstate travel for radiotherapy.

On the basis of our findings, we offer the recommendations given below. We emphasise that these recommendations are confined to the development of a radiation-oncology service in the NT. They should be considered in the context of a comprehensive framework for cancer services. We understand that the NT Government intends to formulate such a framework. The need for radiation oncology is so strongly evident that the establishment of a radiation-oncology service at the RDH should not be delayed.

**Recommendations**

**Recommendation 1:**
A new radiation-oncology service should be established in Darwin, at the Royal Darwin Hospital, provided that it can be supported by a large interstate radiation-oncology service in a hub-and-spoke relationship.

**Recommendation 2:**
The new Royal Darwin Hospital radiation-oncology service should incorporate a radiotherapy unit with two linear accelerators. The facility should have sufficient space for installation of a computed-tomography simulator at a later date. The design should allow for expansion in the long term.

**Recommendation 3:**
As indicated in Recommendation 1, the Darwin radiation-oncology service should be linked with a large, established radiation-oncology service elsewhere in Australia in a hub-and-spoke relationship.

- **Recommendation 3.1:** An existing major service should be selected as the hub on the basis of a series of defined criteria that reflect its clinical and technical scope and expertise, its ability to support the Darwin service, and its familiarity with the health-care, geographic and cultural environment of the Northern Territory.
Recommendation 3.2: The Northern Territory Government, through the Department of Health and Community Services, should have a formal agreement with the selected hub service.

Recommendation 3.3: The hub service should have responsibility for providing advice on the development of the new radiation–oncology unit in Darwin, including detailed specification of its configuration and staffing, in accordance with the requirements of the Northern Territory Government.

Recommendation 3.4: The hub service should enter into a contract to guarantee adequate staffing of the Darwin service and maintenance of the facilities.

Recommendation 3.5: The hub service should receive appropriate benefits for its contribution. The Royal Darwin Hospital should promote opportunities for the interstate staff to receive academic appointments at the Charles Darwin University.

Recommendation 4:
Other Northern Territory health–care services that are likely to experience an increase in workload as a consequence of the establishment of the Darwin radiation–oncology service should be enhanced. This enhancement should be planned in parallel with the planning of the new radiation–oncology unit.

Recommendation 5:
Radiation oncologists appointed to the Darwin unit should contribute to the general oncology service offered at the Royal Darwin Hospital.

Recommendation 6:
The Northern Territory Department of Health and Community Services should ensure that the radiotherapy service that is developed in Darwin is attractive to all cancer patients in the Northern Territory, including those from the ‘southern zone’, who might otherwise prefer to travel interstate for treatment.

Recommendation 7:
The Northern Territory Department of Health and Community Services should offer the Western Australian Government the opportunity to refer cancer patients from northern parts of Western Australia to Darwin for radiation–oncology services, on a standard cost–recovery basis. If this offer is accepted, a formal service agreement should be established between the Western Australia and Northern Territory Governments.

Recommendation 8:
Immediate steps should be taken to minimise the stress experienced by Northern Territory cancer patients who need to travel interstate for radiotherapy.

Recommendation 8.1: The Northern Territory Patient Assistance Travel Scheme should make automatic provision for escorts to accompany cancer patients who are referred to the Royal Adelaide Hospital and other interstate centres for radiotherapy. It would be desirable for support to be available either for two sequential escorts, or for a single escort to make a return trip to the Northern Territory during the course of radiotherapy if necessary.
- **Recommendation 8.2**: Patients treated at an interstate radiotherapy centre must be certified fit to travel by their radiation oncologist before they return home on a flight funded through the Patient Assistance Travel Scheme. The Scheme should be sufficiently flexible to allow their travel to be delayed if they are unwell.

- **Recommendation 8.3**: Until the new Darwin radiation–oncology unit becomes fully operational, the Northern Territory Department of Health and Community Services should establish and fund a position for a Patient Coordinator at the Royal Adelaide Hospital to work with patients, their referring practitioners, and the Adelaide oncologists, in ensuring that all aspects of patients’ preparation, care, accommodation and travel are managed effectively.

**Recommendation 9:**
The Northern Territory Government should acknowledge the outstanding contribution made by staff of the Royal Adelaide Hospital to the care of cancer patients in the Northern Territory.
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Some of the individuals whose names appear above are also included in our list of consultations (see Appendix B).
1 Introduction

1.1 Our terms of reference

In 2002, the Australian Government published the Report of the National Inquiry into Radiation Oncology, which was chaired by Professor Peter Baume AO. The Report:

- reaffirmed the central importance of radiotherapy in cancer management;
- emphasised the premise that adequate access to radiotherapy services is essential in any effective cancer–care system; and
- reiterated the well-recognised fact that access to radiation–oncology services is deficient in many parts of Australia (Inquiry Committee, 2002).

Limited radiation–oncology services are provided in Darwin, mainly through outreach visits from Adelaide–based specialists and through multi–disciplinary cancer–care meetings conducted by video–conferences linking the Royal Darwin Hospital (RDH) with the Royal Adelaide Hospital (RAH). However, no radiotherapy facilities exist anywhere in the NT.

Following from the findings of the Baume Inquiry, both the NT Government and the Australian Government identified the need to overcome problems of access to radiotherapy services for residents of the NT. The Australian and Northern Territory Health Ministers subsequently agreed to support a comprehensive study of the options for providing radiation oncology services for the people of the NT, including the possibility of establishing a local radiotherapy facility linked to a major interstate cancer centre.

In the NT Government Request for Tender (No D03–0858) relating to the study, Darwin was categorised as an ‘area of medium need’. Particular characteristics of the NT justified special consideration in the planning of services. These characteristics were ‘extreme geographic disadvantage and high proportion of Indigenous Australians’.

We were commissioned to carry out and report on the study. Our terms of reference, as stated in the Request for Tender, were as follows.

- Examine and report on the extent to which Territorians’ current access to, and utilisation of, radiotherapy is in accordance with national service benchmarks.

- Establish the requirements for the provision of a cost–effective, sustainable, best–practice radiation oncology service to Territorians, involving investigation and comparison of the alternative service model options for meeting the projected demand for radiation oncology in the Northern Territory over the next 10 years.

- Recommend the preferred future model for the provision of radiation oncology to Territorians which optimises:
access to appropriate, comprehensive cancer-care services;
clinical outcomes;
cost–effective service provision;
service sustainability; and
linkages with other services.

The steps that we took to fulfil these terms of reference and the methods that we used are outlined in Appendix A.

This report examines radiation oncology services in the NT. It should be considered in the context of a comprehensive framework for cancer services.

1.2 Structure of this report

In Chapter 2, we place radiotherapy in the context of modern multi-disciplinary cancer care. We then provide a short explanation of how radiotherapy works, introduce the different types of radiotherapy equipment, and describe how radiotherapy is given to patients. Finally, we highlight the difficulties faced by NT cancer patients in obtaining access to radiotherapy services at present, and list some of the challenges that would have to be addressed if a radiotherapy unit were to be established in the NT.

In Chapter 3, we summarise the main geographical and demographic factors that affect the delivery of cancer care in the NT. We then review the epidemiology of cancer in the NT, and estimate the numbers of patients who would benefit from radiotherapy. We project both the demographic and the epidemiological data to 2010.

In Chapter 4, we describe the current organisation of cancer services in the NT, concentrating on services delivered in Darwin and Alice Springs. We also report on the perspectives of cancer patients and health–care professionals who participated in our consultations in the NT and in Adelaide.

In Chapter 5, we identify the options for the delivery of radiation–oncology services in the NT over the next 10 years. We specify the types of equipment that might be considered if a radiotherapy service were to be established, and estimate the costs of acquiring, installing, and running the equipment. We also describe possible service–delivery models, identify the risks associated with establishing and operating a radiation–oncology service in the NT, and show how these risks could be managed.

In Chapter 6, we present our preferred option.

Our main recommendations are given just after the Executive Summary, near the beginning of this report.
2 Radiotherapy: background information

Main points:

- Radiotherapy can cure some cancers when used on its own, cure other cancers when used in conjunction with surgery or chemotherapy, and provide palliative treatment. Adequate access to radiotherapy is a crucial component of modern multi-disciplinary cancer care.
- External-beam radiotherapy can be delivered by cobalt machines or linear accelerators. All external-beam radiotherapy in Australia is now delivered by linear accelerators.
- Radiotherapy equipment is complex, and the safe and effective delivery of radiotherapy relies on careful planning of treatment for each patient. This in turn depends on a full radiation-oncology team of doctors, radiation therapists, and physicists, with engineering back-up.

2.1 The terms ‘radiation oncology’ and ‘radiotherapy’

The terms ‘radiation oncology’ and ‘radiotherapy’ are sometimes used interchangeably, but the distinction between them is important.

Radiation oncology is the study and discipline of treating malignant disease with radiation.

Radiotherapy (or radiation therapy) is the treatment that is used in radiation oncology. It involves the application of ionising radiation (from X-rays, γ-rays, or particles) to kill tumour cells.

Radiotherapy can also be used to treat some non-cancerous conditions (e.g. keloid or ‘heaped-up’ scars). Our report focuses on its applications in cancer.

2.2 Radiotherapy and multi-disciplinary cancer care

Modern multi-disciplinary cancer care depends on three primary treatment modalities: surgery, radiotherapy and chemotherapy. Radiotherapy has a crucial role in the treatment of many cancers.

- It can itself be curative for some cancers (e.g. early-stage lymphoma, and cancer of the larynx).
- It may be an adjuvant therapy (following surgery and/or chemotherapy, e.g. following lumpectomy for breast cancer).
• It can be given as palliative treatment for relief of symptoms (e.g. pain due to metastases that erode bone).

Thus radiotherapy can prolong survival, contribute to the preservation of organs affected by malignancy, provide palliation, and improve patients’ quality of life. Recent research shows that at least 50 percent of patients with newly-diagnosed cancers (other than non-melanotic skin cancers) would benefit from radiotherapy (Delaney et al, 2003). One quarter of these patients may need further treatment after relapse. Adequate access to radiotherapy services is therefore essential in any cancer-care system.

However, the provision of a safe and effective radiation oncology service is complex. As described in Chapter 5, it requires a substantial capital investment in radiotherapy equipment and a specially-designed building, an ongoing investment in maintenance and replacement of the equipment, expert teams of doctors, therapists, and physicists, and good access to engineering support. Even if funds are available, the necessary medical, scientific and technical expertise is in short supply, not only in Australia, but also in many other developed countries.

The introduction or expansion of radiation-oncology services in any health-care system inevitably has implications for other services. The introduction of radiotherapy opens up opportunities for the local multi-disciplinary care of cancer patients who might otherwise have been referred elsewhere. This has great advantages for cancer patients and the community. However, the benefits of multi-disciplinary care depend on adequate access to the full range of services involved. In addition to radiation oncology, these include surgical and medical oncology, as well as pathology, imaging, general and specialist medical and surgical services (including emergency services, palliative care and general practice), and nursing and psycho-social support services. Therefore, careful, comprehensive planning of all of these services is critical if the value of an investment in radiation oncology is to be realised.

2.3 How radiotherapy works

2.3.1 Tissue effects

It is important to understand the following basic points in order to make decisions about options for the development and organisation of radiation-oncology services.

• Different types of normal and malignant cells vary in their susceptibility to ionising radiation. Clinical radiotherapy schedules are designed to exploit the differences between normal tissues and tumours, so that as many malignant cells as possible are killed, while damage to normal tissue is minimised. In radical curative treatments, total radiation doses are close to the tolerance of normal tissues. In palliative treatments, low doses are used.
Some tumours, such as seminoma of the testis and lymphoma, are very sensitive to radiotherapy and can be treated with relatively low doses, with an expectation of cure. Other tumours, such as melanoma of the skin and glioblastoma multiforme in the brain, are notoriously resistant, even to large doses.

A course of radiotherapy may be spread over days or weeks. This is known as fractionating, and the radiation delivered to a patient in a single treatment session is called a fraction. Fractionating allows normal tissues to repair much of the radiation damage, while tumour cells, which are less efficient at repair, do not recover. A beam of radiation is called a field. A fraction consists of one or more fields delivered sequentially.

In general, most modern radiotherapy is delivered with very high-energy, highly-focused beams, which can reach deeper tumour tissues while depositing relatively small doses in the normal tissues through which they pass.

However, both acute (early) and late side-effects do occur. The side-effects depend on several factors, including the body site being treated, the volume of normal tissue irradiated (the larger the volume, the higher the risk and severity of side effects), the total dose, and the rate of dose accumulation (the amount per week).

Early side-effects result from damage to proliferating tissues such as the mucosa (lining) of the gastro-intestinal tract, or the skin. For example, radiotherapy to an abdominal tumour may damage the mucosa of the small bowel, causing malabsorption and diarrhoea. Most patients recover completely.

Late reactions occur at least three months after a treatment course has ended, and are usually permanent or progressive. They usually result from damage to non-proliferating differentiated tissues, which cannot compensate for cell death by dividing to replace lost cells. Once late effects occur, it is very difficult to reverse them, but they are very uncommon.

Side-effects of radiation can be minimised by meticulous planning and delivery of a course of radiotherapy. Late-reacting tissues are particularly sensitive to the size of each radiation dose, so they can be protected to a large extent by giving small fractions of radiation, provided the total dose is not too high.
2.3.2 Sources of ionising radiation

Ionising radiation is produced either from radioactive sources (isotopes), or from machines in which a target is bombarded by an electric current or other high-energy particles.

The radiation is delivered to the patient in one of two ways:

a) as **brachytherapy**, where the source is inserted directly into tumour-infested tissue or into a cavity lined by tumour; and

b) as an **external beam**, generated by a radioactive source or a machine outside the patient, and focused on to the tumour.

In this report we concentrate on external-beam radiotherapy.

**a) Brachytherapy**

Brachytherapy is a highly-specialised technique that can be effective when applied to particular tumours. For example, seeds containing a radioactive isotope of iodine can be permanently inserted into the prostate for early-stage prostate cancer, and a radioactive isotope of iridium can be inserted temporarily into the cervix to treat carcinoma of the cervix. These isotopes emit radiation that is directed to the tissues into which they are inserted. The delivery of brachytherapy is confined to large cancer centres with expertise in both radiation oncology and the relevant specialised field of oncological surgery (e.g. gynaecological oncology).

**b) External-beam radiotherapy**

External-beam radiation is categorised according to the energy of the beam into kilovoltage radiotherapy (carrying thousands of volts) and megavoltage radiotherapy (carrying millions of volts). Kilovoltage X-rays are used for diagnostic imaging and for the treatment of superficial tumours such as skin cancers.

Kilovoltage X-rays are produced by superficial radiotherapy equipment (generating up to 120kV) and orthovoltage or ‘deep’ radiotherapy equipment (up to 300kV).

