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Recommendations for achieving a world-class radiotherapy service in the UK

Final report prepared for Cancer Research UK

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Executive summary

Radiotherapy is an essential cancer treatment that experts suggest contributes to four in ten cases where cancer is cured.[1] It is a relatively cheap, safe,[2] cost-effective treatment that is associated with high levels of patient satisfaction[3]. Yet the radiotherapy service does not get the attention it deserves and is underfunded compared to other cancer treatments.

Recent developments in England, such as the Prime Minister's commitment that all patients should have access to the innovative radiotherapy they need,[4] and the subsequent establishment of the Radiotherapy Innovation Fund, have boosted radiotherapy services. The recent NHS England and Cancer Research UK Vision for Radiotherapy[5] has set ambitious goals for what radiotherapy services should be offering patients over the next 10 years. Investment in new equipment in Wales and Scotland, and new satellite centres in Scotland and Northern Ireland, are encouraging.

But it is recognised that more work is needed to achieve a truly world-class radiotherapy service across the UK. Radiotherapy services remain under capacity, vary in terms of quality and patient access, and have been slow in adopting new techniques compared with the leading radiotherapy services internationally[6]. Radiotherapy capacity needs to increase considerably in response to the UK's ageing population, with an estimated increase on current activity of 72% in England, 61% in Scotland, and 97% in Wales by 2016.[7, 8]

Although there is general optimism about the changes in England, some experts remained concerned that they may hinder progress. Scotland, Wales and Northern Ireland also face barriers in improving their radiotherapy services. This report explores the barriers that currently exist to building a world-class radiotherapy service across the UK, identifies the components that make up a world-class radiotherapy service, and defines the factors that need to be addressed.

Conclusions and recommendations

The overall observation arising from this research is that national oversight and leadership for radiotherapy services should be improved in all UK nations, along with strong national strategies. National leadership must be able to drive the overall improvement of radiotherapy to match the standards of the best. Leadership bodies must be able to address shortcomings in the service such as a) centres' resources b) management and staffing and c) adequate capacity to meet demand.

In **England and Scotland** the roles of leadership bodies - the Radiotherapy Clinical Reference Group (CRG) and the Radiotherapy Programme Board, respectively - are vital for driving improvements and should be enhanced. **Wales** would benefit from better national oversight to improve coherence across their radiotherapy services. **Northern Ireland** is challenged primarily because it is a small service, although recent developments are encouraging.

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[1] Department of Health (2012) *Radiotherapy Services in England*, p12
[2] Williams, M.l V. and. Frew.T. L (2011) "How Dangerous is Radiotherapy?" *International Journal of Radiation Oncology*Biology*Physics* 79.5 (2011): 1601
[3] NCAT (2013), National Radiotherapy Patient Experience Survey
[4] https://www.gov.uk/government/news/eight-thousand-patients-to-benefit-from-advanced-cancer-treatment
[5] Cancer Research UK and NHS England (2014), *Vision for Radiotherapy 2014-24*. https://www.cancerresearchuk.org/sites/default/files/policy_feb2014_radiotherapy_vision2014-2024_final.pdf
[6] See Annex 4 for further details on the international benchmarking
[7] Round, C. E., et al.(2013), "Radiotherapy Demand and Activity in England 2006–2020." *Clinical Oncology*
[8] Northern Ireland figures were not provided but, given that access to radiotherapy was the lowest of the four countries at 32%, it is likely that Northern Irish activity will need to increase significantly.

Across the UK there is wide variation in the quality of services, patient access to radiotherapy, and the availability of advanced techniques. Mechanisms such as the Malthus modelling tool[9] and peer review exist to identify issues in centres and regions. In England there is a service specification to set the standard for all radiotherapy services. Tools like these should be used to drive equitable quality improvement so that all patients receive a high standard of care wherever they are treated. The benefit to patients and value for money provided by radiotherapy means that this service is worthy of further support and investment.

The results of this research identified seven components that make up a world-class radiotherapy service and how the UK compares to these. These are outlined below, along with the main recommendations (further recommendations can be seen on page 32):

1. ***Ensuring sufficient capacity***

There is insufficient capacity in UK radiotherapy centres to meet demand in the short to medium term. In England access to radiotherapy varies from 25% to 49% depending on the centre, with the average around 38%.[10] International modelling indicates that 52% of cancer patients should receive radiotherapy as part of their treatment[11]. Modelling in England suggests access should be around 40.6%.[12] While debate continues about the true proportion of patients that should receive radiotherapy, it is clear that some patients are still missing out. The emergence of hypofractionation techniques (fewer, higher dose treatments) for more common cancers and plans for out-of-hours working in England may encourage better use of existing capacity and should considered when looking at future capacity needs. National leadership and strategies for radiotherapy in all four UK nations must support the service to achieve the appropriate capacity.

- **Each national government needs to address variation in access to radiotherapy. They should each map capacity and demand requirements and ensure that the service in their country is of high quality and is well resourced to meet current and anticipated demand.** While it may not be appropriate for all centres to provide all types of treatment, all must achieve minimum quality standards in the treatments they provide. New models of working in partnership should be explored to ensure this, and appropriate access to all radiotherapy techniques. Capacity issues could be addressed by investing in out of hours working to ensure that equipment is utilised more effectively and efficiently. Travel time is thought to have an impact on referrals to radiotherapy treatment - where appropriate, building satellite centres for treatment could both increase capacity and increase access rates. However, this must be seen in the context of emerging hypofractionation techniques, which may reduce the number of times patients have to travel.
- **The roles of national leadership bodies in England and Scotland – the Radiotherapy Clinical Reference Group and the Radiotherapy Programme Board, respectively – should be enhanced.** In England, the Radiotherapy CRG should be well supported and resourced to enable effective leadership and promote system wide improvements. In Scotland, there is a clear need for better national leadership to promote coherence and collaboration between SCAN, NOSCAN and WOSCAN and ensure a more joined up radiotherapy service.
- **The Welsh Government should consider creating a national leadership body with oversight for radiotherapy services across Wales**. This body could include the Welsh

[9] http://www.camradiotherapy.org.uk/malthus
[10] Cancer Research UK (2009) *Achieving a world-class radiotherapy service across the UK*, p15
[11] Ibid
[12] Round, C. E., et al.(2013), "Radiotherapy Demand and Activity in England 2006–2020", *Clinical Oncology*

Government, NHS Wales, Local Health Boards, and senior experts and management from each of the radiotherapy centres in Wales.

2. *Delivering state-of-the-art technologies*

New radiotherapy techniques are more targeted and reduce side effects for patients. However, shortages in up-to-date linear accelerators, technology to adapt existing machines to deliver more complex treatments, and a lack of staff both in terms of numbers and those with the skills and confidence to use new equipment, mean these techniques are underused in the UK. Sustained effort is needed to ensure patients access the advanced radiotherapy they need across the UK.

- **NHS England should build on the success of the Radiotherapy Innovation Fund and continue to promote better access to advanced and innovative radiotherapy, focusing on technology and workforce skills development.** The Radiotherapy Innovation Fund was a successful, cost-effective intervention in improving the levels of IMRT delivered in England. The delivery of Image Guided Radiotherapy (IGRT) remains low, so it may be appropriate for attention to turn to this advanced technique as the focus of future initiatives. The devolved administrations should consider similar mechanisms to increase access to advanced techniques as appropriate.
- **NHS England should extend the provisions of the current payment mechanisms to incentivise the provision of specialist technologies and techniques like 4D adaptive technologies, SABR, IGBT, and molecular radiotherapy, where evidence has shown their benefit.** Investment needs to be made to ensure these techniques are taken up and disseminated across the NHS. The use of hypofractionation where evidence has shown it to be beneficial should also be incentivised. An assessment of the cost of these techniques should be done rapidly so that they can be paid for appropriately. More widespread use of these complex techniques should be encouraged as they treat cancer more accurately and reduce the side effects. The devolved administrations should also consider costing and payment mechanisms in developing appropriate solutions for encouraging the uptake of advanced techniques.

3. *Adequate numbers of staff with the appropriate training*

Sufficient numbers of highly trained staff is crucial to meeting patient demand and ensuring delivery of advanced techniques. Across the UK trainee retention and high attrition amongst radiography students is a cause for concern, alongside the lack of specialist staff in radiotherapy clinical oncology and palliative care. There is a particular shortage of medical physicists entering the profession. Staff training remains excellent in some centres whilst others lack balanced training programmes that combine academic rigour and hands-on learning.

- **Health departments in each UK nation, working with the professional bodies, should develop and implement a strategy to address radiotherapy workforce needs.** Strategies should consider investment in education, compilation of best practices domestically and internationally, and develop clear national educational targets. Strategies should also support greater co-operation between professional bodies and government agencies responsible for implementing broader health workforce agendas (for example Health Education England), to address issues around skills shortages and imbalances in the radiotherapy workforce. It is particularly important to address the insufficient number of medical physicists and the attrition rate of student radiographers.

4. ***Effective funding and commissioning mechanisms***

There are concerns that the new funding mechanisms in England will not cover the significant capital costs of new radiotherapy equipment, and are not sufficiently flexible to adapt to the fast pace of change in radiotherapy.

- **In England, the Department of Health, NHS England and NHS Trusts should continue to work with the NHS Supply Chain to ensure sufficient numbers of up-to-date linacs across England and capitalise on the economies of scale, which can be delivered through co-ordinated purchasing. Similar mechanisms should be utilised in the devolved nations where needed.** In England, the purchase of equipment is ultimately the responsibility of NHS Trusts who must ensure that having sufficient equipment to provide high quality, safe and cost effective services for patients is the main investment priority for radiotherapy centres.

5. ***Building research capacity***

Research is a key indicator for world-class radiotherapy. Currently, research capacity is concentrated in larger and more successful centres. Services find it difficult to dedicate time for research, both in terms of machine availability and staff time. Further work is needed to embed research into the culture of the radiotherapy service in the UK.

- **All centres should be encouraged to engage with national research and should enter patients in national trials.** Centres must have the appropriate capacity and dedicated time for research, including radiotherapy machine availability and workforce capacity. Centres not undertaking research should be aware of national trials and be encouraged to enter patients on trials where appropriate.

6. ***Evaluation and quality systems***

Radiotherapy in the UK currently lacks an 'evaluation culture'. While the radiotherapy dataset will allow external scrutiny of the quality of services provided at each centre (in England, Scotland and soon Wales), evaluation of performance should also be supported by appropriate incentives for service development.

- **Radiotherapy centres should create the conditions to make each centre a 'learning organisation'.** This could include developing specific evaluation tools to enable the centre to connect its mission and goals with activities and expected outcomes; creating a space to enable staff and service users to reflect on and review their performance, and; taking advantage of the opportunities new technologies (such as electronic patient records) provide to enable closer monitoring of treatments and their outcomes.

7. ***A good working culture supported by strong leadership***

Pressure on the service, through staffing shortages and increasing demand, means that radiotherapy centres have a culture of over-working. This allows little time for staff to share learning and to undertake the necessary planning to implement new technologies and techniques. Even in the best centres, co-ordination between the three key professions - therapeutic radiographers, oncologists and radiotherapy physicists - could be improved. Management and leadership skills remain under-developed.