Two types of megavoltage external-beam radiotherapy are available. The first uses a beam of radiation produced by a radioisotope of cobalt ($^{60}$Co) that emits radioactive energy as it decays. The second uses a beam of radiation produced by a linear accelerator (abbreviated linac). All megavoltage radiotherapy machines in use in Australia today are linacs.
**Cobalt radiotherapy**

External-beam radiotherapy using $^{60}$Co was the mainstay of radiation oncology for several decades in the 20th Century. In a cobalt machine, the $^{60}$Co source is placed in a gantry 80 to 100 cm from the patient, and the radiation is directed at the site of the tumour. Cobalt machines are simple, reliable, and relatively inexpensive, and some of the more recent models have had the capacity to produce a fairly well-focused beam. However, the use of cobalt has several disadvantages, as described in section 5.3.1. No external-beam radiotherapy equipment using radioactive sources is currently in operation in Australia, the last machine having been retired by 2000 (Wigg and Morgan, 2001; Faculty of Radiation Oncology, Royal Australian and New Zealand College of Radiologists, the Australian Institute of Radiography, and the Australasian College of Physical Scientists and Engineers in Medicine, 2001).

**Linear accelerators**

In a linac, electrons are accelerated via a wave guide onto a tungsten target, and this generates X-rays within the megavoltage energy range. The X-rays are then aimed at the tumour. A linac can also emit electrons alone, and the electrons can also be used therapeutically. Electrons behave differently from X-rays, having different tissue penetration and therefore different applications.

The X-rays produced in a linac have much higher energy, and penetrate tissue more deeply, than X-rays from a diagnostic machine. With modern linacs, the dose of radiation can be concentrated at deeper sites by directing the X-ray beams, thus minimising skin side-effects. An isocentric gantry allows multiple beams to be directed at the tumour. The sharp edge of the beam allows definition of complex field borders that assist in shaping the beam to the tumour volume and avoiding critical normal tissues.

**Installation of radiotherapy facilities**

Both cobalt machines and linacs are installed in concrete bunkers, usually located directly on the ground. A concrete-lined corridor typically separates the room containing the radiation-generating equipment from other rooms in a radiation-oncology unit. Because of the cost of shielding, it is unusual for any rooms to be placed above the bunker. Other rooms in the unit comprise waiting areas for patients, clinic rooms where patients are assessed, offices for staff, and various workshops.

Specifications and the requirements for installation of radiotherapy equipment are given in Chapter 5.
2.4 Professional roles

Three types of professionals are involved in the prescription and safe delivery of radiation treatment.

The radiation oncologist is a specialist medical practitioner with expertise in:
- assessing cancer patients, jointly with other members of a multi-disciplinary integrated cancer–management team;
- determining whether radiotherapy is the most appropriate treatment modality for individual patients;
- explaining treatment options to patients, and helping them to make treatment choices;
- planning courses of radiotherapy for individual patients, including the prescription of doses of radiotherapy;
- supervising the delivery of radiotherapy;
- managing complications of radiotherapy;
- providing support and ongoing advice to patients; and
- follow–up of patients.

The radiation therapist is technically trained, and is skilled in the planning and delivery of radiotherapy in accordance with the prescribed dose and the pre–determined tumour volume.

The radiation physicist:
- helps to ensure that the prescribed dose of radiotherapy can be delivered within the tolerances of the available equipment;
- ensures that the dose prescribed is actually delivered by taking dose–verification measurements;
- calibrates the radiotherapy machinery; and
- plays a major role in radiation safety.

Physicists have a crucial role in ensuring the accuracy of all steps in the treatment process, including verifying and quantifying the accuracy of CT scans, making calculations using planning computers, and monitoring the quality of linac beams.

The team is also supported by engineers employed by the manufacturer or distributor of the equipment. Modern radiotherapy equipment is sophisticated but often requires engineering attention. Specialised computer support and data management are also required because treatment and planning systems are complex and closely linked to specialised patient–information management systems.

There are acute shortages of radiation therapists and radiation physicists in Australia and in many other developed countries. Training programs have been or are being established to address these shortages. Australia also has a relative shortage of radiation oncologists.
2.5 How radiotherapy is given

Once both doctor and patient have decided on radiation treatment, the radiotherapy regimen is prescribed according to the individual patient’s condition. The regimen depends on the site and pathological characteristics of the tumour, the natural history of the disease, and previous therapy (e.g. chemotherapy, surgery, or previous radiotherapy). Various quantities known as volumes are determined. These include:

- the gross tumour volume, which is tumour that can be directly assessed by physical examination and diagnostic studies;
- the clinical target volume, which includes areas of probable subclinical spread of disease, e.g. adjacent lymph nodes;
- the planning target volume, which represents an additional margin that takes account of variations in measurements, e.g. those due to breathing in the case of a lung-cancer patient.

Before the actual treatment begins, the patient usually attends for a radiotherapy simulation session. This may be done on a radiotherapy simulator, which has the same geometry as a linac, but produces plain X-ray images with the patient in the treatment position – it does not generate therapeutic high-voltage X-rays. Today simulation is mostly done today using CT equipment, which may either be located in the radiation-oncology unit or in an imaging department. Simulation images are used for treatment planning. Simulation can take up to an hour, and there may be a need to inject contrast medium into the patient to obtain better definition of tumour and normal structures.

The simulation images are transferred to planning computers where the areas to be treated are reconstructed in three-dimensional displays. The doses are then calculated, taking account of different tissue densities. Based on measurements obtained by simulation, multiple beams can be used to give close coverage of the tumour volume and careful sparing of normal tissues.

During the simulation, small permanent marks may be made on the patient’s skin with the aid of localising laser lights. These marks enable the patient’s treatment position to be replicated accurately at every treatment session. Some patients may need a customised immobilisation device such as a thermoplastic shell.

For primary radiotherapy of a newly-diagnosed cancer (as distinct from palliative radiotherapy), treatment fractions are usually given once daily, five days a week, usually for five or six weeks. The patient usually spends 10–15 minutes in the treatment room for each fraction. Most of that time is taken in ensuring that the patient is correctly positioned (i.e. positioned in accordance with the planning); the radiation beam is usually activated for only a few minutes. While the beam is on, radiation therapists leave the room to avoid exposure. They watch the patient via a closed-circuit television monitor, and the patient can communicate with staff via a microphone system.
Palliative treatments are similar but usually use simpler techniques and much fewer fractions. For example, 80 percent of patients with bone pain from metastatic cancer get relief with just one treatment (Steenland et al, 1999).

Quality-assurance programs, which are mainly the responsibility of radiation physicists, ensure that the treatment given accords with the radiation oncologist’s prescription.

### 2.6 Special techniques

The following special radiotherapy techniques are mentioned here because they are often specified (by inclusion or exclusion) in estimates of the costs of purchasing and running radiotherapy equipment.

In intensity-modulated radiotherapy, the radiation beam is modified during treatment. This allows the dose of radiation to be increased when the beam concentrates on tumour tissue, and decreased for adjacent normal tissue.

Stereotactic radiotherapy employs multiple narrow high-energy beams that intersect in the tissue requiring treatment. It may also be delivered as multiple γ-rays from isotopes fixed in a treatment device called a gamma knife. This technology may be effective for small intra-cranial lesions, such as arterio-venous malformations, posterior fossa tumours, and solitary metastases.

### 2.7 Current situation in the Northern Territory

As the Baume Inquiry highlighted, access to radiation-oncology services throughout Australia is very variable (Inquiry Committee, 2002). In general, cancer patients who live in the capital cities and other major centres of population have fairly good access. Cancer patients in the Northern Territory (NT) are an exception. As we noted in section 1.1, no radiotherapy facilities currently exist in the NT. Cancer patients who need radiotherapy are referred to interstate services, with most patients going to the Royal Adelaide Hospital (RAH). Through video-conferencing, collaborative arrangements with imaging services, and outreach services, preparation for treatment planning can now be done in Darwin for many NT cancer patients, but all patients who have radiotherapy must travel interstate for the actual treatment.

The travel poses three types of problems for patients, their families, and the wider community.

- The first is the emotional, domestic and financial stress associated with being away from home. Patients receiving a primary course of radiotherapy are usually away
from home for a long period (the typical duration of a course of radiotherapy is 6–8 weeks). At the time when these patients are facing the crisis of a major illness and may have distressing side-effects of treatment, they are required to endure separation from their families and their communities, cope with disruption to their domestic lives and their work, and possibly absorb a significant loss of income. While the NT Department of Health pays for travel and subsidises accommodation and living costs, funding to support an accompanying person (such as a spouse) is very limited.

- Second, for patients needing palliative radiotherapy, the interstate journey is often difficult and uncomfortable, although the duration of treatment can be relatively short. The prospect of travel may be distressing for many such patients, and may dissuade them from having treatment that would be highly effective.
- Third, for patients with acute problems requiring urgent radiotherapy, such as spinal-cord compression or respiratory obstruction, the travel time inevitably adds a significant delay to the start of treatment, delaying relief of acute symptoms and increasing the risk of adverse outcomes.

The provision of radiotherapy services within the NT would obviously ameliorate these problems. However, the development of a local radiation-oncology capacity raises several difficult questions, all of which hinge on the relatively small population of the NT and its remoteness from other major centres of population. The main questions are as follows:

- Are the numbers of new cases of cancer among NT residents sufficient to make good use of a radiotherapy facility?
- Given the shortage of expert medical, scientific and technical personnel throughout Australia, would it be possible to attract sufficient staff to the NT, and retain them?
- Would it be possible to provide the engineering support that is needed to ensure the reliable delivery of radiotherapy?
- Assuming that radiotherapy equipment is located in Darwin, would cancer patients from other parts of the NT prefer to travel to Darwin, rather than interstate?
- Could other health-care services in Darwin absorb the additional caseload that would result from the retention of cancer patients in the NT?
- In the context of the answers to these questions, should a large amount of public money be spent on a local radiation oncology service? To what extent would other opportunities for improving the health of the people of the NT be foregone?
3 Northern Territory: demography and cancer epidemiology

Main findings

- The NT has a small, sparsely-distributed population, with a higher proportion in young age groups than any other Australian State or Territory, and a lower proportion aged 65–plus.
- About half of the population lives in Darwin, and about a quarter lives in small remote communities.
- The proportion of the population aged 65–plus is increasing by approximately one percent each decade. This represents a relatively rapid rate of increase (33 percent between 1991 and 2001).
- The proportion of Indigenous people (29 percent) is higher than that of any other Australian State or Territory. The Indigenous population is linguistically and culturally diverse, and geographically dispersed.
- The NT can be regarded as having two geographical zones: a tropical ‘northern zone’, centred on Darwin, with a population of about 156,000; and an arid ‘southern zone’, centred on Alice Springs, with a population of about 42,000.
- A total of 448 cases of cancer were diagnosed among NT residents in 2001. Smoking–related cancers were over–represented, due to their relatively high incidence in Indigenous people. A linear projection suggests that there will be about 580 new cases of cancer per annum by 2010.
- Radiotherapy was indicated for a total of 252 people with newly–diagnosed cancer in the NT in 2001. We estimate that this figure will reach 320 by 2010.

3.1 Population and geography of the Northern Territory

3.1.1 Main population characteristics

A total of 210,664 people were counted in the NT on Census night, 7 August 2001. This included some 12,000 visitors, of whom almost 8,000 were from overseas. As at 30 September 2003, the estimated resident population of the NT was 198,600.

The population of the NT increased by about 20 percent in the ten years to 2002, but the growth rate has slowed markedly since 2001. Over the 12 months to September 2003, the population grew only by an estimated 0.2 percent. This was the smallest growth rate of all Australian States and Territories, and much smaller than the Australia–wide figure of 1.3 percent.

Some 107,400 people (54 percent of the total population) live in Darwin. Other than Darwin, there are only two large towns in the NT: Alice Springs, with a population of
about 26,500, and Katherine, with a population of about 10,500. Other significant centres of population are Nhulumbuy (with 4,000 people), and Tennant Creek (with 5,000 people). At least a quarter of the NT population live either in small communities or in isolated settings.

As at 30 June 2001, the estimated resident Aboriginal and Torres Strait Islander population was 57,600. The Indigenous population comprised 29 percent of the total population of the NT, the highest proportion of any State or Territory. The Indigenous population is itself culturally diverse; at least 70 Aboriginal languages or dialects are spoken in the NT.

The NT has the youngest population of all the Australian States and Territories. As Figure 3.1 shows, the proportions of the NT population in almost all age groups up to 40–44 years are higher than those of Australia as a whole, while the proportions of the NT population in all the age groups above 40–44 years are lower than those of Australia as a whole. The difference between the NT and Australia as a whole increases progressively with age, and is particularly marked for the 65–plus age groups. This is an important point, because the incidence of cancer increases with age, and most cases occur in people aged 65–plus.

**Figure 3.1:** Age distributions of the NT and Australian populations, 2001.
(Source: Australian Bureau of Statistics, via Healthwiz)

The proportion of the population that was aged 65–plus in 2001 was about four percent in the NT, and about 12.5 percent across the rest of Australia. However, the rate of
increase in the proportion aged 65–plus over the preceding 10 years was 33 percent in the NT, but less than nine percent across the rest of Australia (Figure 3.2). Thus although the proportion of older people in the NT is small compared with the rest of Australia, its relative rate of increase is much greater. A linear projection suggests that, by 2010, about five percent of the NT population will be aged 65–plus, while the figure in the rest of Australia will be about 14 percent (Figure 3.2)

**Figure 3.2:** Proportions of people aged 65–plus in the NT and in other Australian States and Territories combined, 1991–2001, with projections to 2010. (Source: Australian Bureau of Statistics, via Healthwiz)

![Graph showing proportions of people aged 65–plus in the NT and in other Australian States and Territories combined, 1991–2001, with projections to 2010.](image)

### 3.1.2 The land mass and social geography of the NT

Among the States and Territories, the NT has the third-largest land area, after Western Australia and Queensland. At 1.35 million square kilometres, the NT represents 17.5 percent of Australia’s total land area of 7.69 million square kilometres, but contains about one percent of the total Australian population. Apart from Darwin and the other large towns, the NT is extremely sparsely populated.

Distance and climate tend to divide the NT into two natural zones: a ‘northern zone’, which is centred on Darwin, and has a tropical climate; and a ‘southern zone’ (encompassing much of Central Australia), which has Alice Springs as its nucleus, and has a desert climate. The geographical boundary between the two zones is indistinct.
The ‘northern zone’ extends south from the Arafura Sea and the Timor Sea, across Arnhem Land, Kakadu, and the Daly River and Port Keats areas. For the purposes of describing the patterns of cancer occurrence in the NT, we defined the ‘northern zone’ as comprising all of the Statistical Local Areas (SLAs) in the NT other than those listed below for the ‘southern zone’. The estimated resident population of the ‘northern zone’ in 2002 was 156,156.

The ‘southern zone’ extends north from the South Australian border to the Tanami Desert in the west and the Barkly Tableland in the east. We defined it as comprising the Alice Springs, Peterman, Sandover, Tanami and Tennant Creek SLAs. Its estimated resident population in 2002 was 41,857.

From a service-planning perspective, it is significant that, ‘as the crow flies’, Alice Springs is almost exactly midway between Darwin (1,289 km to the north) and Adelaide (1,328 km to the south).

### 3.2 Occurrence of cancer in the Northern Territory

In 2001, there were 448 new cases of cancer in the NT (Condon and Zhao, 2004). Seventeen percent occurred in Indigenous people. For Indigenous and non-Indigenous people combined, 58 percent were in males (Table 3.1). Of the 448 new cases, 344 were estimated to have occurred in residents of the ‘northern zone’, and 104 in residents of the ‘southern zone’.