- **National governments should develop and fund national programmes to provide training in management and leadership skills.** Improving leadership in radiotherapy centres is vital. Local leadership is often crucial for turning a struggling centre into a thriving centre and that strong leadership is a necessity at every centre to push for continuous improvements.

Introduction

Radiotherapy is a highly effective way of treating cancer. Four in ten people whose cancer is cured receive radiotherapy. The adoption of new radiotherapy technologies, which increasingly help deliver precise treatment, will lead to even better outcomes and will mean that more patients will benefit. Radiotherapy works well in combination with other treatments: it has been estimated that the addition of radiotherapy to other treatments improves five-year survival by 16% overall for all cancer patients.[13] This compares extremely favourably with cytotoxic chemotherapy, which contributes to five-year survival by just 2%.[14]

Radiotherapy in the UK is delivered in 59 radiotherapy centres: 50 in England, 5 in Scotland, 3 in Wales and 1 in Northern Ireland. Radiotherapy is a relatively inexpensive cancer service which, for example, accounts for only 5% of the total cancer budget in England - disproportionately low considering its contribution to cancer survival overall.[15] However, it is seen as expensive because linear accelerators (linacs) generally cost over £1 million and need to be situated in a bunker, costing over £500,000.[16] Other than the linacs themselves, staff costs, like in other health-related activity, dominate long-term financial planning, accounting for 54% of the costs of radiotherapy services.[17]

There have been improvements to the service in recent years. In England, there has been a significant reduction in treatment waiting times, with virtually all centres now achieving the target of 94% of patients seen within 31 days.[18] It is estimated that, in comparison with waiting times in 2003, this reduction in waiting times saves around 2,500 lives annually.[19] The Radiotherapy Innovation Fund has improved access to IMRT, with at least 5,800 more patients a year having access to this treatment as a result.[20] However, variation in access to radiotherapy still exists between centres.[21]

Scotland and Wales have invested in new technologies in recent years.[22] However, the staff capacity and skills to use this to its full potential remains an issue. The centre in Northern Ireland is establishing a satellite service, expected to be up and running in 2015, so that they can provide effective access to radiotherapy for the whole population.

Recent patient experience survey data show very high levels of patient satisfaction regarding radiotherapy treatment.[23] This is impressive in the context of the demands on staff time and the repetitive nature of visits. The results of the survey for radiotherapy patients across England during April 2012 (shown below in Figure 1) found that 69.3% of patients reported excellent service, with 24.4% stating that it was very good.[24] The survey also found that 92.9% of patients considered themselves to have been treated as a 'whole person' whilst undergoing radiotherapy.

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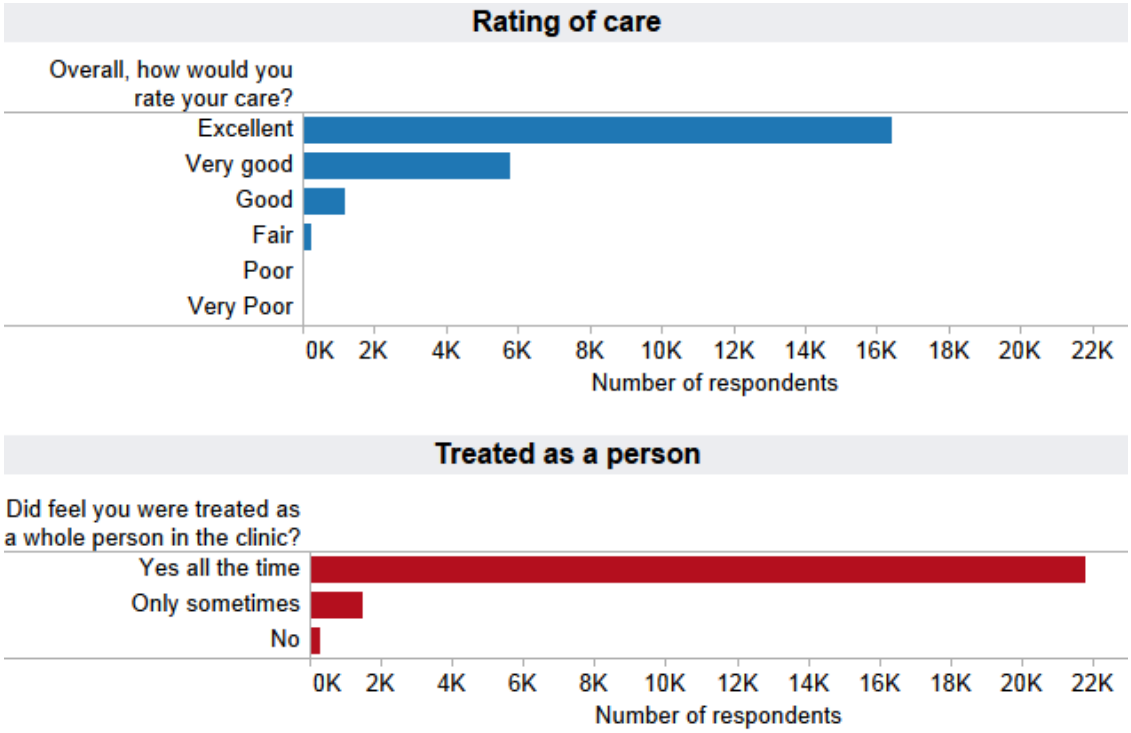
[13] National Cancer Action Team (2009), *Intensity Modulated Radiotherapy (IMRT): A Guide for Commissioners*, p5
[14] Ibid, p5
[15] Ibid, p6
[16] There are currently 270 linacs in operation in England alone.
[17] NCAT supra note 12, p6.
[18] Supra note 1
[19] Ibid, p8
[20] Cancer Research UK et al (2013), *The Radiotherapy Innovation Fund: An evaluation of the Prime Minister's £23 million fund*
[21] Hoskin P.J. et al (2013), "Variations in Radiotherapy Delivery in England – Evidence from the National Radiotherapy Dataset", *Clinical Oncology*
[22] http://www.scotland.gov.uk/Publications/2014/02/4321/3
[23] Comparable recent data on service quality are not available for Scotland, Wales and Northern Ireland.
[24] NCAT (2013), National Radiotherapy Patient Experience Survey

Figure 1: Radiotherapy survey – patient responses on experience of care



Whilst these improvements are impressive in relation to how patients perceive the service, they do not consider treatment outcomes or standard of radiotherapy treatment regimens offered to patients. The main question this report looks to address is whether the UK provides a *world-class* radiotherapy service: if not, why not, and what can be done to reach this world-class standard?

We found there is a broad consensus, from the literature, from examples of best practice, and from experts and practitioners in the field that a world-class radiotherapy service must have:

- Sufficient capacity and activity volume to create economies of scale;
- Full utilisation of up-to-date technology and equipment;
- Sufficient trained staff to meet demand and develop the service;
- Adequate capital investment with an appropriate business model and commissioning structure to utilise it effectively;
- High quality research and the transfer of research knowledge into practice;
- An evaluation culture and robust measurement tools to support evidence-based practice and to drive forward quality;
- A work environment and organisational culture,supported by effective leadership and management, that promotes joined up planning, multi-disciplinary working, good radiotherapy practices and standards, and research.

Some of these attributes are already in place in centres in the UK. Some UK centres are among the largest radiotherapy centres in the world, with very large numbers of highly skilled staff, sufficient linac capacity and funding. This puts them in a position not only to deliver a high level of quality of care, but to carry out world-class research.

Other, smaller centres are also among the leading innovators in delivering efficient and effective services. Recent advances in technologies and techniques mean that some patients now have access to advanced radiotherapy procedures, like Intensity Modulated Radiotherapy (IMRT), Image Guided Radiotherapy (IGRT), 4D Adaptive Radiotherapy (4D-ART), Stereotactic Ablative Radiotherapy (SABR – also referred to as Stereotactic Body Radiotherapy or SBRT) and Proton

Beam Therapy[25] (to be established in England by the end of 2018).[26] These innovative treatments have the potential to significantly improve patient outcomes as well as the quality, efficiency and effectiveness of service delivery.

Yet while there are areas of best practice in the UK, there is also a prevailing view that some things need to change to enable a truly world-class service to be delivered to all patients. Recent reviews of services, carried out by government,[27] the NHS,[28] and by leading non-governmental organisations in the field[29, 30] highlight challenges faced by the service. Namely, that radiotherapy in the UK remains under capacity, slow in adopting new techniques compared to other countries, with variation in standards across each country and a need for strong national oversight and leadership. Achievement of service level targets[31] remains variable both between and within centres. To reach the optimum access rate and optimal dose,[32] radiotherapy capacity needs to account for the UK's ageing population, with an estimated increase on current activity of 72% in England, 61% in Scotland, and 97% in Wales by 2016.[33, 34]

Using a variety of methods, this report explores the reasons for this current state of the service, set against the emerging trends in radiotherapy in the UK and in comparison countries. It considers what the radiotherapy service should look like, and provides recommendations for overcoming the barriers to achieving a world-class service in the UK.

[25] Currently patients who require Proton Beam Therapy are treated outside the UK.
[26] See glossary for more details on the different forms of radiotherapy.
[27] Supra note 17
[28] NHS Improving Quality (2013), *NHS Improvement Cancer*
[29] Supra note 8
[30] Northern Ireland Cancer Network (2012), *Overview of Cancer Services in Northern Ireland*
[31] Including 24% of radical fractions delivered by inverse planned IMRT; 6.8 linear accelerators per million population; no machines over 10 years old; throughput of 7300 fractions per machine per year; four tier model of therapeutic radiographer implemented; and reducing staff attrition levels.
[32] Round et al (2013) have suggested the optimal access rate for England should be revised down from 52% to 40.6%. However the article also suggested that radiotherapy patients are currently not being given close to sufficient dosages. Because of this Round et al recommend a similar increase in capacity to Cancer Research UK's 2009 report, *Achieving a world-class radiotherapy service across the UK* (supra note 8).
[33] Round, C. E., et al.(2013) "Radiotherapy Demand and Activity in England 2006–2020." Clinical Oncology; CRUK at supra note 8
[34] Northern Ireland figures were not provided but given that access to radiotherapy was the lowest of the four countries at 32%, it is likely that activity in Northern Ireland will need to increase significantly.

The main barriers to world-class radiotherapy in the UK

Our research has highlighted five key areas in which there are barriers to achieving a world-class radiotherapy service in the UK. These are broadly common across the four countries, though the exact nature and significance of the issues vary from country to country. The barriers are:

1. Inadequate capital investment;
2. Shortages of skilled staff;
3. Ineffective work culture and leadership;
4. Fragmentation of services and a lack of national coherence;
5. Inequitable resources, services and outcomes.

Inadequate capital investment

Achieving world-class status is only possible with significant investment in technology to meet rising demand and provide the treatments that patients need, including advanced radiotherapy techniques. The issue of under-investment in new technology affects England and Northern Ireland more than Scotland and Wales, where investment has been relatively high over the last few years.[35]

In the 50 English centres there are currently 269 linacs, 143 machines short of the target of 412 by 2016 set out by the Department of Health.[36] But buying new machines to cater for growing demand is only one of the challenges. Existing machinery also needs to be replaced, and compliance with the recommendation of replacing linacs over 10 years old would mean replacing 38 machines now and a further 101 by 2016. Since each new machine costs around £1 million, and in some cases there would be an additional £500,000 cost of siting the machine in a radiation-proof bunker, new investment in machines potentially puts significant pressure on NHS Trust budgets given the high 'up-front' costs involved.

However, the emergence of hypofractionation techniques and out-of-hours may make better use of existing linac capacity and should be taken into account when thinking about future capacity demands. In any case, it was considered that funding has not been consistently available for purchasing new equipment due to combination of several factors:

1. Inadequate replacement programmes negotiated at Trust level;
2. Resistance to discard equipment halfway through a lifespan to keep up to date with the newest technology;
3. The 'risk-averse' nature of senior staff to change current practice and not enough highly trained and experienced physicists needed to commission new machines.

A new national commissioning structure in England provides the opportunity for, "better deals for new technology", especially if the procurement power of the NHS is sufficiently harnessed through the NHS supply chain.[37] The recent Department of Health £30 million deal to purchase 20 new linacs in England shows how this is possible and provides a step in the right direction to addressing the problems noted above.[38]

[35] Delphi experts in Scotland and Wales.
[36] Supra note 18 at p30.
[37] Delphi expert in England.
[38] https://www.gov.uk/government/news/department-of-health-invests-additional-30-million-into-cancer-treatment

Shortages of skilled staff

Increasing investment in new linacs alone would not create a world-class service. While it is acknowledged that some centres may have adequate staffing, a chronic shortage of staff was reported in the centres where we interviewed. Two case study sites were below 50% of the recommended number of oncologists and physicists. This was worse in smaller centres. In one small centre, difficulties in attracting senior physicists have put a "massive strain" on existing physics staff. This can slow progress in introducing equipment, as time is not available to commission these new machines even if funding is available.[39]

> "We would need enough competent staff to ensure a safe service. Later in the day not all the hospital staff are around." (Physicist, small centre)"
>
> "...however, larger centres are also likely to be challenged by the cost of overtime, particularly on weekends, and ensuring the appropriate skill mix at all times to support extended working hours." (Oncologist, large centre)

In Scotland, all machines are now configured to deliver the new targets set for IMRT. It is estimated that professional capacity will need to double in order to meet current demand and the targets set for 2016. The experts interviewed agreed that the slow uptake of IMRT in Scotland is a result of insufficient staffing rather than equipment.[40] In particular, implementation of advanced radiotherapy is thought to be hampered by a lack of "staff confidence and a robust training or mentoring scheme for all grades of staff."[41]

Overall staff levels throughout England remain far below desired levels.[42] Whilst the numbers of radiographers, oncologists and physicists have increased in the past four years, the rates of increase need to more than double in order to meet anticipated demand.[43] It has been argued that radiographer shortages are hampering England's ability to achieve optimal radiotherapy treatment levels.[44] These shortages are linked to low levels of staff retention across all bands, and particularly for trainee radiographers.[45] Current low staffing also means that plans for extending the hours of radiotherapy centres to increase radiotherapy capacity and so enable more patients to be treated on each linac will be very hard to implement, especially in smaller centres.[46]

> "Whilst better at attracting staff, large centres have difficulty in retaining staff due to a lack of opportunity for quick career progression. This continuous turnover challenges the ability of management to plan and expand, as well as retain valuable skills." (Radiographer, large centre)

In Wales, recently commissioned extra radiotherapy equipment and the potential for extended working hours will require increased staffing of clinical and medical oncologists, radiographers, clinical scientists, dosimetrists and engineers.

In Northern Ireland, the staffing capacity appears to be less marked.[47] The recent supply of radiographers has exceeded demand but, in common with the UK as a whole, Northern Ireland suffers from a shortage of medical physics staff.

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[39] Delphi expert in England.
[40] Delphi expert in Scotland.
[41] Ibid.
[42] Supra note 1
[43] Ibid
[44] The Centre for Workforce Intelligence (2012), *Workforce risks and opportunities: therapeutic radiographers*
[45] http://www.sor.org/learning/document-library/improving-retention-radiotherapy-workforce-role-practice-placements-student-attrition-pre-8
[46] Radiographer interview, small centre case study.

Education and training

A contributing factor to staff shortages and low retention is lack of opportunity for post-registration training and continuing professional development. A consistent theme in the literature, interviews and case studies is the importance of job design, continuing professional development opportunities and support from immediate management as pre-requisites for retaining staff. Yet it is clear that many centres, particularly smaller ones, provide fewer opportunities for professionals to develop their existing skills, learn new ones and engage in research.[48] This is a pressing problem in the light of the increasing adoption of advanced radiotherapy treatments, training for which, according to some reports and to the views of experts consulted in this study, is inadequate in the UK in comparison with other countries such as the US, Canada and the Netherlands.[49]

Attracting physics and oncology staff, and trainees, is understood to be easier in larger centres due to a perception that these can better provide effective education, training and continuing professional development.[50] Larger centres are also able to offer greater opportunity for staff to focus on areas of particular interest, whereas smaller departments rely on staff to do "routine work".[51] Careful consideration of job design, continuing professional development opportunities and support from immediate management has been shown to be vital to retaining staff.[52]

There is also a need for more focus on planning of complex treatments in the training of clinical oncologists. Practical experience of advanced techniques is important, and may have lagged behind due to slow adoption of these across all areas of site specialist practice.

Ineffective work culture and leadership

The main elements associated with the organisational structure and processes of radiotherapy services are highlighted in the literature as barriers to achieving a world-class service in the UK. These are: the working culture; leadership and management skills; and service planning and professional relationships.

> "We've had 5% growth in fractions each year for five years now. Staff levels haven't been growing at the same rate. We're at threshold level at the moment... I rely on goodwill and dedication." (Physicist, large centre)

Working culture

Over-working is a common fact of professional life in the radiotherapy service. This has been amplified in recent years by the increasing adoption of advanced radiotherapy treatments, which require more complicated planning procedures. There is a prevailing perception that the culture of overworking has a negative effect on staff morale and motivation and, ultimately, works to the detriment of quality in service provision.[53]

> "This lack of oncology capacity also impacts on physics and radiography staff. Delays in delivering treatment plans, for example, impede physicists in configuring linacs and carrying out quality assurance." (Physicist, small centre)

In the face of budget cuts across the NHS, staff numbers have failed to keep pace with the increased

[47] Supra note 8
[48] Head of service interview, small centre case study.
[49]. Benstead, K.,Gilson, D., Hanna, L.,, Radhakrishna ,G. McAleer, J., Bloomfield, D., Jyothirmay,R.,,. Campbell, A . and. Booth, J (2012), "Training in Clinical Oncology: Results of the Royal College of Radiologists' Survey of New Consultants" *Clinical Oncology* 24, 143-148)
[50] Oncologist interview, Independent Trust.
[51] Physicist interview, Independent Trust.
[52] Probst H, Griffiths S (2007), "Retaining Therapy radiographers: What's so special about us?" *Journal of Radiotherapy in Practice*; 6(1):21
p21
[53] Oncologist interview, large centre case study.

demand on centres.[54] More complex planning for advanced treatments has added further pressure, and dealing with this requires improved leadership and departmental planning.

Leadership and management skills

A combination of advances in technology, increasing adoption of advanced treatments, setting of new targets and, recently, changes in commissioning and funding procedures (in England) has created new challenges for leaders and managers working in radiotherapy services. Radiotherapy planning in the NHS now requires a higher level of flexibility, managerial commitment and dynamism. The case study below highlights good practice from a small centre. However, it is considered that current leaders are not necessarily suited to "the pace of change and leadership required"[55] and there is evidence that training is currently failing to adequately equip some key staff with the skills necessary to fulfil their managerial roles.[56]

The current focus is on recruiting managers with clinical expertise, research excellence or technical skills and not skilled managers. A Royal College of Radiologists survey of new consultants found that only 44% of trainees agreed or strongly agreed that training had equipped them to fulfil their managerial roles.[57] Interviewees for our study also stated that this was the case for physicists and radiographers.

LEADERSHIP IN A SMALL CENTRE

With appropriate leadership, and staff willing to adapt, one of the six case studies managed to deliver IMRT and IGRT to all patients with certain tumours only two weeks after the first IMRT treatment and have maintained this standard ever since. This was in spite of junior and senior understaffing, and the long planning time early in the process. This progress was thought to be in part due to senior staff being seen to sacrifice their own time to achieve roll out. Sometimes being a small centre can facilitate this as "it's easier to communicate and gives us freedom to make changes." (Manager, small centre).

Service planning and professional relationships

The increasing complexity of planning and treatment in advanced radiotherapy appears to be creating greater time pressures in an organisational environment that is already characterised by a culture of over-working. This, it is argued, has led to differences in treatment planning across the country and means that pre-planning meetings may not always take place.[58]

"Treatments are more complex now.... Software can help, a good skills mix can help, but as a consultant you don't have the time to look at the service as a whole." (Oncologist, large centre)

[54] Physicist interview, large centre case study.
[55] Radiographer interview, large centre case study.
[56] Benstead, K.,D. Gilson, D., y, L. Hanna, L., z, G. Radhakrishna ,G. y, J. McAleer, J.,D. Bloomfield, D.,R. Jyothirmay,R.,i k, A. Campbell, A . andJ. Booth, J. (2012), "Training in Clinical Oncology: Results of the Royal College of Radiologists' Survey of New Consultants" *Clinical Oncology* 24:143-148
[57] Ibid, p143
[58] Roques, T (2013), *Volume definition in clinical radiotherapy - how can we improve the weakest link in the treatment chain?*

This situation is linked to a set of issues around differences in professional and departmental working practices. Whilst physicists and radiographers have a focus on radiotherapy, oncologists' time is not protected for radiotherapy activities.[59]

As radiotherapy planning sessions are not protected for most clinical oncology trainees, these can be frequently interrupted by non-emergency work.[60] There is also concern that the split role of clinical oncology between radiotherapy and chemotherapy detracts from the time clinicians can spend on radiotherapy.[61] More broadly, a recurrent theme in the literature, interviews and case studies suggests that radiotherapy is seen as a very specialised service in which working relationships remain within the established clinical community. This limits the amount of cross working throughout wider multi-disciplinary and multi-departmental teams. This constrains the kind of collaborative working that needs to develop to support more effective work and service planning.

International trends

COLLABORATION AMONG PROFESSIONS AND INSTITUTIONS

A world-class radiotherapy service depends on many factors and agents and, thus, relations and negotiation among all stakeholders is a must for a mutual understanding and collaboration. This process happens at different levels, ranging from the multidisciplinary groups inside the service to analyse the different cancer cases, to the inter-organisational relation to support research activity carried out by universities and hospitals, passing by the political and entrepreneurial arena to consider how to finance the service being efficient at the same time that quality standards are assured.

Communication and transparency are key elements, as conditioning factors and objectives may be changing, diverse, and certainly dependent. Particular structures or regular meetings (multidisciplinary groups) and skills and training requirement (leadership and managerial training) are integrated in the leading radiotherapy services, as they are open systems.