**Table 3.1** New cases of cancer by Indigenous status and sex, NT, 2001.
(Source: Condon and Zhao, 2004)

<table>
<thead>
<tr>
<th></th>
<th>Indigenous</th>
<th>Non-Indigenous</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>39</td>
<td>219</td>
<td>258</td>
</tr>
<tr>
<td>Females</td>
<td>39</td>
<td>151</td>
<td>190</td>
</tr>
<tr>
<td>Total</td>
<td>78</td>
<td>370</td>
<td>448</td>
</tr>
</tbody>
</table>

Figure 3.3 replicates Figure 3.1, but superimposes curves showing the cumulative relative frequency of new cases of cancer in 2000 by age for both the NT and Australia as a whole. The NT curve emphasises the concentration of cancer incidence in older age groups. It implies that, as the proportion of older people in the NT population increases, the burden of cancer in the NT will increase markedly. This will create further demands for cancer services in the NT.
Figure 3.3: Age distributions and cumulative relative frequencies of new cases of cancer by age, NT and Australia, 2000. (Sources: Condon and Zhao, 2004; and Australian Bureau of Statistics via Healthwiz)

3.3 Projections of cancer incidence

From trends in the numbers of new cases of cancer reported in the NT over the period 1991–2001 (Condon and Zhao, 2004), we developed simple linear projections of the numbers of new cases of cancer that could be expected to occur in 2010 (Figure 3.4). According to these projections, a total of 582 new cases would be expected (95 percent confidence interval: 505–660). The projections obviously do not take into account the many complex factors that affect cancer incidence, but we do not know of any more sophisticated modelling of these data in existence at present.
Figure 3.4: Numbers of new cases of cancer by year of diagnosis, 1991–2001, by Indigenous status. (Source: Condon and Zhao, 2004, with linear projections to 2010)

3.4 Distribution of cancers by site

The distribution of cancers by site differs between the NT and the rest of Australia. These differences reflect (i) some large differences in the incidence of particular cancers between NT Indigenous people and the rest of the Australian population, and (ii) the age distribution of the NT population.

Table 3.2 compares the distribution of new cancers by site in the NT (separately for Indigenous and non–Indigenous people) and Australia as a whole. It indicates that there were relatively high incidences of cancers of the cervix, oropharynx, lip, tongue and oral cavity, liver, lung, oesophagus, pancreas, thyroid, and lung, and cancers of unspecified sites, among NT Indigenous people. It also indicates that there were relatively low incidences of colorectal, renal, and prostate cancer, and of lymphoma and melanoma, among NT Indigenous people. The pattern of cancer sites among NT non–Indigenous people was similar to that of the Australian population as a whole, apart from a higher incidence of breast cancer and melanoma, and a lower incidence of colorectal cancer.
These findings, based on unadjusted data, accord with age- and sex-adjusted cancer-incidence data from the NT Cancer Registry yet to be published (Condon JR, personal communication).

Table 3.2: Distribution of new cases of cancer by site for Indigenous and non-Indigenous people in the NT, 2001, and for the whole of Australia, 2000. (Sources: Condon JR and Zhao YZ, 2004; AIHW & AARC, 2003).

<table>
<thead>
<tr>
<th>Cancer site</th>
<th>Proportion of total number of new cancer cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NT Indigenous, 2001</td>
</tr>
<tr>
<td>Bladder</td>
<td>0%</td>
</tr>
<tr>
<td>Bone</td>
<td>1%</td>
</tr>
<tr>
<td>Brain</td>
<td>1%</td>
</tr>
<tr>
<td>Breast</td>
<td>15%</td>
</tr>
<tr>
<td>Cervix uteri</td>
<td>6%</td>
</tr>
<tr>
<td>Colorectal</td>
<td>8%</td>
</tr>
<tr>
<td>Kidney</td>
<td>0%</td>
</tr>
<tr>
<td>Larynx</td>
<td>1%</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>1%</td>
</tr>
<tr>
<td>Lip, tongue &amp; oral cavity</td>
<td>15%</td>
</tr>
<tr>
<td>Liver</td>
<td>6%</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>1%</td>
</tr>
<tr>
<td>Melanoma</td>
<td>1%</td>
</tr>
<tr>
<td>Oesophagus and stomach</td>
<td>6%</td>
</tr>
<tr>
<td>Ovary and uterine adnexa</td>
<td>1%</td>
</tr>
<tr>
<td>Pancreas</td>
<td>3%</td>
</tr>
<tr>
<td>Prostate</td>
<td>1%</td>
</tr>
<tr>
<td>Testis</td>
<td>0%</td>
</tr>
<tr>
<td>Thyroid</td>
<td>5%</td>
</tr>
<tr>
<td>Trachea, bronchus and lung</td>
<td>15%</td>
</tr>
<tr>
<td>Uterus</td>
<td>3%</td>
</tr>
<tr>
<td>Unspecified sites</td>
<td>5%</td>
</tr>
<tr>
<td>Others</td>
<td>1%</td>
</tr>
<tr>
<td>All cancers</td>
<td>100%</td>
</tr>
</tbody>
</table>

Over the period 1991–2000, the NT Indigenous cancer mortality rates were also higher than the total Australian rate for cancers of the liver, lung, uterus, cervix and thyroid,
and in younger people only (aged 0–64 years), for cancers of the oropharynx, oesophagus and pancreas (Condon et al, 2004).

The relatively high frequency of and mortality from smoking-related cancers in the NT Indigenous population are probably due to a comparatively recent uptake of smoking by NT Indigenous people (Ivers, 2001; Brady, 2002).

3.5 Implications for radiotherapy services

Two points in the epidemiology of cancer in the NT are particularly important for planning access to radiotherapy services.

- First, the burden of cancer is likely to increase, because (i) the proportion of the population aged 65–plus is increasing quite rapidly, and (ii) there is a relatively high frequency of smoking in the NT Indigenous community.
- Second, the cancers which occur with a higher frequency in the NT tend to be sensitive to radiotherapy.

We used a model developed by Delaney et al (2003) to estimate the numbers and proportions of patients with newly-diagnosed cancers that would be likely to benefit from radiotherapy, taking 2001 as the index year. This model is based on a decision tree in which the best available evidence on the relative benefits of radiotherapy is applied to each cancer site. We took account of the differential incidence of new cases of cancer in the NT Indigenous and non-Indigenous populations, and the observation that, for at least some cancers, Indigenous patients tend to present later than non-Indigenous patients (Condon JR, personal communication).

Our findings are summarised in Table 3.3, which shows the total number of new cases of cancer in 2001 was 445 (rather than 448), as we excluded the three cancer sites in which only one case occurred in 2001 (testis, bone, and myeloma). Overall, radiotherapy was indicated for 252 new cases of cancer in the NT in 2001 (about 55 percent of the total number of new cases). Radiotherapy was indicated for 59 percent of new cases of cancer in Indigenous people, and 54 percent of non-Indigenous people.

Based on the projection given in section 3.3, radiotherapy would be indicated for some 320 new cases of cancer in 2010, if it is assumed that the distribution of cancer sites does not change substantially between 2001 and 2010.

Other contributors to the caseload of a radiotherapy service in the NT are considered in Chapter 5.
Table 3.3: Numbers of new cases of cancer by site in Indigenous and non-Indigenous people, NT, 2001, and estimated numbers and proportions in whom radiotherapy would have been indicated, based on the model of Delaney et al (2003).

<table>
<thead>
<tr>
<th>Site</th>
<th>Number of new cases (2001)</th>
<th>Proportion where radiotherapy is indicated</th>
<th>Number where radiotherapy is indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indigenous</td>
<td>Non-indigenous</td>
<td>Total</td>
</tr>
<tr>
<td>Brain</td>
<td>1</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Head and Neck</td>
<td>13</td>
<td>34</td>
<td>47</td>
</tr>
<tr>
<td>Thyroid</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Lung</td>
<td>12</td>
<td>36</td>
<td>48</td>
</tr>
<tr>
<td>Breast</td>
<td>12</td>
<td>60</td>
<td>72</td>
</tr>
<tr>
<td>Gynaecological</td>
<td>8</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Melanoma</td>
<td>1</td>
<td>52</td>
<td>53</td>
</tr>
<tr>
<td>Kidney</td>
<td>0</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Bladder</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Prostate</td>
<td>1</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>1</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Stomach</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Pancreas</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Liver</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Colon</td>
<td>4</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Rectum</td>
<td>2</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Unknown</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td><strong>All sites</strong></td>
<td><strong>77</strong></td>
<td><strong>368</strong></td>
<td><strong>445</strong></td>
</tr>
</tbody>
</table>
4 Cancer care in the Northern Territory: current arrangements

Main findings:

- High-quality oncology services in the NT, and the capacity to provide modern multi-disciplinary cancer care in the absence of a ‘critical mass’ of specialists, owe much to a long-standing relationships between clinicians in the NT and oncologists in the RAH, and associated referral pathways. Regular multi-disciplinary video-conferences between the RDH and the RAH help to sustain the quality and capacity of NT cancer services, supported by outreach visits and teleconferences.
- While some radiation-oncology services (assessment and follow-up) are provided via the video-conferences and by outreach visits, no radiotherapy facilities exist in the NT. Patients travel interstate for radiotherapy, mostly to the RAH.
- Despite the acknowledged excellence of the RAH radiotherapy services provided to NT cancer patients and the high standard of accommodation run by The Cancer Council South Australia, most patients are distressed by the 6–8 week trip interstate for radiotherapy. Their main concerns are isolation, cost, disruptive effects on family, work, and domestic responsibilities.
- Indigenous patients face even greater difficulties when they travel interstate for radiotherapy, as they are often unprepared physically and financially, and their sense of isolation from their own communities is particularly acute.
- Financial and organisational assistance provided by the NT Patient Assisted Travel Scheme (PATS) has two major shortcomings: its ungenerous policies in supporting escorts (such as family members) for patients, and the inflexibility of the travel arrangements made by PATS, which do not take account of patients’ fitness to travel at the end of a radiotherapy course,
- Cancer patients, their families, and health-care professionals in the NT all support the development of a radiotherapy unit in Darwin. However, those living in Central Australia expressed a wish to retain the freedom to choose between Darwin and Adelaide for referrals or treatment.
- Any new radiotherapy facility in the NT is likely to be associated with an increase in the overall oncology workload. Therefore a local radiotherapy service must be planned in the context of the overall development of services for people with cancer.

4.1 Overall service arrangements

Specialist cancer services exist in only two NT centres – Darwin and Alice Springs – and only limited services are available in Alice Springs.
In general, cancer patients who live in Darwin and elsewhere in northern parts of the NT obtain access to specialist care through services in Darwin, while those who live in southern parts of the NT (i.e. Central Australia) obtain access to specialist care through Alice Springs. Cancer services in both Darwin and Alice Springs have strong, long-standing relationships with services in Adelaide, especially those in and affiliated with the RAH. These relationships have grown from the professional connections of individuals: many of the leading figures in the delivery of cancer care in the NT were trained at the RAH, and several migrated to the NT from Adelaide. In addition, medical and radiation oncologists in the RAH have provided outreach services to the RDH and the ASH for many years, and general resident medical officers and some specialty registrars from Adelaide are seconded to NT hospitals on a regular basis.

Weekly joint RDH/RAH general oncology meetings by video-conference are part of cancer management in Darwin, and they provide a means for the delivery of modern multi-disciplinary cancer care in the NT. They involve surgical, radiation and medical oncologists; pathologists; nursing staff; junior medical staff; and, occasionally, radiologists and general practitioners. The video-conference sessions are described in detail in section 4.2.8.

The connections between the RAH and the RDH and ASH are based entirely on collegial relationships. No formal arrangements have ever been made.

People who need health care in the NT depend heavily on transport to centres within the NT or interstate. Under the Australian Health Care Agreement, the NT Government is responsible for ensuring that the population has equitable access to public-hospital services, regardless of their geographical location. The NT Department of Health and Community Services runs a comprehensive Patient Travel Scheme to help with this requirement. The Scheme provides assistance with both travel arrangements and costs (see section 4.4.2).

4.2 Cancer services in Darwin

4.2.1 Overview

A wide range of diagnostic, surgical and medical oncology, rehabilitation, palliative-care and psychosocial support services are available in Darwin. Most of the services are in the public sector and are provided by the RDH. Some of the medical and surgical specialists affiliated with the RDH also work in private practice, and admit patients to the Darwin Private Hospital, which is located in the grounds of the RDH.
4.2.2 Medical oncology and overall coordination of cancer care

The development of medical oncology and modern multi-disciplinary cancer care in Darwin is due largely to the efforts of an Adelaide-trained physician, Dr Sid Selva-Nayagam. Although originally appointed to the RDH as a staff general physician, Dr Selva has concentrated increasingly on medical oncology, and he is now the only specialist fully dedicated to oncology in the NT. As such, his workload and the calls on his expertise are very great. In addition to his clinical workload, Dr Selva teaches other clinicians (such as junior medical staff and emergency-department staff) about the management of cancer patients. He is a strong advocate of video-conferencing as a means of providing multi-disciplinary cancer care in a setting where a ‘critical mass’ of specialists is not available on site.

In order to preserve his own capacity to cope with a large clinical load and the pressures of being continuously ‘on call’, Dr Selva has made arrangements to ensure that problems arising out-of-hours with individual patients are first assessed by the RDH Emergency Department or another clinician. He is available at all times to take calls from the Emergency Department or queries from other clinicians. General physicians provide cover when Dr Selva is away with back up for medical oncology problems from RAH oncologists.

4.2.3 Surgical oncology

To our knowledge, no NT surgeon concentrates exclusively on cancer surgery, but most general and specialist surgeons undertake some cancer surgery. Surgical specialties represented in Darwin include urology, ear, nose and throat (ENT) surgery, gynaecological surgery, and ophthalmology. Patients with head and neck tumours outside the province of ENT surgery are referred interstate for treatment.

Surgical specialties that are not represented in the NT include colorectal surgery, neurosurgery, and head and neck (other than ENT) surgery. While local surgeons are eminently capable of dealing with emergencies in these fields, much elective cancer surgery is referred interstate. Some surgical specialty outreach clinics are conducted in Darwin, enabling limited pre-operative assessment and post-operative follow-up to be done locally. For example, neurosurgery outreach clinics are conducted by three neurosurgeons from Adelaide.

Limited access to multi-disciplinary care, notably the limited access to radiation-oncology assessment, may constrain patients’ opportunities to make choices among treatment modalities.
4.2.4 Radiation oncology

No radiotherapy services exist in the NT. As outlined in Chapter 1 (section 1.1), patients who need radiotherapy are referred to interstate services, most going to the RAH. Some cancer patients go to other State capitals, either because they choose to do so for family or other personal reasons, or because they need access to super-specialist services elsewhere, in addition to radiotherapy.

Patients requiring radiotherapy are usually referred to interstate services either by Dr Selva or by a surgeon. Those going to RAH for elective radiotherapy can be assessed in the weekly RDH/RAH oncology video-conference (see section 4.2.8); indeed, treatment planning can begin before the patient leaves Darwin. The RDH has a standardised CT couch, and this enables a CT scan to be obtained in the treatment position that can be used for radiotherapy dosimetry planning prior to treatment at RAH. The RAH and RDH have pioneered this approach and it is now being adopted in centres in Australia. However, Darwin-based treatment planning relies on the rapport between RDH and RAH services, and cannot be done for radiotherapy that is to be delivered anywhere other than RAH.