"Our "Comprehensive Cancer Centre" network assures that all patients are equally well treated. However this issue is seen as particularly difficult to be transferable and each country will have a different optimal system." (Dutch expert) The Comprehensive Cancer Centre of the Netherlands (IKNL) is an umbrella organisation composed of seven cancer centres in the Netherlands. The IKNL mission is to ensure that every patient with cancer in the Netherlands receives optimal care close to home. IKNL does not provide patient care, but provides support to carers in oncology and palliative care.

Fragmentation of services and a lack of national coherence

A coherent national strategy for radiotherapy is seen as an essential ingredient to build a world-class radiotherapy service. This theme was repeated consistently in the literature, in the expert interviews and in the benchmarking exercise carried out in this study. However, the research

[59] Oncologist interview, independent Trust case study.
[60] M. Lei,M., Stokoe,J.,MacLeod,N., Yates, L., and Mir, R. (2012), "Clinical Oncology Training: The Trainees' Perspective" *Clinical Oncology* 24, 22-24
[61] Oncologist interview, large centre case study.

evidence suggests that the current situation in all four countries are characterised by fragmentation rather than coherence.

Scotland

In Scotland, the Radiotherapy Programme Board, a sub-group of the Scottish Cancer Taskforce, oversees implementation of radiotherapy actions outlined in Scotland's 2010 cancer plan, *Better Cancer Care, An Action Plan*. The extent of the responsibility this body has to provide national leadership or oversight for radiotherapy is not clear. Scotland has five radiotherapy centres, a population of 5.2 million and an administrative structure that divides Scottish radiotherapy into three networks, SCAN, NOSCAN and WOSCAN. While it is seen as a positive that a strategy is in place, and that discussions are taking place about how the centres can work more closely together, the fragmented nature of the system is considered by some experts to impede progress.[62]

> "It is the leadership in identifying, aligning and delivering a programme which has moved services forward as a whole across England... barriers may now begin to grow again and we may see a more piecemeal approach to service development." (England Delphi expert)

Wales

Wales does not appear to have clear national leadership or oversight for radiotherapy. Civil servants advise the Welsh Government in association with the Clinical Oncology Sub-Committee (COSC), a sub-group of the Wales Scientific Advisory Committee (WSAC). Authority and accountability is given to seven Local Health Boards and Velindre NHS Trust, which contains the largest radiotherapy centre in Wales. The Welsh Delphi panel experts were satisfied with the strategic direction for radiotherapy but believed that there is a current lack of coordination across services in Wales and noted the tension between the independence of Health Boards and the need to take a coordinated approach to specialist services.

Northern Ireland

In Northern Ireland there is currently one cancer centre in Belfast. Oversight of cancer services is provided by the Northern Ireland Cancer Network (NICaN), a collaborative of organisations involved in planning cancer services in Northern Ireland.[63] Northern Ireland is challenged primarily because it is a small service. This means there is only a small reservoir of truly world-class knowledge of radiotherapy in the country to draw upon. Experts also suggest that "commissioners are not fully aware of radiotherapy issues".[64]

England

In England, there remain uncertainties as a result of recent NHS reforms, with radiotherapy commissioning now the sole responsibility of NHS England, advised by the Radiotherapy CRG.

NHS England has committed to continue to progress towards delivering "a world-class radiotherapy service" using the *Cancer Reform Strategy* (2007) and *Improving Outcomes: A Strategy for Cancer* (2011) as a template. According to a Delphi expert, NHS England has recognised that this will "include a requirement to further embed IMRT and IGRT as options for treatment".[65] To achieve this, commissioners need to ensure "capacity for future demand, the equipment is fit for purpose and the location of centres fits with patient need."[66]

[62] Scottish Delphi expert.
[63] http://www.cancerni.net/
[64] Northern Irish Delphi expert.
[65] English Delphi expert.
[66] Ibid.

Until April 2013 the National Radiotherapy Advisory Group (NRAG) and subsequent National Radiotherapy Implementation Group (NRIG), with support from the National Cancer Action Team (NCAT), were responsible for the coordinated implementation of national policy on radiotherapy. This leadership function has been replaced in part by the Radiotherapy CRG, and somewhat by the Radiotherapy Board.[67]

Management staff at the case study sites were concerned that the dissolution of NCAT will have a negative impact on service development. NCAT had been at the forefront of pushing service improvements over many years. Delphi panel experts thought that the leadership changes would impede improvements in radiotherapy services, with one suggesting that "there is little doubt they will have a negative impact…" and that "…the ground gained since the NRAG report will be largely lost".[68]

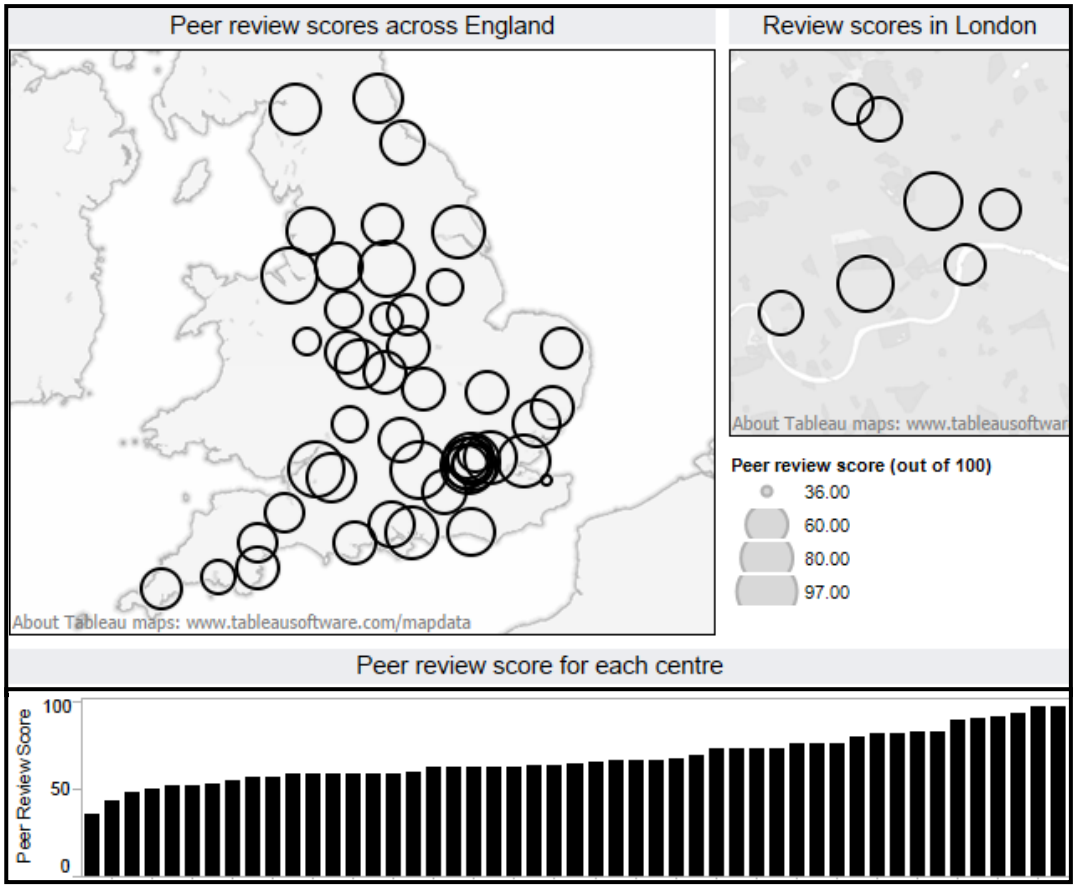
It is difficult to assess whether the changes are promoting coherence or fragmentation. Most managers at the six case study sites said that a lack of information and uncertainty from commissioners made it impossible to say how national commissioning would impact on their service. Some thought there would be winners and losers as "some local leaders seize the opportunities which a reorganisation provides" and others do not.[69] It is thought that the Radiotherapy CRG would take time to set its work programme, and that without dedicated support, would be unlikely that the CRG could take strong and informed action, and drive improved service quality in radiotherapy.

Inequitable resources, services and outcomes

In England, the 2012 Peer Review system, which comprises scores given by peers on quality and process standards, gave an indication that there is a clear gap between the centres which struggle and those which thrive, as shown in Figure 2. At the thriving radiotherapy centres a critical mass of well-trained staff, high numbers of linacs and effective research capacity supports good practice and drives quality. A small number of centres are leading the way and a large number are in various stages of "getting there eventually and a number who (without support, drive and encouragement) will never make it".[70] Delphi panel experts suggested that the high performing centres should play a more engaged role in helping or collaborating with other centres to ensure quality provision of services. The range in overall Peer Review[71] scores (from 36 to 97 out of 100)[72] supports this point and demonstrates the need for better partnership working and collaboration.

[67] A structure established in April 2013 jointly by the Society and College of Radiographers, the Institute of Physics and Engineering in Medicine, and the Royal College of Radiologists, to support the continuing development of radiotherapy.
[68] Ibid.
[69] Ibid.
[70] English Delphi expert.
[71] Peer review scores measure judging staff levels and other service indicators; low scores indicate understaffing and room for service improvement.
[72] Department of Health. (2012). Radiotherapy services in England 2012.

Figure 2: Peer review scores on generic measures in England, 2011*



*Interactive available here: http://public.tableausoftware.com/views/RTcentres/Peerreviewgenericscore

Patient access

There is also variation in access rates to radiotherapy for patients. In England, access rates across centres ranged from 25.2% to 48.8% of cancer patients receiving radiotherapy.[73] Lower access rates were strongly correlated with increasing deprivation.[74] This was supported by the findings of our interviews, in which some experts suggested low uptake of radiotherapy is linked to poverty and ethnicity.[75] Providing an equitable service requires moulding the service to the needs of the local population; this can be achieved with demand modelling based on local cancer incidence and should include data on deprivation, performance status and stage at presentation.[76]

Location of services

Productivity is sometimes less important than providing a balance between the effective use of local resources and the right levels of access to the treatment in local populations.[77] Geographical dispersal and understaffing can become problematic and some experts believe has led some oncologists to refer patients for chemotherapy or surgery rather than radiotherapy. This is especially likely for patients who live outside the 45 minute travel time recommendation for radiotherapy.[78]

[73] Williams, M. V. and . Drinkwater, K.J. (2009), "Radiotherapy in England in 2007: Modelled Demand and Audited Activity", *Clinical Oncology*, 21: 575-590
[74] Ibid
[75] Radiographer interview, large centre case study.
[76] Supra note 72
[77] Supra note 1
[78] Oncologist interview, large centre case study.

While surgery may be the more appropriate course of action in some circumstances, there is a concern that radiotherapy may be overlooked due to a perception that other forms of treatment could be more quickly provided in some situations.[79] An awareness of a lack of capacity in radiotherapy may also influence the treatment choices of referring oncologists.[80] These factors mean that, where satellite services do not exist and staffing is far under capacity, even the 40.6% target referral rate for radiotherapy may not be met.

The emergence of hypofractionated techniques in routine practice, for example the treatment of patients with breast cancer in 15 rather than 25 fractions, or more extreme hypofractionation within clinical trials, would mean fewer trips to hospital. This, along with plans to extend working hours of radiotherapy centres, may change the dynamic between travel times, distance and both patient and clinician choice.

The introduction of new technologies, the need for high quality, and limited staff and financial resources may drive new links and collaboration between centres to deliver this complex mixture of demands across a wider catchment population.

[79] Ibid
[80] Ibd.

How are radiotherapy services likely to develop in the next decade?

This section sets out the likely scenarios that may develop in each nation over the next five to ten years if trends remain as they are.

These scenarios were reached by asking an open question to each of the Delphi panel experts in round one followed by a closed question in the second round on whether the experts agreed with our proposed scenario. These represent an expert view on the potential development of radiotherapy in each of the four UK nations.

Likely scenario in Scotland:

"In the next decade, with the continued slow recruitment of necessary staff, a gradual loose collaboration in the East (SCAN and NOSCAN) will evolve as challenges of recruiting specialists in the North get worse; WOSCAN remains too busy to work in partnership."

Whilst experts in Scotland did not welcome this, several believed this scenario was likely happen. However, this could be avoided if these three issues are addressed:

1. According to one expert, the absence of an obvious clinical leader for radiotherapy.
2. Central political commitment to local delivery and regional networks, with vested interests between SCAN and WOSCAN preventing coherent national oversight.
3. There is no joined-up strategy to address endemic staff shortages.

Likely scenario in Wales:

"In the next decade, with North Wales managing itself initially, Velindre will start leading cancer across Wales in the next five years and in particular radiotherapy services in Wales, allowing more strategic planning, engagement across services, better value contractual relationships with industry, access to latest technologies, and coordination of research improvement."

This scenario was viewed as a positive development given the current fractions of authority. Welsh experts saw this as likely to come about for two reasons.

1. Velindre has the highest concentration of radiotherapy expertise, which makes it a natural leader, particularly for developing and accessing the latest technologies and coordinating research. But centres from all parts of the country will need to work together to ensure improvements are made across the whole system. Experts also saw a potential future benefit in Welsh centres working and exchanging knowledge with English centres.
2. The Welsh Government and the three Welsh radiotherapy centres have a vested interest in keeping partnerships stable. It was agreed that stability is the most likely way to maintain the rate of service improvements.

Likely scenario in Northern Ireland:

"In the next decade, radiotherapy services will become more accessible, use more recent technology, and with greater capacity."

This scenario was viewed as a positive development and appears to be the most certain of the four scenarios. Northern Irish experts saw this as likely to come about for three reasons.

1. A new satellite centre is opening in West Northern Ireland, which will greatly increase radiotherapy capacity and access rates, providing treatment for 500,000 and including three linacs.
2. New machines have recently been commissioned which will deliver IMRT, IGRT, 4D ART, respiratory gating and stereotactic radiotherapy.
3. New service standards have been set which services in Northern Ireland will soon have the ability to meet.

Likely scenario in England:

"In the next decade, after implementing the tariff and national commissioning, successful centres thrive; struggling centres have difficulty in reaching national standards, become underfunded, and inequity increases across England."

Whilst the scenario above is not desirable, the majority of experts believed that this would be likely in the coming five to ten years if improvements were not made. The experts raised concerns that the barriers to improving radiotherapy services in England may not be overcome by the new system. This scenario could be avoided by ensuring:

1. Momentum is not lost following the disbanding of NRIG and the Radiotherapy CRG gets up to speed quickly and sets its work programme. As the CRG has few resources at its disposal, there were concerns that it will have little opportunity to explore and develop the radiotherapy services.
2. The radiotherapy service targets stretch the service to improve, and are not matched to the lowest level providers' capability.
3. The CRG and service targets are drivers for change and incentives are offered to continue to develop services.
4. Struggling Trusts are supported appropriately to ensure they improve and meet the national standards. Leadership must be strong enough at the local level to drive quality improvement in these Trusts.
5. Trusts create appropriate business plans to replace equipment; the high capital costs of equipment mean many machines have become outdated. If not addressed, centres will continue to struggle to deliver high quality treatments.
6. The new payment mechanisms are flexible to keep pace with emerging evidence-based treatment options.
7. There is collaboration between centres to provide adequate site-specialist expertise, access to new technologies and to optimise the treatment of rarer cancers.

"The main concern with changes to the NHS is the continuing lack of clarity around radiotherapy commissioning since the policy was announced." (England Delphi expert).

Projection of future of the radiotherapy service in England

The projections for England are more difficult to assess than those for other countries due to the large changes in commissioning and governance from April 2013. A number of issues might influence the future direction.

National commissioning

Experts saw national commissioning as a potentially positive development in the search for a fairer service. But a lack of communication about how national commissioning works in practice was raised as a concern.

> "Standardising as one will lead to overall improved quality." (England Delphi expert)

One view put forward is that national commissioning "could really drive improvement if it focuses on measureable outputs and monitoring the quality of service actually delivered to patients."[81] Concentrating commissioning knowledge in one place may have a positive impact: "the case for extra necessary resources may become easier, especially in rare tumour sites or tumour sites that require a certain expertise, by creating a greater knowledge base."[82]

It was thought that national commissioning would make the service more consistent and therefore less of a postcode lottery; drive service improvement through focusing on monitoring and rewarding measurable outputs; and expand and integrate the knowledge base. It would "bring a standardised methodology to the commissioning of the service"[83], and should make the service more consistent.

> "The introduction of a tariff for radiotherapy is also considered likely to redistribute funding for radiotherapy rather than significantly increase the total funding pot." (England Delphi expert)

However, this will only happen if outputs and outcomes are actively monitored and tough decisions are taken when Trusts do not invest appropriately in their services.[84] Making data available on performance and quality may also help struggling centres to improve.[85]

National tariff

A national tariff for radiotherapy has also been introduced. Previously, each radiotherapy centre had a local tariff, which resulted in centres receiving differing amounts for providing the same services. Funding did not necessarily distinguish between the complexities of radiotherapy when considering payment. The national tariff covers almost all treatments and pays almost double (£1096) for IMRT radiotherapy than for conventional radiotherapy (£567).

> There is also concern that the tariff could seriously penalise treatments that use fewer fractions:
>
> "Cancer sites such as breast cancer are making huge progress in clinical trials to reduce the number of fractions but maintain patient outcomes. This is likely to be better for patients and more cost effective. It is important that the complexity of treatment is recognised and centres are not financially penalised just by delivering less fractions." (England Delphi expert)

Some experts and staff considered the new national tariff for radiotherapy a step forward (for instance, in supporting and rewarding more complex treatment procedures). Due to the complexity weightings given to IMRT and IGRT and the standardisation of charges within the tariff, this is seen as a better system to achieve a fair income from activity. Subjecting each centre to the same funding structure may also create a system where learning can be transferred more easily. At some centres "the tariff will help us make financial cases more accurately."[86]

However, there were concerns that perverse incentives could lead to life extension being inappropriately prioritised over quality of life and that monitoring would require additional resources for

[81] Delphi expert in England.
[82] Delphi expert in England.
[83] Delphi expert in England.
[84] Delphi experts in England.
[85] Oncologist interview, large centre case study.
[86] Physicist interview, large centre case study.

data collection.[87] This is linked to broader concerns around creating a 'cost-centred culture' within radiotherapy as a result of the introduction of the tariff. Centres that perform well may be considered to be too costly to maintain.[88] This is because successful resource-heavy centres are not solely delivery-focused and conduct many research projects that are not remunerated under the tariff system.

A cost focus may also fail to capture intangibles such as research and reducing patient anxiety. Of the case study sites, it was the smaller centres which were more procedure-orientated that were likely to receive more funding than before, whilst larger centres with high research and development capacity were likely to see a shortfall under the new system. One large research-intensive Trust calculated that they will have a shortfall of "around £1m" under the new system.[89] Whilst this is a small sample, it is worth exploring in more depth whether research centres are disadvantaged by the tariff, particularly as research is considered a key driver for continuous improvement of radiotherapy services both nationally and internationally. In addition, unless properly funded, implementation of emerging techniques such as hypofractionation is "likely to be patchy."[90] There remains scepticism amongst staff and experts on whether the tariff is flexible enough to adapt quickly to pay for the delivery of new treatments.

Accurate data collection through the radiotherapy dataset (RTDS) will be needed to ensure the tariff is appropriately rewarding quality radiotherapy. However, data collection needs more resources and there are concerns that, without dedicated funding, this could divert staff time from patient care. Comparisons were made with the US where "they employ armies of people to collect the data and make sure they get paid".[91]

The introduction of a tariff also presents an opportunity for managers to generate income for the Trust, which can be reinvested in their own centres: "we'd like more autonomy. [At the moment] income and outgoings are totally separate. If we had more control... we could plough money back into the Trust".[92]

Increased access to advanced radiotherapy

The results from the Delphi panel, case studies and benchmarking exercise suggest a more positive scenario regarding the impact of the Radiotherapy Innovation Fund on access to IMRT in the English radiotherapy service. This was confirmed in the evaluation report published by Cancer Research UK and the professional bodies.[93] The £23 million Fund, announced in October 2012 by the government, was commonly seen as a timely and welcome initiative - one that will make it easier to provide a high quality service for a broader constituency of patients. By providing additional planning capacity for IMRT the Fund has helped improve both planning and treatment time for IMRT. The investment has been helpful in increasing capacity for delivering IMRT. By providing upgrades to linacs the Fund has enabled centres to get more out of their capital equipment, enabling them to "update our technology through the lifetime of the linac".[94] But rather than revolutionising the service, "the Fund has allowed providers to make some of the step changes necessary to offer a wide range of treatments to a wide group of patients".[95]

[87] Head of service interview, independent Trust case study.
[88] Physicist interview, independent Trust case study.
[89] Ibid
[90] Delphi expert in England.
[91] Manager interview, Independent Trust case study.
[92] Physicist interview, large centre case study.
[93] Supra note 19
[94] Head of service interview, small centre case study.
[95] Delphi expert in England.

Components of a world-class radiotherapy service

This section focuses on what is needed to move the UK radiotherapy service to a world-class service. This assessment of what a world-class radiotherapy service would look like is, in turn, set against the likely scenarios that are currently developing.

The research highlighted seven pre-requisite components of a world-class radiotherapy service. These components emerged consistently across all sets of data - expert opinions from both the Delphi panel and the international benchmarking research, and supplemented by literature, case study interviews, and interviews with patient representatives. These components therefore show a high degree of consensus and correlation across these sources on what it means to be world-class in radiotherapy and the best ways of creating a world-class service.

The research also highlighted additional elements that help in achieving a world-class service. These additional elements were identified by some experts and in some literature, but were not consistent across all four sets of data.

Seven common elements are needed to deliver a world-class service. These are:

1. Strategies and mechanisms to increase and sustain capacity;
2. Strategies and mechanisms to deploy and utilise state-of-the-art technologies;
3. Effective staffing and training policies and arrangements;
4. Appropriate and effective funding and commissioning mechanisms;
5. Mechanisms to consolidate and grow research capacity;
6. Evaluation and quality systems;
7. Changes in work culture and organisational structures.

The components of the envisaged world-class service are described in more detail below.

1. Strategies and mechanisms to increase and sustain capacity

To achieve a world-class service, two essential things are needed to increase and sustain capacity.