Patients requiring emergency radiotherapy (for spinal-cord compression or, rarely, respiratory obstruction) are treated with steroids and transferred as soon as possible to the RAH. As described in section 4.4.1, travel is usually on a regular commercial flight. The delay from diagnosis to treatment is usually less than 24 hr, but may depend on the time of presentation. For example, if spinal-cord compression is diagnosed in a patient presenting to the RDH Emergency Department at 2200 hr, the patient could travel on an early-morning flight the next day, arriving at RAH before 1200 hr. However, if there is no morning flight on the day, the patient would travel on a lunchtime flight, and would not arrive at the RAH until about 1700 hr.

Notwithstanding the limitations of flight schedules, the most important cause of delay in managing an emergency is the clinical recognition of the problem. For example, spinal-cord compression is not always immediately suspected as a cause of pain, paraesthesia and other sensory disturbances, lower-limb weakness, or sphincter control. Once clinical suspicion is aroused, diagnosis relies on magnetic resonance imaging (MRI), and arrangements for palliative radiotherapy interstate do not usually begin until the diagnosis is confirmed. Dr Selva’s tutorials to emergency-department staff, and an increasing ability of palliative-care staff to recognise problems requiring urgent attention, are helping to reduce delays.

A senior radiation oncologist at RAH, Dr Michael Penniment, participates in the weekly oncology video-conference, and also visits Darwin on a regular basis to conduct outreach clinics. Patients whose need for radiotherapy is recognised around the time of Dr Penniment’s Darwin clinic can be assessed in person, rather than in a video-conference. Thus Dr Penniment’s clinics represent another route of referral for radiotherapy. Dr Penniment also follows up patients who have returned to Darwin after courses of radiotherapy at the RAH, and provides advice on management.
4.2.5 Palliative care

At the time of writing, palliative-care services in the NT were under review. The RDH–based palliative-care service is largely focused on Darwin. According to Dr Rayner, the service does not have the capacity to cover rural and remote areas in the north of the NT. Oncology accounts for about 95 percent of the workload of the palliative-care service.

Dr Rayner, assisted by a registrar, is constantly on call via a toll-free telephone number for five out of every six months. He takes leave in the sixth month, with an interstate locum being engaged for his month away. A part-time position for a second staff palliative-care position has recently been created, and at the time of our visit to the RDH (the end of March 2004), it was filled on a short-term basis.

The palliative-care service accepts patients at any stage in the progression of their illness, not only after they stop receiving active treatment. GPs, community-based palliative-care nurses and generalist community nurses make a very important contribution, especially in rural and remote locations.

Patients requiring palliative radiotherapy are often reluctant to travel interstate. They have pain or discomfort, and the prospect of a four-hour flight with transfers at either end is daunting. Palliation can usually be achieved with a very short course of radiotherapy, but some patients are especially reluctant to endure the travel for only one or two days of treatment. Aboriginal people have particular concerns about travelling afar when they have a terminal illness, fearing death away from their lands. Consequently, palliative radiotherapy is probably under-utilised by NT cancer patients. Dr Rayner considered that palliative radiotherapy would be used much more if it were more accessible. Dr Penniment’s view was that patients would get better pain relief if they had better access (i.e. lived near) to a radiotherapy unit.

4.2.6 Rehabilitation

Two rehabilitation physicians and one registrar cover the whole of the NT. Members of the rehabilitation–medicine team conduct outreach services, visiting Alice Springs for three days every six weeks. The full range of allied–health professions relevant to rehabilitation, including speech pathology, is on staff at RDH. Cancer accounts for a small but significant part of the overall rehabilitation–service workload, but staffing levels are such that no capacity exists to accommodate any expansion of demand.
4.2.7 Diagnostic services

The RDH is equipped for a wide range of diagnostic imaging, including ultrasound scanning, CT scanning, MRI, and nuclear medicine excluding PET scanning. Diagnostic radiology services in the RDH are provided by one or two Darwin-based radiologists, with one additional visiting radiologist from Adelaide. The additional specialist radiology capacity is provided by an Adelaide-based private radiology practice under contract to the RDH. Some 12–14 radiologists from the Adelaide practice rotate through the RDH on a fortnightly basis. The radiologists participating in the roster typically spend a total of four weeks in Darwin each year. The practice owns or leases a Darwin apartment and other necessities of living for the use of its staff when they visit Darwin. The visiting radiologists reportedly enjoy their Darwin rotations, not only because of the setting, but also because of the range of pathology that they encounter.

While the RDH has an in-house anatomical pathology and histopathology capacity, some tumour tissues (e.g. lymphomas and sarcomas) are sent to Adelaide for expert diagnosis.

4.2.8 Multi-disciplinary care through video-conferencing

The weekly oncology video-conference is a mainstay of multi-disciplinary cancer care in Darwin, and also contributes to cancer care in Adelaide. Its effectiveness depends heavily on the input of three clinicians: Dr Selva, Dr Penniment, and Professor Ian Olver, Clinical Director of the RAH Cancer Centre, and Professor of Cancer Care at the University of Adelaide. RDH surgeons tend to participate only for discussions on their own patients. Others who participate on ad-hoc basis include radiologists, pathologists, and GPs. Nursing staff and junior medical staff are strongly encouraged to attend. Patients are invited to attend and participate in discussions on their own care, but few avail themselves of this opportunity. Patients are also offered video-cassette recordings of the discussion of their care, and some take up this offer, whether or not they attend the discussion in person.

The video-conferences comprise case presentations and discussions about the management of individual patients. The following types of cases are typically included:

- All RDH patients for whom radiation oncology is indicated.
- Difficult cases (such as those in whom a pathological diagnosis is uncertain).
- Patients who have tumours with which RDH staff do not have much experience (e.g. sarcomas).
- Patients who request a second opinion or advice from a wider forum of experience than that provided by a single practitioner.
- Patients with oncological problems that are considered to be interesting or instructive.

In addition to NT cancer patients, South Australian cancer patients treated at the RAH are also presented in the video-conferences.
4.3 Cancer services in Alice Springs

The ASH provides some surgical and medical oncology services, although its capacity is limited. Its medical staff includes two general surgeons, 2–3 gynaecologists, two orthopaedic surgeons, five general physicians, two renal physicians, one part-time palliative-care physician, and five paediatricians. Typically, 10 patients are undergoing chemotherapy at any one time, under the supervision of a general physician and the nursing unit manager in charge of the day-stay unit. The gynaecologists do not provide an oncology service, other than supporting the administration of chemotherapy for gynaecological cancer. Professor Olver visits Alice Springs once every three months to conduct a medical-oncology clinic. Professor Olver also conducts a fortnightly teleconference, in which he is available to answer questions from Alice Springs clinicians.

Diagnostic imaging facilities, which are located in the ASH, include ultrasound and CT scanning, but MRI is not available. The CT machine is privately owned. Diagnostic imaging services are provided by Adelaide radiologists on a rostered visiting basis similar to that at the RDH (see section 4.2.7). Tumour tissue for histopathology from ASH is sent either to RDH or to the Institute of Medical and Veterinary Sciences in Adelaide. Although video-conferencing facilities are available in both the ASH and the Central Australian Division of Primary Health Care, they are not used for telemedicine in oncology, and there has been no attempt to develop multi-disciplinary cancer care by video-conference.

The ASH employs one breast nurse, with no back-up. ASH medical staff identified the need for a dedicated chemotherapy nurse (possibly a nurse practitioner), who could provide back-up for the breast nurse and give the breast nurse more scope for coordinating the care of a wider range of cancer patients. This could be a valuable contribution, as ASH staff highlighted the difficulties of coordinating the care of individual cancer patients in the Central Australian environment. The coordination role cannot be assumed by resident medical staff, who have short-term rotating placements in the ASH, or by GPs, who individually have very small cancer caseloads.

The ASH-based palliative-care team treats 25–30 people per month, of whom about half are Aboriginal. About two-thirds of the palliative-care patients live in Alice Springs, and about one-quarter live in remote locations. The capacity of the palliative-care team to reach remote sites is limited, but advice on symptom control is provided to local health-care workers. The team is able to provide services for larger communities near Alice Springs (e.g. Hermannsburg), and can sometimes arrange to travel by air with the District Medical Officer to visit patients in more distant communities (e.g. Docker River).

GP s have a strong role in cancer detection and cancer care, including the delivery of palliative care. The Central Australian Division of Primary Health Care has 70 members, more than half of whom practice in Alice Springs. Eight full-time-equivalent GPs work in the Central Australian Aboriginal Congress (i.e. the Alice Springs Aboriginal Medical Service).
In the perception of Alice Springs health-care personnel, the NT does not currently have a well-developed oncology service. In general, Alice Springs personnel do not accept the current oncology service at RDH as an alternative to that provided by the RAH, even for patients who do not need radiotherapy or complex surgery. Any new Darwin-based oncology service that aspires to provide cancer care across the NT would have to show that it was comparable with the Adelaide service. Alice Springs health-care personnel consider that, to be viable and acceptable, the new service would have to demonstrate its ability to deliver high-quality comprehensive care, and its success would depend on the formation of new relationships and new outreach services.

Patients from Central Australia requiring elective or emergency radiotherapy are invariably referred to the RAH. Travel arrangements are described in section 4.4.

4.4 Patient travel

Most of our inquiries about patient travel centred on access to interstate radiation oncology services. Of course, if a radiotherapy facility were to be established in Darwin, patients would still have to travel to Darwin from all parts of the NT. If some radiation oncology services were to be established elsewhere in the NT (for example, on an outreach basis in Alice Springs and Katherine), patients would also have to travel to those centres for assessment and follow-up, as well as to Darwin for radiotherapy. Many of the issues discussed in sections 4.4.1, 4.4.2 and 4.6.1 – 4.6.3 apply to intrastate as well as interstate travel. It is important to note that, in the wet season, movement by road is limited and often impossible, especially in the northern parts of the NT.

4.4.1 Interstate air transport

Wherever possible, patients requiring elective or emergency radiotherapy travel by commercial airline to a centre where they can receive treatment. As described in sections 4.1 – 4.3, most patients are referred to the RAH. Qantas is the only carrier that operates direct services from Darwin and Alice Springs to Adelaide. The scheduled journey time from Darwin to Adelaide is 3 hr 35 min, and the scheduled time from Alice Springs to Adelaide is 1 hr 55 min. Qantas currently operates a morning flight from Darwin to Adelaide (departing at 0530 or 0730) five days a week, and an afternoon flight (departing at 1300 hr) every day. There is one flight a day from Alice Springs to Adelaide (departing at 1700 hr).

Cancer patients referred electively to Adelaide for a primary course of radiotherapy mostly travel as ordinary, seated economy-class passengers. Emergency referrals require a stretcher and must be accompanied by two professional staff (typically a nurse and a doctor). A total of 12 seats are required to mount a stretcher for a patient who is not on a ventilator, and to accommodate the staff. A hydraulic lift must be available to place the stretcher-borne patient
and associated equipment in the aircraft. Most Qantas aircraft used on the Darwin–Adelaide route can take a patient on a stretcher. However, Qantas cannot take stretcher patients from Alice Springs to Darwin because no suitable hydraulic lift is available at Alice Springs Airport, and because the scheduled aircraft transit time at Alice Springs is too short for removal of seats and securing of the stretcher. Consequently, emergency referrals from Alice Springs are flown to Adelaide by the Royal Flying Doctor Service. Stretcher transfer of oncology patients is uncommon.

Ambulant Indigenous patients are met at Adelaide Airport by one of a team of five Aboriginal drivers. The drivers take the patients either to an Aboriginal hostel (see section 4.5.3), or to other accommodation, depending on availability and preference.

After an elective primary course of radiotherapy is completed, patients return to their homes in the NT via Darwin or Alice Springs, again travelling as ordinary seated economy–class passengers on scheduled Qantas flights. Qantas currently operates a flight from Adelaide to Darwin every day at 0840 hr, a midday flight (departing at 1120 hr) three times a week, and an evening flight (departing at 1910 hr) twice a week. There is a once–daily morning flight from Adelaide to Alice Springs (departing at 0940 hr).

The cost of a return economy–class airfare from Darwin to Adelaide is approximately $1,500. Qantas charges a one–way fare of $4,600 for taking a stretcher patient and two professional attendants from Darwin to Adelaide.

4.4.2 Support for patients

The most important component of the Patient Travel Scheme for NT patients requiring radiotherapy is the Patient Assistance Travel Scheme (PATS). The PATS:

- makes flight bookings for patients travelling to and from Adelaide for radiotherapy;
- arranges direct payment by the NT Department of Health and Community Services for return economy–class airfares to Adelaide;
- arranges ticketing to and from Adelaide;
- makes accommodation bookings in Adelaide; and
- pays a subsistence allowance to patients for the duration of their time away from home.

Under some circumstances, the PATS also pays for the travel and subsidises the costs of an accompanying individual (escort) nominated by the patient. The criteria for the funding of an escort are applied rather strictly. The Patient Travel Scheme guidelines (Hospital Services, 1998/2001) define an escort as ‘a person who is regarded by the requesting practitioner and/or the treating specialist, as being appropriate and responsible for the client’s needs during the period of transport and/or accommodation and during treatment…The escort must be able to facilitate and/or participate in the patient’s care and at least one of the following:

-...
- Receive education/training critical to the continuing care of the patient at home which cannot be delivered at the patient’s local community
- Assist with patient care for the majority of the episode of travel
- Assist with basic requirements of life in an unfamiliar location
- Assist with significant language and cultural barriers
- Assist patients with disabilities
- Otherwise required for safe transport of the patient.’

Escorts are approved only if they are aged 18–plus. Escorts are automatically approved only for patients under 16 years of age.

Patients who go to Adelaide receive a subsistence allowance of $30 per day to stay in a designated hostel. If they choose to stay elsewhere (e.g. with relatives), the subsistence allowance is $10 per day. Patients who go to other State capitals for radiotherapy are required to make their own travel and accommodation arrangements. They are eligible for an airfare subsidy to the value of travel to Adelaide ($1,500 return), and also for the $10 daily subsistence allowance. Escorts receive the same airfare and accommodation support as patients.

In Darwin, the PATS is overseen by a committee comprising the Medical Superintendent of RDH, the Deputy Medical Superintendent, a patient advocate, the PATS Senior Travel Clerk, and the Directors of the Divisions of Surgery, Medicine, Paediatrics, and Obstetrics and Gynaecology. The committee meets fortnightly and discusses all patients needing interstate referral, concentrating on those whose requirements are contentious. Individual committee members can approve travel. The committee’s primary purpose is to ensure that PATS resources are used appropriately. For radiotherapy patients, the committee’s decisions mostly concern approval for the funding of escorts. In Alice Springs, no committee structure exists, and authority for approving travel rests with the Medical Superintendent of the ASH or her delegate.

Under the PATS, accommodation assistance is available only from one night before radiotherapy services (including treatment planning) begin, up to and including the night after the last treatment. Travel arrangements are made by the PATS on the assumption that patients are fit to travel on the relevant dates. No attempt is made to assess the patient’s condition and fitness to travel.

### 4.5 Interstate accommodation

#### 4.5.1 Overview

Patients undergoing primary courses of radiotherapy in Adelaide or other State capitals are usually away from home for at least six weeks. Because radiotherapy is delivered on an
outpatient basis, they need somewhere to stay. Those travelling to Adelaide usually opt to stay accommodation provided by The Cancer Council South Australia (TCCSA) or in Aboriginal hostels. Those travelling to other centres usually find their own accommodation, or stay with friends or relatives. For those who need accommodation, the various State Cancer Councils can help in finding it.

4.5.2 Facilities operated by The Cancer Council South Australia

The Cancer Council South Australia (TCCSA) operates two accommodation facilities for patients who are referred to Adelaide, either from within South Australia or from interstate, for investigation, assessment or treatment. These are Greenhill Lodge, in Eastwood, and Seaview Lodge, in Fullarton.

Greenhill Lodge was formerly a motel in a major national chain. It was purchased by TCCSA for use as a hostel in 1997. It provides ‘four-star’ motel–style accommodation, and has 55 rooms, a dining room with a full meal service (breakfast and dinner), a well–equipped shared kitchen for those who wish to prepare their own meals, a common recreation room, and garden area. It offers contact with a cancer–support social worker, and provides a minibus (driven by volunteers) to take patients to and from treatment centres. Each of the guest rooms is fully furnished with a double bed and a single bed, and has an en–suite bathroom, a refrigerator, a telephone, tea– and coffee–making facilities, and a television. The rooms are cleaned and bed linen is changed once a week, and there is a shared laundry for guests to use.

Seaview Lodge is a group of nine self–contained apartments. Patients staying at Seaview have access to the services provided at Greenhill Lodge, including catering and transport. Each apartment is fully furnished, and has one bedroom with two single beds, a bathroom with a washing machine and dryer, a fully–equipped kitchen, and a lounge–dining area with a television and video–recorder.

Both Greenhill Lodge and Seaview have off–street parking and storage areas that guests can use.

The two Lodges together have 223 beds to accommodate both patients and escorts. Over the period January–June 2003, average monthly occupancy ranged from 79 to 90 percent. Guest satisfaction surveys have rated both Lodges very highly.

The Lodges concentrate on providing accommodation, meals if required, and a supportive environment for patients. They do not provide medical or nursing care. If guests become unwell, house staff can call an ambulance or help with other arrangements to obtain medical advice. The part–time social worker helps patients with such matters as finances and difficulties associated with separation from their domestic environments.
Overall, six percent of the occupants of Greenhill and Seaview Lodges come from the NT.

4.5.3 Aboriginal hostels

While Indigenous cancer patients who travel to Adelaide for radiotherapy sometimes stay in TCCSA accommodation, they reportedly prefer to stay in hostels run by Aboriginal Hostels Limited (AHL), a company that provides temporary accommodation for Aboriginal and Torres Strait Islander people. AHL, which is funded by the Australian Government, has a network of hostels across Australia (www.ahl.gov.au). Two of its Adelaide hostels – Mulgunya and Luprina – are intended specifically to provide short-term accommodation for people receiving medical care. In both of these hostels, an Aboriginal manager is on site 24 hr a day and can assist patients with their needs. All meals are provided, and the rooms are serviced daily. Transport to treatment centres is available. Community nurses can visit patients in the hostels if they become ill, and the hostels can provide special diets if needed (e.g. bland, soft foods for patients with oral and pharyngeal conditions).

If preferred accommodation is unavailable in Mulgunya or Luprina Hostel, Indigenous patients may elect to stay in Greenhill Lodge or Seaview Lodge, or in the RAH residential wing. The RAH residential wing has one major disadvantage: it is 12 stories high, and many Aboriginal people are uncomfortable if they cannot live at ground level. Also, the RAH residential wing is fully self catering, and therefore may not meet the needs of Indigenous people who arrive unprepared (see section 4.6.3).

4.6 The perspectives of patients and their families

We met many cancer patients with and without active disease, both in the community in Darwin and Alice Springs and in RDH inpatient wards. We were also met a group of patients’ partners (spouses). The following themes emerged from our discussions with cancer patients and their partners.

4.6.1 Cancer patients in the north

Cancer patients in Darwin who had received radiotherapy in Adelaide, Perth or Brisbane welcomed the idea of developing a full-scale radiation oncology service in Darwin, with a radiotherapy unit at RDH.

All those who had undergone radiotherapy at RAH and other interstate centres gave high praise to the treatment that they had received. They considered that the education and information which they had received in the RAH Radiotherapy Department and from RAH dieticians and social workers was excellent, and that the care was professional, friendly and
compassionate. Those who had used the accommodation facilities provided by TCCSA found them very satisfactory.

However, they found that being away from home for 6–8 weeks was disturbing and created many difficulties. They had been distressed about their isolation from family and friends at a time when they were facing up to a potentially life-threatening illness. They had also been concerned about their inability to fulfil domestic responsibilities, and about the burden that was placed on other family members due to their absence. Those in the workforce had worried about their jobs, and those who were self-employed had worried about adverse effects on business and the additional workloads borne by others.

For many of the patients, the need to be away from home for 6–8 weeks imposed serious financial hardship, and the modest accommodation subsidy that they received from the NT Government did not make up for this.

Many patients and their families considered that the PATS criteria for escorts were unduly restrictive. They identified two problems:

- the application of the PATS criteria often denied fares and accommodation allowances for spouses; and
- the criteria did not take account of the possible (and not infrequent) need for spouses to make a return visit to Darwin for domestic or business reasons at some time during the long interstate treatment period.

Many patients and their families also complained about the inflexibility of travel arrangements made by the PATS. They reported that they were given insufficient notice of the date and time of departure for the outward journey, and were unable to prepare adequately for their time away. They often had insufficient time to organise their affairs before leaving for their interstate courses of radiotherapy. Important personal matters were often left unattended, and concern about these matters was a major source of stress. They included making their homes secure if they were going to be unoccupied for several weeks, making arrangements for the care of pets and plants, cancellation of regular deliveries, diversion of mail, paying of bills, and making arrangements for access to funds while interstate.

They also considered that the requirement to travel home immediately after the completion of radiotherapy created problems for patients who were unwell. We heard anecdotes of patients being told that they would lose their paid air tickets if they did not return home on the flights nominated by the PATS, and instances of patients being required to embark on long homeward journeys while still very unwell with acute radiotherapy side-effects such as diarrhoea.

In some instances, patients’ partners had accompanied patients interstate at their own expense when PATS partner funding was not provided. In some of these instances, patients’ partners had taken time off work as leave without pay, and this obviously added to the
financial burden. However, they considered that the emotional support which they had been able to provide was of the greatest importance.

Health-care professionals responsible for cancer management told us that few patients declined a primary course of radiotherapy, despite the need to be away from home for 6–8 weeks, with all the associated difficulties. However, they remarked that many patients who would benefit from palliative radiotherapy declined the offer of interstate treatment. They thought that at least some of these patients would be willing to have radiotherapy if it were available locally.

Some particular difficulties were identified for Indigenous cancer patients travelling interstate for radiotherapy, as described in section 4.6.3. A specific problem faced by Indigenous patients and their escorts from the northern parts of the NT is the relatively cold climate in Adelaide, especially in the cooler months of the year. Many Indigenous people in the north have never experienced cool weather, and do not possess appropriate clothing for it. They reportedly find the Adelaide climate very uncomfortable.

4.6.2 Cancer patients in Central Australia

In general, people living in Central Australia appeared to have a more natural affinity with Adelaide as a major centre of supply and services than Darwin.

Cancer patients in Central Australia generally supported the notion of establishing a full-scale radiation oncology service in Darwin, but indicated a desire to retain the option of referral for radiotherapy to Adelaide. They preferred to be able to make an individual choice in consultation with a multi-disciplinary cancer care team. They indicated that they would consider the Darwin option favourably only if they had confidence in the quality and range of services provided. They made it clear that they expected the Darwin service to be nationally accredited if an accreditation system were available (none exists at present).

They highlighted the need for adequate resources to run a new unit in Darwin, including:

- good access to multi-disciplinary care;
- provision for expertise in radiation oncology and the delivery of radiotherapy;
- provision for expert staff to provide psychosocial support and advice on the management of radiation side effects such as local pain and burning;
- access to accommodation facilities like those in Adelaide; and
- easy parking at RDH.

Cancer patients in Central Australia expressed concern that the establishment of radiotherapy facilities in Darwin would lead the NT Department of Health and Community Services to cut off PATS funding for interstate treatment if services could be provided in Darwin. They felt that this would effectively deprive many patients of choice.
Many of the problems associated with the PATS, described in section 4.6.1, also apply to cancer patients from Central Australia.

### 4.6.3 Indigenous cancer patients

Indigenous cancer patients face most of the problems of non-Indigenous patients, and also have some particular difficulties that can affect their outcomes and their quality of life. Service-providers’ experience, as well as research (Condon JR, personal communication, 2004), suggests that Indigenous people often present later than non-Indigenous people. Two explanations can be advanced for this. First, Indigenous people are often reluctant to present for medical assessment unless they feel unwell or have pain or discomfort. Thus they may not present, for example, with a lump that is palpable but otherwise asymptomatic. Second, many NT Indigenous people are reportedly very concerned about the gender of the practitioner who assesses them, especially if they have symptoms of a personal nature. Women want a female practitioner and men a male practitioner. Health-care personnel visiting remote locations are usually highly-trained remote-area nurses, but a choice of gender is mostly unavailable (most are female).

Several specific problems were identified for Indigenous cancer patients travelling interstate for radiotherapy. These problems were common to cancer patients from both the northern parts of the NT and Central Australia.

- **Escorts.** It was widely recognised that escorts were often particularly important for Indigenous cancer patients, but cultural factors often made it difficult for an Indigenous person to find an appropriate escort who was available to travel interstate for 6–8 weeks. We were told that escorts who were acceptable to patients, especially those from remote communities, were sometimes highly upset by the treatment environment. Those so affected could provide little support for the patients whom they accompanied, and some went home before the radiotherapy course was completed.

- **Dislocation.** While the need to spend 6–8 weeks interstate for a course of radiotherapy was stressful for non-Indigenous people, it often posed insuperable problems for Indigenous people, who tend to have wider responsibilities to their communities. For example, if a member of a community died while a patient and/or escort from that community were interstate, there would be pressure for at least the escort to return to return to the community immediately. As noted in section 4.6.1, the PATS does not provide travel funds if either a patient or an escort is required to interrupt the treatment and return home briefly for urgent domestic or community-related reasons.

- **Fear of death away from home.** Indigenous culture promotes the belief that people should die on their own lands. Indigenous cancer patients – especially those with terminal
conditions requiring palliative radiotherapy – fear that they will die while receiving treatment far from their lands. We were told that many Indigenous patients decline the offer of radiotherapy, especially palliative radiotherapy, for this reason.

- **Language difficulties.** English is often the third or fourth language for Indigenous people in the NT. While interpreters are available in the RAH for some NT Aboriginal languages, the full range of these languages is not represented in the Adelaide translation service. It may be especially inappropriate for an Indigenous escort to have to serve as the interpreter for a cancer patient, given social and family hierarchies.

- **Lack of preparation.** Indigenous cancer patients often arrive at their interstate radiotherapy centre unprepared for a stay of 6–8 weeks, having evidently left home with an understanding that they would away for only a short period. They frequently lack appropriate clothing (especially warm clothing), they often have money problems (sometimes lacking any capacity to withdraw cash), and they sometimes arrive without a Medicare or Health Care Card.

- **Lack of weekend support services.** The RAH employs an Aboriginal Liaison Officer (Ms Laura Knowles) and an Aboriginal Liaison Nurse at Clinical Nurse Consultant level (Ms Josie Owens). They provide comprehensive support, ensuring that the diverse needs of Indigenous patients are met as far as possible. This includes dealing with medical problems, providing food, and arranging for social–security payments to be diverted to Adelaide. However, their duty roster covers weekdays only. If they do not receive information about the weekend arrival of an Indigenous patient, the patient may receive no support until the Monday. Ms Knowles and Ms Owens told us of instances where Indigenous cancer patients who arrived in Adelaide on a weekend had gone without money – and even without food – until the Monday.

### 4.7 Perspectives of health–care professionals

In general, the health–care professionals whom we consulted in the northern parts of the NT were in favour of the establishment of a radiotherapy facility in Darwin, and assumed that it would be located at the RDH. They identified a need for radiotherapy in the primary treatment of newly-diagnosed cancers, the treatment of recurrences, and the provision of palliative care. They consistently expressed the view that many patients who would benefit from radiotherapy do not currently get it; and that patients would make greater and more appropriate use of radiotherapy if it were more accessible.

However, they were emphatic that a radiotherapy facility must be developed as part of an integrated multi-disciplinary cancer service with sufficient capacity to serve the NT population, taking account of geographical, demographic and socio-cultural factors. They pointed out that the establishment of a local radiotherapy service would be associated with an increase in the overall oncology workload, as more NT cancer patients who received
radiotherapy in Darwin would need and expect other aspects of their care to be provided locally. Therefore a local radiotherapy service would lead to an increased demand not only for medical and surgical oncology, but also for other specialist services that cancer patients need, such as oncology nursing, haematology, imaging services, and psychosocial support services. It would also create a need for additional capacity in general and specialist surgery, allied health (e.g. speech pathology), and high-dependency care. These needs have obvious implications for infrastructure and recurrent costs.

Health-care professionals whom we consulted in Alice Springs mostly supported the establishment of a radiotherapy facility in Darwin. However, they thought that it was important for cancer patients from Central Australia to retain the option of going to Adelaide for treatment. As one senior Alice Springs figure remarked, a new Darwin-based radiotherapy unit would have to be ‘resilient’. That is, the unit have to demonstrate an ability to deliver high-quality services consistently and reliably before Central Australian cancer patients and their carers would switch from their traditional Adelaide referral pathway.

Health-care professionals in the northern part of the NT also expressed the opinion that cancer patients from Central Australia should retain the option of going to Adelaide for radiotherapy. They anticipated that a significant proportion of Central Australian patients would prefer to undergo radiotherapy at the RAH over the RDH. However, they thought that cancer patients from the northern parts of Western Australia would probably be referred to a Darwin-based radiation oncology service (see section 5.2).

Practitioners involved in the care of NT cancer patients, both in Darwin and in Alice Springs, were unanimous in their appreciation of the services provided by oncologists in the RAH, especially Professor Olver and Dr Penniment. They were very keen to preserve the relationship between the NT and the RAH, whatever new services may be developed in the NT. They enthusiastically endorsed the concept of any new NT radiation oncology services operating in partnership with oncology services in the RAH.
5 The options for radiation–oncology services

Main points:

- Irrefutable arguments support the establishment of a radiotherapy facility in the NT.
- The facility should be part of a radiation–oncology unit that should be developed in Darwin, at the RDH.
- The radiation–oncology unit could be expected to serve the 75 percent of the NT population who live in the ‘northern zone’ of the NT; some of the 25 percent who live in the ‘southern zone’; and at least some patients from the Pilbara and Kimberley Health Zones in the north of Western Australia.
- The radiotherapy facility should be equipped with two machines, both to allow for anticipated growth in caseload and to cover planned and unplanned machine ‘down time’. The preferred configuration is two linear accelerators – either two new linacs, or one new and one second-hand linac.
- Given the relative isolation of Darwin, adequate numbers of qualified and experienced radiation oncologists, radiation therapists and physicists would have to be recruited. The unit would also require nurses and administrative personnel.
- The Darwin radiation–oncology unit should be linked and developed in conjunction with a large, established radiation–oncology service elsewhere in Australia.
- Other health–service units in the RDH will need to be enhanced as a consequence of the increasing caseload and complexity of cases that would be treated in Darwin rather than being managed elsewhere.
- Radiation oncologists who join the Darwin service will be able to assist with the general oncology workload.
- The cost of a two–linac radiotherapy facility would be $7.9 million (if both machines were purchased new). Capital works (construction) and infrastructure would cost $6.45 million. Net recurrent costs – after allowing for cost offsets – would be of the order of $2.35 million per annum. The cost per patient treated would be slightly under $8,000.
- Existing NT legislation and regulations relating to radiation safety would need to be reviewed to ensure the safety of patients and staff in a new radiotherapy facility.