Firstly, greater coherence across the radiotherapy service in each country. Each service in the UK presents a different set of contextual factors. Within each landscape, services compete for resources and in some areas competition is fiercer than in others. This leads to inconsistencies and unevenness in the services provided. Coherent strategies on how to increase and sustain capacity are therefore vital.

Secondly, a reversal the historical pattern of prolonged under-funding that had once led to radiotherapy becoming a ‘cinderella service’ in comparison with other branches of health.

These two fundamental measures need to be supported by other reforms that include:

- National leadership and oversight of services, with measures to help services that fall behind;
- Appropriate administrative and governance systems to ensure effective and appropriate distribution of resources and maintenance of quality, for example, through establishing and reinforcing quality guidelines;
- Measures to address skills shortages, to ensure staffing levels meet demand, and to improve workforce planning.

2. Strategies and mechanisms to deploy and utilise state-of-the-art technologies

Particularly in England, one of the main barriers to developing a world-class service is the current need for more up-to-date linacs capable of delivering core treatments to patients who need it, as well as delivering more complex and specialist treatment. England would need an estimated 52.5% increase in the number of machines if the target set for 2016 is to be achieved. This would bring the service in line with the level of services currently being provided in countries such as Canada, the Netherlands and Sweden. However, the potential for out-of-hours working and increase in use of hypofractionation techniques are also likely to provide added capacity and should be considered as part of the solution.

Providing state-of-the-art equipment is only part of the technology 'story'. Currently, the wide implementation of IMRT, IGRT, and SABR is hampered by the lack of staff confidence and the absence of robust training and mentoring schemes for all grades of staff, particularly in Scotland.[96] A world-class radiotherapy service needs to enable the integration of equipment purchasing with appropriate training mechanisms that support the acquisition of the technical skills required to use the equipment effectively.

In turn, acquiring and using equipment effectively is dependent on putting clear commissioning and funding mechanisms in place that allow centres to plan for the significant capital costs required for new machines, without a reduction in the services they need to provide.

3. Effective staffing and training policies and arrangements

A world-class radiotherapy service will have high levels of staff retention and low levels of attrition. This means a service that works to ensure staff are well motivated and provides sufficient opportunities for well-trained staff to achieve promotion.

A world-class service will achieve the right balance of professional staff to meet the particular profile of demand in each service, as well as providing appropriate levels of required specialist skills, for example in palliative care. There is currently a particular shortage of medical physicists across all four nations, with too few coming through from the universities in the past decade.[97] A world-class radiotherapy service has effective links with higher education to ensure stronger relationships between educational provision, skills supply and service demand. A world-class service also utilises skills more effectively through examining service requirements and optimising skills.

This in turn requires appropriate, high quality training and continuing professional development. World-class services tend to use a combined approach that integrates academic training, hands-on experience and new teaching approaches and methods. This would include using information and communication technologies such as on-line systems (which are considered to be under-used 'on the ground' especially in small centres).[98]

4. Appropriate and effective funding and commissioning mechanisms

As noted above, building and maintaining sufficient capacity to meet demand, in terms of equipment, staffing and skills, depends on the right funding and commissioning mechanisms being in place. Developing a world-class service would therefore require a number of revisions to current mechanisms, including:

[96] Delphi expert in Scotland.
[97] Service manager interview, small service case study, and physicist interview, Foundation Trust case study.
[98] Manager interview, small service case study (1), manager and radiographer interviews, small service case study (2).

- Building adaptability into the commissioning system at both local and national level. This system should have national oversight, but enable local services to apply a business model that is suited to their particular needs, and which ensures the quality of their service provision is not penalised by capital costs incurred through purchasing new equipment;
- Building flexibility into the national tariff in England and the payment mechanisms that exist in Scotland, Wales and Northern Ireland, to support the development of specialist and complex techniques and practices. This would require much more rapid evaluation of new techniques and the imposition of a price that reflects the clinical effectiveness and demand for the procedure. This would mean that techniques that may reduce the number of fractions needed to treat a patient are over-compensated to make them appeal to centres to invest in and deliver such techniques.[99]

5. Mechanisms to consolidate and grow research capacity

High research capacity is a fundamental feature of a world-class radiotherapy service. The 'benchmarking' country examples (the Netherlands, Canada and Sweden) all exhibit a high level of research activity, including extensive deployment of clinical trials and utilisation of their results, with multicentre trials enabling outcomes to be gathered more quickly and, if beneficial, to be translated into routine clinical practice. Such a service, therefore, needs to promote enquiry, innovation, validation and testing, knowledge diffusion, and retention of staff. This can create a virtuous circle that ultimately results in improvement of service quality. It is also crucial that there is dedicated time for research in centres, both in terms of staff time but also linac availability.

6. Evaluation and quality systems

A world-class radiotherapy service helps centres and Trusts to engage much more actively in developing and promoting a 'quality-driven' service that is focused on continual improvement. Improvement can only be driven by evidence-based practice, ensuring that research contributes to the improvement of treatment offered. This requires more active collaboration with research centres to promote knowledge exchange and learning that can feed into the quality improvement process. An additional benefit of closer collaboration with research centres and HEIs would be the dissemination and diffusion of more effective education, training and continuous professional development models and methods that would contribute to continually developing world-class staff with the required skills.

To drive forward quality, a world-class service supports the embedding of an evaluation culture in services. This is supported by robust assessment methods that are clearly linked to, and accurately measure, achievements and progress. Possible metrics to measure whether, and in what ways, the service is world-class could include:

- Full utilisation of appropriate technology and equipment: delivery of IMRT and other evidenced based advanced technologies to all patients who would benefit;
- Development of effective and efficient patient pathways: compliance with benchmark cancer waiting times;
- Appropriate targets for different clinical profiles - currently all patients must be seen within 31 days of diagnosis. However, shorter targets should be set for patients with more rapid tumour growth;
- Development of 'quality' measures for radiotherapy planning: monitoring of fractions administered and quality of treatment;
- Monitoring of radiotherapy activity against access models such as the Malthus model;

[99] Physicist interview, large centre case study.

- A continuous supply of an appropriate number of trained staff at centres and compliance with national standards for all professions;
- Participation in clinical trials;
- A safety culture with reporting and learning systems in place to support learning from incidents errors and near misses.

7. Changes in work culture and organisational structures

Moving towards a world-class service requires significant changes in work culture and organisation. The key changes required would cover:

- Better and more co-ordinated planning across patient pathways and a review of skills mix and automated technology capability to streamline processes (for example oncologists working closely with physicists to plan procedures) and more equitable sharing of responsibilities to manage fluctuations in workload better;
- Collaboration may be necessary by smaller centres with other centres, small or large to ensure adequate site specialisation by clinicians and to meet planning, MDT and clinical cross cover demands;
- Strengthening multi-disciplinary teams through promoting better integration. Strong multi-disciplinary teams support patients to receive better treatment as well as allowing services to improve as different perspectives are incorporated in diagnosis, treatment, monitoring and research;
- A more coherent and co-ordinated referral system which is disseminated down to GP level;
- The introduction of measures to reduce overworking. This issue is seen as inherent in the way services operate but has negative effects on quality of service provision and on providing a workplace that is motivating and fulfilling to work within. Overworking is linked to the need for measures to promote greater flexibility in service delivery, particularly to make services available to patients over a longer period of time (including weekends) and to enable services to adapt to variations in demand;
- Promoting and supporting effective management and leadership, including designing bespoke training for managers in radiotherapy once they reach management positions where a need is identified;
- New IT and smarter ways of working using remote video links and planning solutions may give opportunities to use limited staffing to greater efficiency and enhance quality.

Additional elements

As mentioned above, additional elements were identified that are also important in developing a world-class service. While the pre-requisite components above were identified consistently across all datasets, these additional elements were present in some but not across all datasets.

Two additional elements were identified through the literature review and Delphi panel:

- Ensuring equity and consistency of service provision;
- Promoting a coherent national vision and strategy.

These two additional elements reflect to some extent regional variations, with a greater emphasis placed on equity and access issues in Wales and Northern Ireland and on promoting a joined up national strategy and single authority in Scotland.

Underlying all of these themes and elements is the recognition that a world-class radiotherapy service needs to place the patient and the quality of care delivered to the patient at its heart.

Several other themes and elements were also highlighted in the results obtained from interviews with patient representatives, which highlighted four main desired attributes in a world-class service:

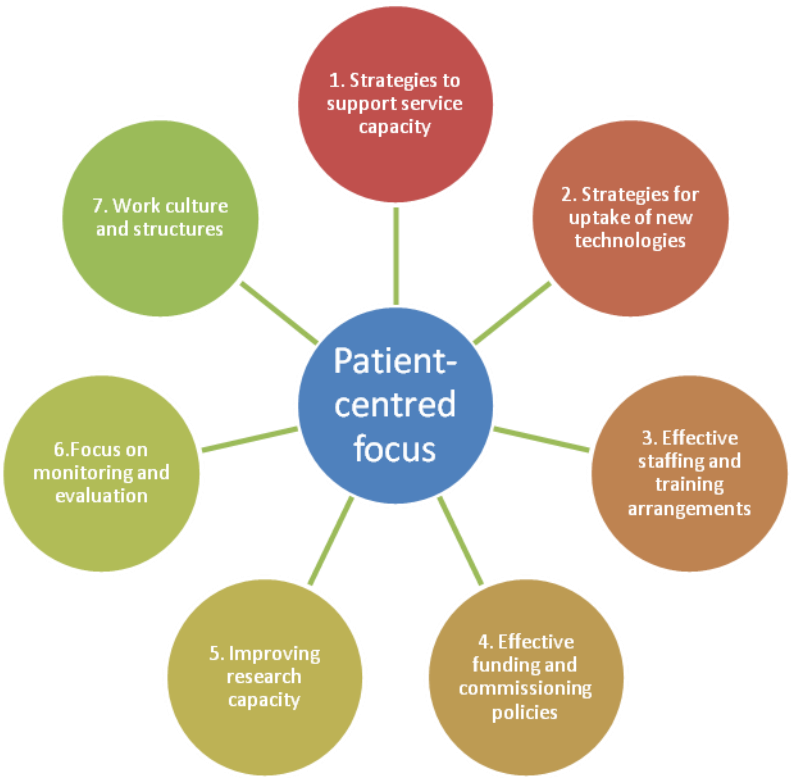
- Strong central leadership on strategy;
- Regular monitoring of standards and targets – particularly compliance with waiting time targets;
- A patient-centred focus;
- Flexible service models (longer hours; extended opening times).

National strategies

It is clear that the foundations for a reformed radiotherapy service rest on developing and implementing effective national strategies to develop the appropriate radiotherapy capacity. In response to the UK's ageing population, radiotherapy capacity in each country needs to be reviewed to understand, and meet, changing demands, with a new focus on quality of treatment and availability of specific technologies for appropriate patients. Our research suggests that national strategies should address all of the pre-requisites of a world-class radiotherapy service, as highlighted above.

Any strategy should be geared towards promoting systemic change (and learning from these changes) throughout the system. Ideally, a future world-class radiotherapy system would need to look something like the diagram shown in the illustration below. This illustrates how systemic change would need to be configured to drive forward a world-class radiotherapy service.

As the illustration shows, all the key constituent elements of the system are inter-dependent and centred around the patient. The absence, or ineffectiveness, of one element will have an effect on the other elements. A future service needs to have the patient at its core and aims ultimately at providing a "holistic care" environment'.[100]



[100] English Delphi expert.

Creating this environment requires an over-arching framework that promotes learning across the whole radiotherapy system in order to provide the best possible service to patients. Rather than individual centres learning alone with infrequent interaction with other centres, national learning events and scaled-up cross-centre learning should be the norm. National-level data collection, diagnosis of issues and learning are central to the promotion of a world-class service. The approach of viewing radiotherapy services in each nation as a whole service rather than individual centres would help to address a number of the key challenges and barriers identified.

In addition, national strategies should address the following:

- Raising public awareness of what radiotherapy is (e.g through the National Radiotherapy Awareness Initiative (NRAI)): what are the 'myths' around radiotherapy and what are its benefits;
- Reducing the negative impacts of professional 'silos' and increasing inter-professional, inter-departmental and inter-service collaboration in order to create interlocking communities of practice and learning;
- Developing effective communication channels between commissioning agencies, service providers, research and higher education communities in order to promote evidence-based practice;
- Improving evaluation through embedding evidence-based practice. This is founded upon assessment of the impact of radiotherapy services in order to learn what works, for whom, under which circumstances;
- Applying learning from this process to the development and implementation of effective and relevant education, training and continuing professional development. This is in order to address the need for adequate and effective staff requirements.

Conclusions and recommendations

Radiotherapy is an essential cancer treatment that contributes to four in ten of cancer cures. It is a relatively cheap and cost-effective service that works well in combination with other treatments, and shows a high level of patient satisfaction. But while improvements have been seen over the last decade, UK services remain far under capacity, are slow in adopting new techniques compared with the best performing countries, with inequity in service standards and a lack of coherence in each of the four nations.

The overall observation arising from this study is that there is a need to improve the coherence of radiotherapy services in each of the UK nations. The findings in this report show a mixed picture.

In England, concerns remain about the impact of the wide-ranging NHS reforms in April 2013 and the loss of important leadership resource in the form of the National Cancer Action Team and the National Radiotherapy Implementation Group. While these functions have been replaced by the Radiotherapy CRG, the Radiotherapy Board and NHS England, leadership is fragmented, poorly resourced and in need of greater support to deliver improvements across the radiotherapy service. The Radiotherapy Innovation Fund provided a boost to radiotherapy services in England and increased delivery of IMRT, but work is needed to continue this upward trajectory.

In Scotland, the prospects for developing a world-class service are considered uncertain. This is because of the endemic shortage of qualified staff but also because of the fragmentation of services, the demands of distance and geography. The lack of clear national leadership and strategy is also an issue and it is vital that the Radiotherapy Programme Board takes a stronger leadership role in promoting improvements across Scotland.

The prospect of a world-class service developing is seen as more likely in Wales, with the emergence of Velindre as a strong leader, and in Northern Ireland, with the new satellite centre opening in West Northern Ireland consolidating recent advances in technology, skills and service standards. However, neither of these countries have a clear form of national leadership and oversight.

Leadership at the national level must be able to drive the overall improvement of radiotherapy to match the standards of the best. Leadership bodies must be able to address shortcomings in the service such as a) centres' resources, b) management and staffing and c) adequate capacity to meet demand. At present this support is not being given at the scale needed.

In centres across the UK there is a wide variety in the quality of services, patient access rates to radiotherapy, and the availability of appropriate advanced techniques. Through tools such as Malthus[101] and peer review, mechanisms exist to identify problems in centres and regions. In England the service specification sets the standard for all radiotherapy services. National leadership bodies, where they exist, must use these tools to drive equitable quality improvement to ensure that patients receive an equivalent high standard of radiotherapy wherever they are treated across the UK. The benefit to patients and value for money provided by radiotherapy means that this service is worthy of further support and investment.

Set against some of the concern raised for radiotherapy services in England and Scotland, there are also mitigating factors that provide optimism.

1. The commissioning of radiotherapy as a national specialised service in England will contribute to developing a more standardised service for patients. If more effort is

[101] http://www.camradiotherapy.org.uk/malthus

channelled into ensuring the development of precise evaluation and monitoring tools to assess progress and outcomes, this could promote improvements across all radiotherapy centres.
2. The potential for better leadership at the local level to improve the work culture at individual centres and collaboration across centres.
3. The opportunities created by new advances in technology and in techniques, for example 4D adaptive and rapid arc technologies, the increased use of hypofractionated regimes such as SABR, and the extensive diffusion of image guided brachytherapy (IGBT) and Molecular Radiotherapy.

These have the potential to promote increases in the knowledge and skills base and to improve practices and service quality if allowed to evolve and diffuse across the whole system. Improvements in work culture and in the organisational structure of radiotherapy could further create opportunities for expanding the drive towards better 'quality'.

Recommendations

There are seven sets of recommendations, corresponding to the seven key components identified that make up a world-class service, and each aimed at addressing the main issues and obstacles related to these components.

The recommendations focus mainly on England but many of these are applicable to the situation across the UK. In addition, some recommendations relevant to the specific situation in Scotland, Wales and Northern Ireland are provided. A variety of factors meant that we were not able to explore and enquire into the situations of radiotherapy in Scotland, Wales and Northern Ireland in as much depth as we would have liked. To build upon the evidence presented in this report, further research into the situation in these three countries should be considered.

Strategies and mechanisms to increase and sustain capacity

1. **Each national government must address variation in access to radiotherapy. They should map capacity and demand requirements and ensure that the service in their respective countries is of high quality and well-resourced to meet current and anticipated demand.** While it may not be appropriate for all centres to provide all types of treatment, all must achieve minimum quality standards in the treatments they provide. New models of working in partnership should be explored to ensure this, and appropriate access to all radiotherapy techniques. Capacity issues could be addressed by investing in out-of-hours working to ensure that equipment is utilised more effectively and efficiently. Travel time is thought to have an impact on referrals to radiotherapy treatment - where appropriate building satellite centres for treatment could both increase capacity and increase access rates. However, this must be seen in the context of emerging hypofractionation techniques, which may reduce the number of times patients have to travel.

2. **The Royal College of Radiologists should ensure appropriate and early training for new oncologists on the value of radiotherapy and its place in the wider context of cancer treatment including ideal access rates for radiotherapy patients.** This is about endowing them with the skills and confidence to work effectively in MDTs and deliver radiotherapy to the highest standards. According to national radiotherapy experts, currently the majority of oncologists do not believe there is an issue with access to radiotherapy or in allocating sufficient numbers of attendances to patients who are treated. More work is needed to ensure that suitable patients are referred for radiotherapy rather than for other treatment types.

3. **The roles of national leadership bodies in England and Scotland – the Radiotherapy Clinical Reference Group (CRG) and the Radiotherapy Programme Board, respectively – should be enhanced.** In England, the Radiotherapy CRG should be well supported and resourced to enable effective leadership and promote system wide improvements. In Scotland, there is a clear need for better national leadership to promote coherence and collaboration between SCAN, NOSCAN and WOSCAN to ensure a more joined up radiotherapy service.

4. **The Welsh Government should consider creating a national leadership body with oversight for radiotherapy services across Wales**. This body could include the Welsh Government, NHS Wales, Local Health Boards, and senior experts and management from each of the radiotherapy centres in Wales.

5. **NHS England should assess whether there are aspects in strategic co-ordination and support that the successor of NRIG and NCAT, the Clinical Reference Group, is currently not providing**. Key stakeholders, such as the professional bodies, Clinical and Translational Radiotherapy Research Working Group (CTRad), funding bodies, industry, the radiotherapy community and patient groups should be engaged in the review.

6. **Each national government should invest in further campaigns to raise awareness and public understanding of radiotherapy, and its importance in cancer treatment**.

Strategies and mechanisms to deploy and utilise state-of-the-art technologies

1. **NHS England should build on the success of the Radiotherapy Innovation Fund and continue to promote better access to advanced and innovative radiotherapy, focusing on technology and workforce skills development.** The evaluation of the Radiotherapy Innovation Fund found that it was an effective intervention in improving access to advanced radiotherapy in England. Continued support through mechanisms such as Commissioning through Evaluation should link new technologies with support for the acquisition of the skills required to utilise them. Given the low levels of IGRT delivered, it may be appropriate for improving delivery of this advanced technique to be the focus improvements. The devolved nations should consider similar mechanisms to increase access to advanced techniques as appropriate.

2. **Given the success of the Radiotherapy Innovation Fund in England, the devolved administrations should consider implementing a similar fund in their nations, focussing on improving the delivery of advanced radiotherapy.**

3. **NHS England should extend the provisions of the current payment mechanisms to incentivise the provision of specialist technologies and techniques like 4D adaptive technologies, SABR, IGBT, and molecular radiotherapy, where evidence has shown their benefit..** Investment needs to be made to ensure these techniques are incentivised in the NHS. An assessment of the cost of these techniques should be done rapidly so that they can be paid for appropriately. More widespread use of these complex techniques should be encouraged as they treat cancer more accurately and reduce the side effects. Governments must also find a solution to incentivising the use of hypfractionation where evidence has shown it to be beneficial.

Effective staffing and training policies and arrangements

1. **Health departments in each UK nation, working with the professional bodies, should develop and implement a strategy to address radiotherapy workforce needs.**

Strategies should consider investment in education, compilation of best practices domestically and internationally, and develop clear national educational targets. Strategies should also support greater co-operation between professional bodies and government agencies responsible for implementing broader health workforce agendas (for example Health Education England), to address issues around skills shortages and imbalances in the radiotherapy workforce. It is particularly important to address the insufficient number of medical physicists and the attrition rate of student radiographers.

2. **Radiotherapy centres should ring-fence funding to provide regular training and professional development that is tailored to staff needs, especially for retraining staff that have taken a career break.** Training and development should incorporate a 'blended learning' approach that combines academic and hands-on experience and utilises the opportunities provided by online learning systems. Centres should support the introduction of already successful educational programmes, such as those for IMRT, as they are easily transferred. Centres should also support mutual learning programmes, exchanges and mentoring, and take advantage of external educational funding opportunities, for example the European Commission's 'Lifelong Learning' Programme.

   The VERT system needs to be reviewed in order to use its capabilities more effectively in centres – particularly smaller ones. Training programmes should also create bridges with HEIs and other educational institutions to ensure better career counselling for prospective radiotherapy professionals at undergraduate level and effective utilisation of placements and work experience opportunities.

3. **All radiotherapy centres should amend the staff review process to enable managers to assess all four of the following aspects of their staff: 1) their current capacity 2) skills gaps and training needs and 3) motivational levels and emotional well-being of staff 4) compliance with professional body recommendations on standards, job planning and CPD.** This could be added to the current peer reviewing process and would support a more accurate assessment of their organisational 'health', including predicting staff retention rates.