5.1 Does the NT need a radiotherapy facility?

This is the fundamental question implied in our terms of reference. The answer is ‘yes’. The three reasons are given below.

I: Numbers of cancer patients who would benefit

In section 3.5 we estimated that, in 2001, some 252 NT patients with new diagnoses of cancer would have benefitted from radiotherapy.
Based on experience elsewhere (Statewide Services Development Branch, 2003), an additional 25 percent of this number of patients would have required a second or subsequent course of radiotherapy, for example to treat recurrence of cancer. A further ten percent of the total would have indications for radiotherapy relating to conditions that were not notifiable to the Cancer Registry, for example non-melanotic skin cancers (Barton et al, 2003). Thus, some 347 patients would have required radiotherapy in 2001.

In section 3.3, we estimated that 582 new cases of cancer could be expected to occur in the NT in 2010. Of these, 55 percent (320 cases) would benefit from radiotherapy. Taking account of re-treatments and radiotherapy for non-notifiable conditions, a total of 440 NT patients would require radiotherapy.

If a commitment were made to purchase radiotherapy equipment and build a radiotherapy facility in the NT in 2004, the facility would be likely to be functioning by the end of 2006. Based on the figures above, at least 400 NT cancer patients could be expected to benefit from radiotherapy by 2006.

In NSW, a single linac can provide radiotherapy for 434 patients in one year (Statewide Services Development Branch, 2003). This represents the capacity of a new linac with modern automated systems. It also allows for ‘down time’ that inevitably occurs with highly-complex machinery.

It is clear from these data that the numbers of NT cancer patients would readily fill the capacity of one linac from the time of its installation, with no scope for growth.

II : Under the current arrangements, many patients who would benefit from radiotherapy do not get it

We had great difficulty determining the numbers of NT cancer patients who actually receive radiotherapy at present.

Estimates from the RAH suggest that, in the 2002–03 financial year, some 110 NT cancer patients were treated in Adelaide (Olver I, personal communication, 2003). Data from the Queensland Radium Institute in the Royal Brisbane Hospital show that an average of 14 NT cancer patients were treated in Queensland (mainly in Brisbane, but also occasionally in Townsville) each year from 1998 to 2002 (Allison R, personal communication, 2003). Our best guess is that 10–20 NT cancer patients receive radiotherapy in Sydney, Melbourne and Perth each year; no data are available to corroborate this.

Thus we estimate that between 130 and 150 NT cancer patients have received radiotherapy each year in recent years. Most of these patients would have had newly-diagnosed cancers. However, if about 10 percent received radiotherapy for conditions that were not notifiable (say 15 out of 140 cases), and 20 percent of the remainder were undergoing re-treatment (say 25
cases), then approximately 100 patients with newly-diagnosed cancer would have received radiotherapy each year. This represents only 40 percent of those who would have benefitted from it. The overall NT radiotherapy utilisation rate for newly-diagnosed cancer would have been 100 divided by 448, or 22 percent – the lowest anywhere in Australia (Wigg and Morgan, 2001).

Alongside this poor utilisation rate, we heard several anecdotes suggesting that people who would have benefitted from palliative radiotherapy declined the opportunity to travel interstate, as described in Chapter 4.

III : The views of cancer patients, their families, and health professionals

Our extensive consultations with cancer patients, members of their families, and health–care professionals involved in cancer management highlighted the difficulties faced by the patients who do obtain access to radiotherapy by travelling interstate. Unlike many patients who travel to obtain medical care, patients having radiotherapy are almost invariably subjected to a long absence from home (typically 6–8 weeks). For many of these patients, the difficulties of access to radiotherapy could be alleviated only by a local service.

5.2 Where should a NT radiotherapy facility be located, and what populations would it serve?

If a radiotherapy facility were to be established in the NT, it could potentially serve three regions: the ‘northern zone’ of the NT, the ‘southern zone’ of the NT, and northern parts of Western Australia.

Location of a radiotherapy unit in the NT

Given the size of the NT population, only one radiotherapy facility could be contemplated. Because Darwin is the only centre with a tertiary–referral hospital, and because the population of Darwin is about half of the total NT population, a radiotherapy facility in the NT would inevitably be located in Darwin.

‘Northern zone’ NT population

Obviously a radiotherapy facility located in Darwin would be highly accessible to Darwin residents. It would also improve access for that 25 percent of the NT population living outside Darwin in the ‘northern zone’ of the NT. Overall, it would provide good or acceptable access for 75 percent of the NT population.

On a pro rata basis, we estimated that a total of 344 new cases of cancer were diagnosed in residents of the ‘northern zone’ of the NT in 2001. Based on our knowledge of the
indications for radiotherapy, 189 of these patients (55 percent) would have benefitted from radiotherapy. An additional 24 patients would have had new non-notifiable conditions, and a further 47 would have required re-treatment, making a total of 260 patients who would have benefitted from radiotherapy.

'Southern zone' NT population

The 25 percent of the NT population living in the ‘southern zone’ of the NT would gain equivocal benefits from a new radiation-oncology service in Darwin. Residents of the 'southern zone' would still have to travel a long way to receive radiotherapy, and for most of them Darwin and Adelaide are equidistant. Our consultations suggest that many or indeed most of these people would prefer to travel to Adelaide.

We estimated that a total of 104 new cases of cancer were diagnosed in residents of the 'southern zone' of the NT in 2001. Based on our knowledge of the indications for radiotherapy, 57 of these patients (55 percent) would have benefitted from radiotherapy. An additional seven patients would have had new non-notifiable conditions, and a further 14 would have required re-treatment, making a total of 78 patients who would have benefitted from radiotherapy.

Whether they chose to travel to Darwin or Adelaide for radiotherapy, cancer patients in Central Australia would be likely to benefit from any expansion of outreach services that would inevitably flow from the development of a full radiation-oncology capacity in Darwin. Our consultations suggested that many patients would welcome the choice of referral to Darwin or Adelaide, provided that they retained the choice.

Northern parts of Western Australia

It is likely that, if a well-equipped radiation oncology service were established in Darwin, patients from northern parts of Western Australia would travel to Darwin for treatment, rather than Perth, because Darwin is much closer, and communities are likely to have climatic and other affinities with the ‘northern zone’ of the NT.

We assumed that cancer patients resident in the Pilbara and Kimberley Health Zones might be referred to Darwin for treatment. These two Health Zones together embrace the following Local Government Areas (LGAs):

- Ashburton
- Broome
- Derby–West Kimberley
- East Pilbara
- Halls Creek
- Port Hedland
- Roebourne
Wyndham-East Kimberley.

The total estimated resident population of these LGAs in 2002 was 73,146, and a total of 145 new cases of cancer were notified to the WA Cancer Registry for residents of the Pilbara and Kimberley Health Zones in 2001. Of the 145 patients with newly-diagnosed cancer, radiotherapy would have been indicated for 80 patients, given a 55 percent uptake rate. An additional 10 patients with new non-notifiable conditions would have required radiotherapy, and a further 20 would have required re-treatment or palliative radiotherapy. Thus a total of 110 patients from the Pilbara and Kimberley Health Zones would have required radiotherapy in 2001.

Implications

Four different combinations of catchments for a radiation–oncology service in Darwin can be envisaged. These are as follows, in increasing order of size:

- ‘Northern zone’ NT only
- ‘Northern zone’ and ‘southern zone’ NT
- ‘Northern zone’ NT and northern parts of Western Australia
- Whole of the NT, and northern parts of Western Australia.

The estimated patient load for each of these combinations is given in Table 5.1. They range from 260 to 448 patients per annum, based on 2001 cancer notifications. A 30 percent increase in these caseloads could be expected by 2010.

**Table 5.1:** Estimated caseloads for different potential catchments of a Darwin radiotherapy unit, based on 2001 cancer notifications

<table>
<thead>
<tr>
<th>Catchments</th>
<th>New cases of cancer</th>
<th>Radiotherapy cases</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>New cases</td>
<td>Re–treatments</td>
</tr>
<tr>
<td>‘Northern zone’ NT</td>
<td>344</td>
<td>189</td>
<td>47</td>
</tr>
<tr>
<td>‘Northern zone’ and ‘southern zone’ NT</td>
<td>448</td>
<td>246</td>
<td>61</td>
</tr>
<tr>
<td>‘Northern zone’ NT and northern WA</td>
<td>489</td>
<td>269</td>
<td>67</td>
</tr>
<tr>
<td>Whole of the NT and northern WA</td>
<td>593</td>
<td>326</td>
<td>81</td>
</tr>
</tbody>
</table>
5.3 How should the service be configured?

The service configuration covers:

- the numbers and types of megavoltage machines;
- staffing;
- linkages with oncology services outside the NT; and
- linkages with other services in the NT.

5.3.1 Numbers and types of megavoltage machines

Numbers of machines

Our estimates show that one megavoltage machine would be almost entirely occupied by the caseload in 2001 (see section 5.2). However, there is an undeniable argument for two machines because of:

- the inexorable growth of the caseload; and
- the need for back-up to cover machine ‘down time’.

By the time a radiotherapy unit is established, the capacity of a single machine is likely to have been exceeded, assuming a high level of radiotherapy uptake.

All megavoltage machines require planned ‘down time’ for quality assurance and maintenance. Manufacturers of linacs typically quote a reliability rate of 98 percent. Thus a linac will be out of service for unplanned ‘down time’ for about five operating days each year. If a major breakdown were to occur, patient outcomes could be adversely affected (Barton and Withers, 1998), and respected guidelines for radiotherapy units with linacs recommend that there should be ready access to a minimum of two fully-staffed machines (Board of the Faculty of Clinical Oncology, The Royal College of Radiologists, 1996).

Types of machines

If a new radiotherapy unit were to be established in the NT, it would be equipped either with linacs or cobalt machines, or a combination. Features of linacs and cobalt machines, and their costs, are outlined below.
Linear accelerators

Two types of linacs are available: low-energy, single-modality linacs, which produce X-ray beams in the 4–6 megavolt range; and high-energy, dual-modality linacs, which produce X-ray beams in the range 6–18 megavolts, and can also produce electron beams.

Modern linacs have three features that improve their precision, efficiency, and safety, as follows.

- **Multi-leaf collimators and dynamic wedges.** A collimator shapes the X-ray or electron beam. Multi-leaf collimators have up to 120 leaves, each controlled by a servo motor, and the leaves are directed so that together they shape the beam very precisely to the anatomy of the tumour. Before the advent of multi-leaf collimators, radiotherapy departments produced individualised shield blocks to achieve customised beam shaping. The shield blocks were fashioned from low-melting-point alloys containing heavy metals, using Styrofoam moulds. Their production required a workshop with a fume cupboard and other special handling facilities. Multi-leaf collimators have greatly reduced the need for shield blocks, reducing the labour involved and the associated workshop hazards. They have also greatly improved the precision with which the radiation beam is delivered. Modern linacs are also equipped with dynamic wedges, which bend the beam so that a consistent dose can be delivered regardless of tissue thickness and contours. Dynamic wedges have replaced static wedges, again improving efficiency.

- **Auto-sequencing.** Auto-sequencing refers to computerised programming of a linac so that it delivers the correct series of fields, multi-leaf collimator configurations, and dynamic wedges to the patient. Before the advent of auto-sequencing, the delivery of each fraction was often a stop-start process, with the radiation therapist re-entering the treatment room to replace shield blocks and static wedges, and re-start the machine for the next field. Because the radiation therapist would be stationed at the far end of a corridor during each field (as described below), he or she would have to run up and down the corridor to set up for each successive field. By enabling these interruptions to be avoided, auto-sequencing is reported to have increased the productivity of radiotherapy equipment by up to 13 percent (Delaney et al, 2004).

- **Electronic portal imaging.** This makes use of an electronic image intensifier for recording each treatment field. The recordings are used for quality-assurance purposes, enabling the oncologist to compare the treatment delivered with the planned treatment.

Ancillary equipment for linacs comprises the following:

- Imaging equipment for simulation. An existing CT machine in a radiology department can serve this purpose, but a dedicated CT simulator is needed if the throughput of cancer patients requiring radiotherapy is high.
- A three-dimensional planning computer.
Physics equipment. This consists of dosimetry and testing equipment, equipment for an electronics laboratory, a computer network server station, a dark room and film processor.
- A supply of spare parts.
- General metal-working and other equipment for a mechanical workshop.

Cobalt machines

As described in Chapter 2, cobalt machines are much simpler than linacs and are, in general, very reliable. Treatment times depend on the activity of the $^{60}$Co source. If a high-activity source is used, a higher dose rate can be achieved, with shorter treatment times. However, the higher-activity source is significantly more expensive.

Cobalt machines have several limitations, as follows:

- $^{60}$Co constantly emits radiation, and has a half-life of 5.6 years. The source therefore needs to be replaced after about five years, because the radiation output falls to half of the original output, and the treatment duration is therefore doubled.
- The intensity of external-beam radiotherapy using radioactive sources is less than that achievable by a high-energy linac radiation, and may be inadequate for obese patients, especially if they have deeply-situated tumours.
- The capacity of cobalt machines to produce a highly focused beam that accommodates complex tumour shapes and minimises damage to adjacent normal tissue is limited.
- Skin doses from radiation of lower energy than that produced by linacs, and from scattered electrons, may cause more severe acute reactions, possibly with long-term scarring.
- It may not be possible to link a treatment planning computer to a cobalt machine.

Much of the ancillary equipment for cobalt machines is similar to that for linacs

Options for the configuration of a radiotherapy service in Darwin

There are four options for a two-machine service (Table 5.2).

Table 5.2: Combinations of types of machines to be considered for a two-machine radiotherapy unit in Darwin

<table>
<thead>
<tr>
<th>Option</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>New linac</td>
<td>New linac</td>
</tr>
<tr>
<td>Option 2</td>
<td>New cobalt</td>
<td>New cobalt</td>
</tr>
<tr>
<td>Option 3</td>
<td>New linac</td>
<td>New cobalt</td>
</tr>
<tr>
<td>Option 4</td>
<td>New linac</td>
<td>Second-hand linac</td>
</tr>
</tbody>
</table>
In selecting the best option for the NT, the following criteria should be taken into account:

- Reliability.
- Beam matching, which enables patients to receive treatment on one or other machine with minimal or no requirement for repeating the treatment-planning process.
- Capacity to deliver radiotherapy to all patients, regardless of their anatomical characteristics.
- Capacity to deliver radiotherapy to most types of tumours.
- Cost.
- Experience of operators.

Although cobalt machines are reliable and relatively inexpensive, we consider that Options 2 and 3 do not meet the needs of the NT for three reasons.

1. They offer a limited range of services. If two cobalt machines were installed (option 2), it would be necessary to purchase, house and maintain additional superficial and orthovoltage equipment to offer the full range of services.
2. Beam matching between a cobalt machine and a linac (option 3) is impossible.
3. Most Australian radiation oncologists and therapists and many physicists have no experience, or no recent experience, in the use of cobalt machines.

Options 1 and 4 – the provision of two high-energy linacs – fulfil all of the requirements, with the presence of the second machine overcoming concerns about reliability. The two machines would have to be similar in order to achieve beam matching.

High-energy linacs produce electrons which can be used for the treatment of superficial tumours, replacing the requirement for separate equipment such as superficial and orthovoltage X-ray machines.

Option 4 has an obvious cost advantage if a used linac in good working order is available for transfer from another radiotherapy unit. The used linac could be replaced by a second new unit in due course, enabling the staged replacement of equipment.

### 5.3.2 Staffing

As noted in Chapter 2, there are shortages of trained, experienced radiation-oncology personnel of all types, not only in Australia, but also in most other health-care systems throughout the world.

Given the relative isolation of Darwin, a degree of self-sufficiency is imperative, both in the numbers and in the capacity of staff. It would be undesirable to employ junior, inexperienced staff. While Darwin has many obvious professional and environmental attractions, its isolation and climate may also militate against the recruitment and retention of experienced staff.
The Faculty of Radiation Oncology of the Royal Australian and New Zealand College of Radiology recommends that the maximum load for a radiation oncologist should be 250 new patients per year. Thus two radiation oncologists (or two full-time equivalents) would be needed for a Darwin service.

The National Strategic Plan for Radiation Oncology (Australia) (Faculty of Radiation Oncology, RANZCR, the Australian Institute of Radiography, and the Australasian College of Physical Scientists and Engineers in Medicine, 2001) recommends that each linac should be staffed with eight radiation therapists and 1.7 physicists. The physicists should be fully-qualified medical physicists accredited with the Australasian College of Physical Scientists and Engineers in Medicine. It is noteworthy that almost all major systematic radiotherapy errors have been associated with the inadequate provision of physics expertise.

A two-linac radiotherapy service would require 16 therapists if both machines were running at full capacity, and four physicists. Given that both machines will not be running at full capacity, the requirement in Darwin will be less. In addition to therapists and physicists, an electronics technician and an instrument maker are essential.

A full-scale radiation oncology service must also be supported by nursing, administrative and clerical staff.

### 5.3.3 Linkages with oncology services outside the NT

There is historical concern about the safety and quality of radiotherapy delivered by small, isolated units (McKay and Langlands, 1990). There are overwhelming arguments for linking a service in Darwin with a large, established service elsewhere in Australia. Indeed, any service in the NT should be established only if there is a formal contractual arrangement to create a hub-and-spoke system. The benefits of this include the following.

- A guarantee of the viability of the service, with sufficient staff, expertise and back-up available.

- Access to a broad range of tumour-site specialist expertise in radiation oncology. Large radiation-oncology centres have experts in most of the major tumour sites, such as lung and breast cancer, lymphoma, and head and neck cancer. Specialists can provide outreach advice and treatment protocols, and can take over the care of complex cases.

- An established culture for high-quality service delivery. A new radiation-oncology unit must rapidly develop all the practices and attitudes that support the integration of complex processes for safety and quality. This can be greatly facilitated through a relationship with an established high-quality service.
- Access for patients who require special techniques, such as brachytherapy for cancer of the cervix, stereotactic radio–surgery for some small lesions in the brain, and total body irradiation for leukaemia.

- Access to a broader body of physics expertise for the resolution of difficult or unusual physics problems, and in cross–checking for quality assurance.

- Staff development and support. A relationship with a large service may provide a pool of staff who could cover for periods of leave, and a resource for continuing education. While many of the benefits would flow to the smaller unit, staff in the larger unit may value the experience of working in a different setting and with a different caseload.

A radiation–oncology department with which a new Darwin radiation–oncology service might form a relationship should have the following characteristics:

- be large and well–established;
- have the capacity to support all of the professions represented in the Darwin radiation–oncology service, including a fully–qualified workforce capable of standing in for Darwin staff in the event of unexpected absences (e.g. due to illness);
- be itself situated within a multi–disciplinary oncology service;
- have a demonstrated capacity to sustain professional and service–related linkages over long distances;
- have an understanding of the cultural and geographical factors that influence health and health–care in Northern Australia, including an understanding of Indigenous health issues;
- be familiar with the service–delivery environment for cancer care in the NT;
- have experience in providing outreach services and sustaining collegial relationships by telemedicine and video–conference;
- have an interest and/or experience in forming linkages with external markets in South–East Asian countries close to Northern Australia, for professional development and cancer–care referrals; and
- agree to enter into a formal contractual arrangement to guarantee the viability of the Darwin service.

It would be desirable for a new radiotherapy facility in Darwin to purchase equipment that is compatible with at least some of the equipment in the hub. This could strengthen negotiations with manufacturers for favourable pricing, and could make it easier for staff to move between the two units.
5.3.4 Linkages with other services in the NT

In order to realise the full benefits of a radiation-oncology unit, linkages with existing services must be formed. These services include surgical and medical oncology, other general and specialist surgical and medical services, general and specialist nursing services, diagnostic services, allied health services, and psycho-social support services. They may need to be enhanced as a consequence of the increasing caseload and complexity of cases that would be treated in Darwin rather than being managed elsewhere. Thus the planning for a new radiation-oncology service must provide for the strengthening of other services.

The advent of a radiation-oncology service in Darwin is likely itself to enhance the capacity of other cancer services in the NT. The radiation-oncology service will provide improved access to multi-disciplinary cancer care. Radiation oncologists will be able to support the only medical oncologist in the NT, for example by covering for him in his absence, and perhaps by accepting some straightforward cases for ongoing management. Indeed, a valuable selection criterion for radiation oncologists would be a willingness to assist with the general oncology workload, and to undertake the management of uncomplicated medical-oncology patients, such as those receiving concurrent chemotherapy and radiation treatment.

5.4 What are the requirements for housing a radiation-oncology unit?

Both linacs and cobalt machines are installed in concrete bunkers, usually located directly on the ground so that the weight of the structure does not cause problems. A concrete-lined corridor separates the room containing the radiation-generating equipment from other rooms in a radiation oncology unit. These are:

- A waiting room for patients, with changing rooms, toilets and other amenities.
- A holding area for patients in beds.
- A reception area, office space for clerical staff, and space for records storage.
- Clinic consultation rooms.
- A planning room.
- Offices for consultants, the unit manager, the chief radiation therapist, physicists, and others.
- A laboratory for measuring doses, including a dark room for film processing.
- An electronics laboratory.
- A mechanical workshop.
- A mould- and shield-making room.
- A nursing area for dressings, and a nurses’ station.
- A store room for radiotherapy machine spare parts.

While existing CT equipment in a radiology department can be used for simulation, it would be desirable for a new radiotherapy unit to set aside a shielded room that could be used for a CT simulator if one were to be purchased at a later time.
The design of a radiation-oncology unit should allow for expansion over time, as the caseload increases. For example, the unit should be situated in an area where an additional adjacent bunker could be built if needed. This is an essential part of long-term planning.

5.5 Indicative costs

Cobalt machine

We obtained a firm quote for a cobalt machine, delivered and installed, from one of the world’s leading manufacturers, located in Canada. The figure for a fully-equipped machine was Canadian $654,266. This equates to A$682,516.

This machine does not have a multi-leaf collimator. If this could be fitted, which we doubt, there would be an additional cost of more than A$500,000.

Linear accelerator

We obtained information on the approximate purchase price of linacs from a local equipment supplier. A dual-modality, high-energy linac costs about $3.3 million, delivered and installed.

This includes multi-leaf collimation, auto-sequencing, and electronic portal imaging.

The actual price of the machine may vary according to the client’s capacity to negotiate. For example, a better ‘deal’ may be obtained if two or more machines are ordered.

Ancillary equipment

The ancillary equipment listed below is common to any configuration. Only one set of ancillary equipment is needed for one or two machines.

The approximate costs of ancillary equipment are as follows (Table 5.3).
Table 5.3: Indicative costs of ancillary equipment for a radiotherapy unit in Australian dollars.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-dimensional treatment planning computer</td>
<td>700,000</td>
</tr>
<tr>
<td>Physics equipment</td>
<td>400,000</td>
</tr>
<tr>
<td>Electronic test equipment</td>
<td>50,000</td>
</tr>
<tr>
<td>Mechanical workshop</td>
<td>150,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,300,000</strong></td>
</tr>
</tbody>
</table>

**Housing for a radiation-oncology unit**

The construction of a radiation-oncology unit with two bunkers, simulation-planning and clinic space at each of two NSW regional sites has been estimated at $6 million. A further $450,000 should be allowed for essential built-in infrastructure, such as computer cabling, power sources, air-conditioning, and other requirements (Cox C and Bridgefoot R, personal communication, 2004).

**Recurrent costs**

A Review of Recurrent Costs of NSW Radiation Oncology Services was conducted by the NSW Health Department in 2002 but circulated only in May 2004 following consultation. It estimated that the recurrent average annual operating cost for a linac was approximately $1.9 million. As a guide, clinical staffing accounts for approximately 80 percent of total costs, with the remaining 20 percent related to administration, goods and services, and routine maintenance and repairs. If the life of a linac is 10 years, an additional $300,000 per annum should be set aside for machine replacement. Thus the total recurrent cost of running a linac is about $2.2 million per annum.

The cost of a two-machine unit in Darwin is likely to be substantially less than double this figure because the two machines will not be operating at full capacity, so there will be some savings in staff and maintenance. As a guess, the two-machine unit could be operated for the cost of operating one machine, plus 20 percent to maintain the second machine, plus the replacement costs. This amounts to about $2.9 million per annum for the two machines.

**Cost offsets**

**Australian Government Health Program Grant for radiotherapy equipment**

The Australian Government makes a Health Program Grant (HPG) to cover the replacement costs of linacs and some other equipment. The HPG differs between the private sector and the public sector.
In the private sector, the HPG covers the total replacement cost over the notional lifetime of the equipment, with payment capped when the replacement cost of a machine is reached.

In the public sector, the HPG applies only in respect of patients for whom a Medicare charge is raised (not for hospital inpatients). The amount paid is half the notional replacement cost of the equipment, and there is no cap. Thus in the public sector the value of the HPG is a maximum of $1.5 million per linac over 10 years. This figure can be attained only if all patients are billed to Medicare (which is unlikely). If a Medicare charge were raised for 75 percent of patients, and the total caseload were 400 patients per annum, the HPG would be of the order of $110,000 per annum.

**Savings in the PATS**

If a radiotherapy unit were to be established in Darwin, most patients requiring radiotherapy – especially those in the ‘northern zone’ of the NT – would no longer require PATS funding for interstate travel. At present, some 130 patients travel interstate each year for radiotherapy (see section 5.1). Because of clinical indications it is inevitable that some patients will still be required to travel interstate for super-specialised radiotherapy services (eg brachytherapy, stereotactic radiotherapy). If (say) 30 patients were to travel interstate, savings could be realised for the remaining 100. If it is assumed that the PATS funds an escort for half of the patients, and that the average interstate stay is seven weeks, then airfare savings would amount to about $225,000, and accommodation and subsistence savings to about $220,000, i.e. a total of $445,000 per annum.

**Earnings from Medicare**

The average Medicare earnings for radiotherapy in NSW amount to $2,644 per patient for a course of 18.5 fractions, with three fields per fraction and one planning episode. If a Medicare payment at the same rate were made for 75 percent of the 400 patients treated in a year in the NT, the total earnings would be about $800,000. In NSW, such earnings are usually dispersed in part to radiation oncologists (as salary support), and in part to pay for research and education. Arrangements are different in other States and Territories. However, the funds may give scope to offer radiation-oncology staff favourable remuneration packages that attract them to Darwin.

**Costs of ‘cross-border flows’**

If NT patients receiving radiotherapy were treated in the NT there would be savings to the NT Government because ‘cross-border’ charges would not have to be paid. If patients from northern parts of Western Australia were referred to Darwin for radiation-oncology services, the NT Government would claim payments from the Government of Western Australia according to established ‘cross-border’ charging policies. We have not been able to estimate the sums that are likely to be involved.
Overall effect

The HPG and savings in the PATS would amount to about $555,000 per annum. This could be offset against the recurrent cost of running a two-machine unit in Darwin, reducing it from about $2.9 million to about $2.35 million per annum. It would be further reduced by savings in payment for ‘cross-border flows’ for NT patients and by charging the Government of Western Australia for ‘cross-border flows’ of cancer patients to Darwin.

Summary of costs

As we have rejected cobalt machines (Options 2 and 3), attention should be directed to the cost of acquiring and operating linacs and constructing a radiation-oncology unit. These costs of developing a radiation-oncology unit and acquiring new linear accelerators are summarised in Table 5.4.

**Table 5.4:** Indicative costs of establishing a two-linac radiation-oncology service

<table>
<thead>
<tr>
<th></th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase of two new linacs</td>
<td>*6,600,000</td>
</tr>
<tr>
<td>Ancillary equipment</td>
<td>1,300,000</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>450,000</td>
</tr>
<tr>
<td>Capital works</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>$14,350,000</td>
</tr>
</tbody>
</table>

*This could be reduced by about $3 million if the second linac were procured second hand.

Net recurrent costs of running a two-linac radiation-oncology unit amount to $2.35 million per annum, including depreciation of major items of equipment.

These costs do not provide for the expansion or enhancement of any other services that may experience increased workloads as a consequence of the establishment of a radiation-oncology service in Darwin.

Cost per patient

While the capital and recurrent costs of a radiation-oncology service may seem high, the cost per patient is modest.

Assuming that a radiation-oncology service in Darwin treats 400 patients per annum, and that the major items of equipment are replaced every 10 years:

- the establishment cost component per patient is $8.35 million (from Table 5.4) divided by 4,000, which equals about $2,100 per patient; and
the recurrent cost component per patient is $2.35 million divided by 400, which equals $5,875 per patient.

Thus the cost per patient treated is just under $8,000. This compares favourably with many other major contemporary therapeutic endeavours, such as interventional cardiology, the prescription of many common drugs, and hip-replacement surgery (Barton et al, 1995).

We have deliberately excluded the cost of capital works (construction) from this calculation, because it can be amortised over the life of a building, which is usually several decades.

5.6 Legislation and regulations

Nationally and in each State and Territory, radiation safety is covered by legislation and regulations. The legislation and regulations applying in the NT should be reviewed and, if necessary, amended to ensure the safety of patients and staff in the Darwin radiation-oncology unit.

5.7 Barriers to a viable radiation-oncology service in the NT

The development of a radiation-oncology service obviously carries an appreciable opportunity cost. Radiation oncology has great value, both for cancer patients and as an important component of a sophisticated health system for the community of the NT. It is a matter for the NT Government to weigh the value of providing a radiation–oncology service against other priorities. A radiation–oncology service should only be developed if there is a commitment to safety, quality and sustainability.

The establishment of a radiotherapy service in the NT carries three broad types of risk:

1) the risk of being unable to recruit and retain professional staff with expertise that is in short supply, and of being unable to provide a continuous service without interruption due to technical factors;
2) the risk that expensive equipment will be under-utilised if patients are referred elsewhere, leading to a higher unit cost for service delivery; and
3) the risk that other health-care services in the NT will not be able to provide the expertise and capacity to support the management of radiation-oncology patients.

Risk (1) could be managed by a contract with a major interstate radiotherapy service that guarantees continuity of staffing with a buffer for contingencies, and a contract with a radiotherapy equipment supplier or a radiotherapy service that guarantees equipment reliability and prompt repairs.
Risk (2) could be managed by promoting the appropriate use of radiotherapy through professional education, multi-disciplinary patient-management systems, and the application of national accreditation standards when they become available.

Risk (3) could be managed by careful planning and enhancements of currently-available services.
6  Preferred option

6.1 Developments in Darwin

Strong arguments exist to support the establishment of a radiation–oncology service in Darwin, at the RDH. This report only deals with radiation oncology services and needs to be considered in the context of a comprehensive framework for cancer services in the NT. We understand that the NT Government intends to formulate such a framework. The need for radiation oncology is so strongly evident that the establishment of a radiation–oncology service at the RDH should not be delayed.

The service in Darwin should incorporate a radiotherapy unit with two linear accelerators. The facility should have sufficient space for installation of a CT simulator at a later date. The design should allow for expansion in the long term.

The Darwin radiation–oncology service should only be established if it is linked with a large, established radiation–oncology service elsewhere in Australia (see section 6.3).

Other NT health–care services which are likely to experience an increase in workload as a consequence of the establishment of the Darwin radiation–oncology service should be enhanced.

Radiation oncologists appointed to the Darwin service should contribute to the general oncology service offered at the RDH.

The NT Department of Health and Community Services should ensure that the radiotherapy service that is developed in Darwin is attractive to all cancer patients in the NT, including those from the ‘southern zone’, who might otherwise prefer to travel interstate for treatment.

The NT Department of Health and Community Services should offer the Western Australian Government the opportunity to refer cancer patients from northern parts of Western Australia to Darwin for radiation–oncology services. If this offer is accepted, a formal service agreement should be established between the NT and WA Governments.

6.2 Interim arrangements

Even if an immediate commitment were made to establish a radiation–oncology service in Darwin, the existing arrangements would have to continue for at least two years until the new service is operational. Some aspects of the existing arrangement warrant immediate remediation.
The PATS should make automatic provision for escorts to accompany cancer patients who are referred to the RAH and other interstate centres for radiotherapy. Because of the long duration of radiotherapy, it would be desirable for funding support to be available either for two sequential escorts, or for a single escort who would be funded to make a brief trip home to the NT during the course of radiotherapy if necessary.

Patients treated at an interstate radiotherapy centre must be certified fit to travel by their radiation oncologist before they return home on a PATS-funded flight.

The NT Department of Health and Community Services should establish and fund a position for a Patient Coordinator at the RAH to work with NT patients, their referring practitioners, and the RAH oncologists, in ensuring that all aspects of patients’ preparation, care, accommodation and travel are managed effectively.

6.3 Linkage arrangements

The NT Government should acknowledge the outstanding contribution made by staff of the RAH to the care of cancer patients in the NT.

The NT Government, through the Department of Health and Community Services, should establish a formal link with a large, established radiation-oncology service elsewhere in Australia in a hub-and-spoke relationship. The development of the proposed new radiation-oncology service should only proceed if the hub service can offer sufficient support to guarantee the viability of the proposed Darwin service.

The hub should have responsibility for providing advice on the development of the proposed new radiation-oncology service in Darwin, including detailed specification of its configuration and staffing, along the lines of the preferred option.

The NT should formally contract with the hub service to establish and run the proposed Darwin service, and it should be funded and recognised for its contribution. The RDH should promote opportunities for staff from the hub who contribute to the Darwin service to receive academic appointments at the Charles Darwin University.
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Board of the Faculty of Clinical Oncology, The Royal College of Radiologists (UK). Guidelines for the Management of the Unscheduled Interruption or Prolongation of a Radical Course of Radiotherapy. RCR, London, 1996.


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Appendix A
How we fulfilled our terms of reference

A.1 Components of the project

To fulfil the terms of reference given in the tender brief, we will carried out the following inquiries and analyses.

(a) We reviewed national service benchmarks for radiotherapy.

(b) We examined the current utilisation of radiotherapy in the NT. This included (i) a review of the incidence and distribution of cancer in the NT population and demographic characteristics of cancer patients; (ii) an assessment of the proportion of NT cancer patients who require radiotherapy, and the proportion who receive it as a primary treatment modality, taking account of cancer sites and appropriateness of radiotherapy for each site; (iii) an estimate of the proportion of cancer patients who required radiotherapy for recurrence and/or palliation; (iv) an estimate of the numbers of patients who required emergency radiotherapy; and (v) an examination of service arrangements for patients who require emergency radiotherapy.

(c) We compared NT cancer patients' requirement for radiotherapy, and their utilisation of radiotherapy, with the benchmarks given in (a).

(d) We inquired into factors affecting NT cancer patients' access to radiotherapy, and preferences for obtaining access to radiation oncology and radiotherapy services, through review of reports, consultations (including discussions with cancer patients), and site visits.

(e) We studied current referral patterns for radiation oncology and radiotherapy services provided to NT cancer patients, and the limitations imposed by the current interstate referral patterns. We consulted the major interstate providers of these services. We also investigated the capacity of other NT-based oncology services to provide high-quality multi-disciplinary cancer care.

(f) We attempted to estimate the costs of current arrangements for the provision of radiotherapy services, (i) to the Northern Territory Government, and (ii) to patients.

(g) We developed projections of the need for radiotherapy in the Northern Territory up to 2010, taking account of population growth and trends in cancer occurrence.

(h) We reviewed different models for the safe provision of radiotherapy services in small isolated departments. These included hub-and-spoke arrangements such as that in the Single Machine Unit trial in Victoria; stand-alone configurations such as that in Townsville,
Queensland; and relevant international models. We assessed these models for effectiveness, safety, feasibility and costs.

(j) We assessed the relative merits of the types and configurations of equipment appropriate for installation in Darwin, including planning systems, imaging systems, and megavoltage and brachytherapy X-ray sources.

(k) We estimated the cost of each option, including initial costs, recurrent operational costs, replacement costs spread over the anticipated life of equipment, and the costs of staff and maintenance, taking account of the projections obtained in (h).

Based on (a) to (k), we identified a preferred option and alternatives. We estimated its cost, and catalogued the benefits. Finally, we outlined implementation issues relating to the preferred option.

A.2 Methods

**Literature review.** We examined published and unpublished literature on the issues listed in section 1.3, including the anticipated radiotherapy caseload in the NT, models of remote service provision, and costing models for radiotherapy services (using available reports on the NSW costing model, and other costing models identified in the literature).

**Data compilation and analysis.** We compiled and analysed data from the NT Cancer Registry on cancer incidence and mortality, inpatient statistics collection data on hospitalisation for cancer, records from radiotherapy departments in South Australia, Queensland and Western Australia, and Medicare billings for radiotherapy, in order to determine:

- Cancer incidence in the NT, with reference to site and stage.
- Cancer mortality rates.
- The size and projected growth of population, and its age and ethnic distribution.
- The geographical distribution of the population, and the geographical distribution of cancer incidence and mortality.
- The number of visitors to the NT, including any information on cancer incidence, hospital admissions, and emergency events among visitors.
- The use of inpatient services by cancer patients.
- The number of patients requiring and receiving radiotherapy in the Northern Territory – estimated by applying the optimal utilisation tree (Delaney et al 2003) to Northern Territory cancer data.

**Consultations.** We placed particular emphasis on discussions with community representatives, and cancer patients and their carers. Our consultations included potential users of radiotherapy services from outside Darwin. We canvassed, *inter alia*, patients’ comments about the services that they received and direct and indirect costs that they
incurred. We also consulted NT health-service providers (including health-service managers, surgeons, the medical oncologist, a general practitioner, senior nursing personnel involved in cancer care, and personnel involved in patient transport within the NT and between NT and interstate referral centres). Our consultations also included discussions with senior staff of the NT Department of Health and Community Services involved in health-services planning and cancer services policy; senior staff of The Cancer Council Northern Territory, and staff in the Northern Territory (Charles Darwin) University and the Menzies School of Health Research interested in cancer and service organisation. We obtained information from providers of radiotherapy services outside the NT, including medical physicists. In the course of a visit to Adelaide, we held discussions with the current major provider of radiotherapy services for NT (the Royal Adelaide Hospital) and examined patient accommodation facilities provided by The Cancer Council South Australia.

Site visits. As part of our consultation process, we placed great value on site visits. We visited the offices of the NT Department of Health and Community Services in Darwin and Alice Springs, the Royal Darwin Hospital, the Alice Springs Hospital, the Maningrida Health Clinic in Arnhem Land, remote Aboriginal communities connected with cancer services in Arnhem Land, the offices The Cancer Council Northern Territory and The Cancer Council South Australia, the Central Australian Aboriginal Congress, the Royal Adelaide Hospital, and Greenhill Lodge (owned by TCCSA).

Cost estimates and modelling cost effectiveness. We compiled and analysed data on the cost of existing assessment and referral processes. We also estimated the potential of a new facility to attract funds to the Northern Territory from the Australian Government, both through Medicare (for patient services) and through the Health Program Grant Scheme for the replacement of radiotherapy equipment. We examined the costs of the different options for radiotherapy service delivery (as outlined above) by assessing the costs of developing a radiotherapy facility and staffing and operating it; assessing the benefits that it would bring to the people and the health system of the Northern Territory; estimating the costs associated with existing services that would no longer apply; and estimating the income that the facility could bring. We calculated overall net cost estimates and costs per patient treated.
Appendix B:
List of consultations

Ms Liz Abell
Manager, Cancer Support Services, The Cancer Council South Australia

Ms Sam Arbuthnott
Nursing Unit Manager (Day Stay Unit), Alice Springs Hospital

Ms Eva Bezak
Physicist, Radiation Therapy, Royal Adelaide Hospital

Dr John Boffa
Medical Director, Central Australian Aboriginal Congress, Alice Springs

Ms Joyce Bowden
Department of Health and Community Services, Alice Springs

Dr Steve Brady
Director of Medicine, Alice Springs Hospital

Mr Lance Brooks
Community member, Darwin

Ms Julie Burdis
Community member, Alice Springs

Ms Jill Burgoyne
Breast Care Nurse Advisory Committee, Alice Springs

Dr Jim Burrow
Neurologist, Royal Darwin Hospital

Ms Kate Cameron
Counsellor, The Cancer Council South Australia

Mr Peter Campos
Assistant Secretary, Acute Care Division
Northern Territory Department of Health and Community Services

Ms Sandra Clyne
Palliative Care Association, Alice Springs
Dr Jean Collie  
Director of Medical and Clinical Services, Alice Springs Hospital

Ms Kate Davis  
Registered Nurse, Radiation Therapy, Royal Adelaide Hospital

Mr Wayne Dillon  
Patient advocate, The Cancer Council Northern Territory

Ms Esther Evans  
Community Nurse, Northern Territory Department of Health and Community Services  
(as a community member)

Dr Howard Flavell  
Director of Rehabilitation, Royal Darwin Hospital

Mr Kar Giam  
Radiation Therapist, Royal Adelaide Hospital

Mr Bill Green  
Prostate Cancer Support Group of the Northern Territory, Darwin

Ms Jenny Green  
Community member, Darwin

Dr Stephen Guthridge  
Director, Health Gains Planning

Dr Christine Haighe  
General practitioner, Maningrida

Ms Marg Hodgetts  
Support Services Coordinator, The Cancer Council Northern Territory

Mr Shane Houston  
Assistant Secretary, Office of Aboriginal Health, Family and Social Policy  
Northern Territory Department of Health and Community Services

Dr Diane Howard  
General Physician/ Endocrinologist, Royal Darwin Hospital

Dr Alan Hughes  
Visiting Obstetrician and Gynaecologist, Alice Springs Hospital
Ms Mary Hughes  
Executive Director of Nursing, Royal Darwin Hospital

Mr Gus Hunter  
Ear, Nose and Throat Surgeon  
Head, Division of Surgery, Royal Darwin Hospital

Mr Michael Jenkins  
Clinical Nurse Consultant, Maningrida Health Clinic

Mr Robert Kennedy  
Community member, Darwin

Ms Ellen Kerrins  
Program manager, The Cancer Council South Australia

Ms Denby Kitchner  
Nursing Director Medical, Royal Darwin Hospital

Ms Laura Knowles  
Aboriginal Liaison Officer, Royal Adelaide Hospital

Ms Lena Leone  
Social Worker, The Cancer Council South Australia

Ms Adeline Lim  
Operations Manager, Radiation Therapy, Royal Adelaide Hospital

Ms Liz Locke  
Bosom Buddies Central Australia, Alice Springs

Ms Jane Mackintosh  
Manager, Patient Assistance Travel Scheme  
Northern Territory Department of Health and Community Services

Dr Colin Mathews  
Staff Specialist in Medicine, Alice Springs Hospital

Mr Fred Miegel  
Senior Nurse in Palliative Care, Alice Springs Hospital

Mr Ralph Nicholls  
Physicist, Radiation Therapy, Royal Adelaide Hospital
Mr Roger Nixon
Radiotherapy Planning Coordinator, Royal Adelaide Hospital

Ms Cheryl North
Community member, Alice Springs

Dr Len Notaris
Medical Superintendent, Royal Darwin Hospital

Professor Ian Olver
Clinical Director, Royal Adelaide Hospital Cancer Centre
The Cancer Council Professor of Cancer Care, University of Adelaide

Ms Josie Owens
Aboriginal Liaison Clinical Nurse Consultant, Royal Adelaide Hospital

Dr Michael Penniment
Radiation Oncologist, Royal Adelaide Hospital

Mr Ian Pollock
Senior Policy Officer, Policy and Service Development, Acute Care Division
Northern Territory Department of Health and Community Services

Mr Carl Putt
Acting Director, Business and Performance Monitoring, Acute Care Division
Northern Territory Department of Health and Community Services

Dr Rob Rayner
Director of Palliative Care, Royal Darwin Hospital

Dr John Reece
Radiologist, Adelaide
Visiting radiologist, Royal Darwin Hospital

Dr Sid Selva-Nayagam
Specialist Physician, Royal Darwin Hospital

Ms Helen Smith
Director, The Cancer Council Northern Territory

Mr Chris Strange
Manager, Accommodation Facilities (Greenhill Lodge & Seaview Lodge)
The Cancer Council South Australia
Ms Vicki Taylor
Central Australian Coordinator
Northern Territory Department of Health and Community Services, Alice Springs

Ms Susan Tulley
Breast Cancer Voices, Darwin

Associate Professor Tim van Doorn
Head of Physics, Radiation Therapy, Royal Adelaide Hospital

Dr Susan Wearne
Chair, Central Australian Division of Primary Health Care

Ms Fran Wickes
Breast Cancer Support Group of the Northern Territory, Darwin

Dr Sally Williams
Palliative Care, Royal Darwin Hospital

Mr Keith Williams
Prostate Cancer Support Group of the Northern Territory, Darwin

Ms Pat Williams
Community member, Darwin

Associate Professor Brenda Wilson
Chief Executive Officer, The Cancer Council South Australia