Appropriate and effective funding and commissioning mechanisms

1. **In England, the Department of Health, NHS England and NHS Trusts should continue to work with the NHS Supply Chain to ensure sufficient numbers of up-to-date linacs across England and capitalise on the economies of scale, which can be delivered through co-ordinated purchasing. Similar mechanisms should be utilised in the devolved nations where needed.** In England, the purchase of equipment is ultimately the responsibility of NHS Trusts who must ensure that having sufficient equipment to provide high quality, safe and cost effective services for patients is the main investment priority for radiotherapy centres.

2. **A review should be undertaken of the way the new national commissioning service is currently operating in England, to support more effective commissioning that harnesses the procurement power of the NHS as a whole.** This review should also target the funding mechanisms for radiotherapy, with a particular focus on addressing the issues of up-front capital investment for Trusts and centres with an emphasis on the cost-effectiveness of radiotherapy in comparison to other cancer treatments.

Mechanisms to consolidate and grow research capacity

1. **All centres should be encouraged to engage with national research and should enter patients in national trials.** Centres must have the appropriate capacity and dedicated time for research, including radiotherapy machine availability and workforce capacity. Centres not undertaking research should be aware of national trials and be encouraged to enter patients on trials where appropriate.

2. **Each UK nation should develop and implement a system to support the replication of evidence-based best practice across the radiotherapy service.** A good example is the 'Realising Ambition' programme currently being piloted by the Big Lottery. This utilises data derived from randomised control trials and other evaluation methods to transfer and scale up what works in crime reduction research to improve programme quality at the national level.

3. **In England, the CRG should develop and implement evaluation methods and tools to measure the impacts of research on quality of training, practice and service quality.** The resulting data should be used to support the case for maintaining research funding in the context of funding negotiations with commissioners and sponsors. Academic positions should be integrated in the service where these do not exist already.

4. **In England, the CRG should support and encourage smaller services that do not carry out direct research to benefit from the outcomes of research by implementing mechanisms to help the dissemination of results to these centres.** This could include: engagement in clinical trials, factoring time into work planning for professional development, and organising seminars, exchange visits and participation in dissemination activities. Entering trials is a particularly good method for small centres to engage in and benefit from cutting edge treatments and engage in the research process.

Evaluation and Quality systems

1. **National standards should be developed in each country, with appropriate national oversight, providing quality measures for the radiotherapy service (e.g. the service specification in England). These standards should stretch and challenge the service as well as help services that are not up to standard to improve or find alternative provision.** The standards should include benchmarking of services and more detailed quality measures. For example, waiting time for urgent cases should be reduced to 14 days. Currently many centres fulfil the 28-day waiting period standard by scheduling appointments in the third week. Whilst this delay is not clinically dangerous for the majority of cancer sites, around 20% of cancers treated in the UK are likely to be fast growing (such as lymphoma and sarcoma) and need to be treated urgently.

2. **Radiotherapy centres should create the conditions to make each centre a 'learning organisation'.** This could include developing specific evaluation tools to enable the centre to connect its mission and goals with activities and expected outcomes; creating a space to enable staff and service users to reflect on and review their performance, and; taking advantage of the opportunities new technologies (such as electronic patient records) provide to enable closer monitoring of treatments and their outcomes.

3. **Demand modelling using tools such as Malthus should include data on the demographic profile of patients: who they are, their age, socio-economic grouping and ethnicity at a minimum.** Data on deprivation, ethnicity and stage at presentation does

not exist in current datasets. Also the effect of deprivation, poverty and ethnicity on access to radiotherapy centres has not been researched on an individual level, only on an aggregate level (correlating low access rates and high deprivation). In monitoring patients the inclusion of more items specifically on their profile is necessary for health policy to mould services to the needs of the local population and improve patient pathways.

Changes in work culture and organisational structures

1. **National governments should develop and fund national programmes to provide training in management and leadership skills.** Improving leadership across radiotherapy centres is vital. Local leadership is often crucial for turning a struggling centre into a thriving centre and that strong leadership is a necessity at every centre to push for continuous improvements.

2. **The Royal College of Radiologists should put guidance in place for stricter implementation of target volume reviews between oncologists.** Interviewees suggested that a large proportion of target volumes drawn up by oncologists are not shared with peers before the plan is put into action by radiographers and medical physicists. Setting up stricter protocols and targets for sharing plans would ensure that mistakes are less likely to be made and treatments would be of a higher standard.

3. **NHS Scotland should review its workforce planning with a view to addressing the shortfall in oncologists' training, which has led to low levels of people coming into the radiation oncology workforce.** This could be supported by paying new discretionary points and making new distinction awards in order to attract consultants.

4. **Radiotherapy centre managers should review current workforce planning and service delivery arrangements, and where possible provide a seven days a week service.** If sufficient funding is available, all radiotherapy facilities should be open seven days a week and there should be capacity to provide emergency or urgent treatment between 8am and 8pm on each of these seven days. However, in the current financial climate this is likely to be very difficult in a number of centres. If they are not already doing so, all centres should explore the possibility of extending opening hours.

Annex 1: Methods

This section outlines the purpose of the methods and the procedures used in the study according to the terms of reference and the study work plan.

A key element of this research approach is the use of 'triangulation' (See Annex 6). This allows for different types of data derived from different sources to be compared against each other to arrive at a balanced, evidence-based picture of the situation. Triangulation also allows for the voices of different stakeholders to be reflected in the analysis, conclusions and recommendations whilst ensuring at the same time that one particular voice or perspective does not dominate the others.

The data produced from each method was triangulated and combined to produce an overall picture of the radiotherapy service in the UK. Through consulting with national and international experts alongside interviewees, we also highlighted the characteristics of a world-class radiotherapy service. In this report the literature review data present the perspective of research and policy analysis in the field. The Delphi panel data present the best-case scenario from the perspective of the key experts consulted. The case studies reflect the point of view of practitioners working on the ground, and their position on what needs to change to make radiotherapy better. The benchmarking analysis shows how a world-class service is currently being provided in other countries.

This is the first study of UK radiotherapy to add robust qualitative data on areas that were previously only covered by surveys and statistics from monitoring data (for example studies on training,[102] on the three professions of radiotherapy,[103] and inequity in England[104]). Those studies provide a valuable baseline in this report. Our research provides qualitative data to explore the issues that occur in UK radiotherapy, how these problems impact on working life, and where these issues are created in a more accurate and detailed way than was previously possible using only survey data. This report also fills the gap on exploring the effect of the recent changes in health service on radiotherapy, particularly the potential impact of the payment by results tariff and the move to a national commissioning structure in England.

The study consisted of the following chronological elements:

Literature review

An initial literature review aimed at mapping the radiotherapy 'landscape'; identifying and analysing key sources of information and evidence, with a particular focus on 'barriers' to achieving a world-class service; clarifying the scope of the study and identifying what questions to ask of whom.

The stages of the review entailed an iterative process:

1. Mapping the key drivers that shape policy and practice through initial scans of the literature and discussions with CRUK.
2. Searching the field for evidence, including grey literature. This involved searching, collating and defining items for review and then entering them into a spread sheet.

[102] Such as. Lei, M., Stokoe J., MacLeod, N., Yates, L., and Mir, R. (2012), "Training in Clinical Oncology: Results of the Royal College of Radiologists' Survey of New Consultants", *Clinical Oncology* 24, 143-148
[103] Such as The Royal College of Radiologists. (2011), *Clinical Oncology UK Workforce Report* 2011; Armoogum, K. and Buchgeister, M. (2010), "Factors affecting knowledge sharing in the radiotherapy department: the radiation physics team as a community of practice", *Journal of Radiotherapy in Practice* 09:01 17 - 26
[104] Such as Williams, M. V., K. and Drinkwater, J. (2009), "Geographical Variation in Radiotherapy Services Across the UK in 2007 and the Effect of Deprivation", *Clinical Oncology* 21: 431-440

3. Applying quality criteria to the material identified, based on relevance and rigour. Any items included needed to be recent (published after 2005). They also needed to have research relevance (covering any of these topics: Barriers to service delivery; NHS reforms; best practice conformance; tariffs and incentives; access to services).
4. Extracting data from the final shortlist of material to uncover evidence in support or contradiction of the drivers identified.
5. Synthesising the results of the data extraction and analysis to re-assess the original 'map' of the field, and to produce conclusions on:
    - what are the main barriers to provision of a world-class radiotherapy service across the UK;
    - who are the key people that need to be consulted for preliminary interviews and to participate in the Delphi panel;
    - what questions need to be asked of them;
    - which criteria need to be applied to select the 'comparators' for the benchmarking analysis;
    - which criteria need to be used to carry out the benchmarking analysis;
    - which centres need to be selected for the in-depth case studies.

Delphi panel

A Delphi panel[105] was aimed at deepening knowledge on the barriers to a world-class radiotherapy service, and possible ways forward, as a result of engaging a diverse group of expert informants in an on-going dialogue. The Delphi method was selected as an appropriate instrument for this study because, unlike surveys and focus groups, it gives a dynamic picture of the radiotherapy 'landscape' rather than a snapshot cross-section.[106] It is more appropriate in addressing complex and emerging environments than both surveys and focus groups, as it allows for a controlled dialogue between respondents. Unlike focus groups, this dialogue is anonymous leads to far fewer 'power dynamic' issues (for example the over-representation of a particularly powerful stakeholder 'voice') which are often an issue in focus groups with a mix of professionals and patients.

The procedures of the Delphi panel are set out in table 1 below:

Table 1: Delphi panel survey methodology

Stage	Activities/methods	Outputs
1 .Panel Recruitment	Recruit 35 experts in radiotherapy in the UK, representing the four nations and key stakeholder groups: clinical, research, patients/carers	35 members of Delphi panel recruited with contact details in database
2. Round 1 questionnaire design	Develop draft questionnaire – structured, open-ended – based on two broad categories of questions: barriers to barriers to world-class radiotherapy in the UK, and possible future scenarios Validation of questionnaire by one expert (Adrian Crellin) and CRUK	Final Round 1 questionnaire drafted
3. First Round delivery	Send out Round 1 questionnaire via e-mail to Panel members	21 completed Round 1 questionnaires by experts (14 English, 3 Scottish, 2 Welsh and 2

[105] A multi-stage anonymous survey of experts in a given field.
[106] Delbecq, A and Gustafson, D, 1975, Group techniques for program planning: a guide to nominal group and Delphi processes, London: Longman Higher Education.

		Northern Irish)
4. First round analysis	i) Content analysis of questionnaire text ii)Statistical analysis of answers to topic questions to assess convergence/divergence of responses	Identification of initial barriers to success and possible scenarios for development Identification of areas of disagreement Identification of additional questions
5. Second round questionnaire design	Develop draft 2nd round questionnaire – structured, open-ended Validation of questionnaire by one expert (Adrian Crellin) and CRUK	Final round 2 questionnaire drafted
6. Second Round delivery	Send out Round 2 questionnaire via e-mail to Panel members	Questionnaire sent to all 21 experts who replied to the first round. 13 completed Round 2 questionnaires (9 English, 2 Scottish, 2 Welsh and 0 Northern Irish)
7. Final analysis and results	Content analysis of Round 2 questionnaire text Statistical analysis of answers to topic questions to assess convergence/divergence of responses SWOT analysis of alternative future scenarios	Identification of final barriers to success and possible scenarios for development Quantification of degree of consensus Analysis of advantages and disadvantages of possible future strategies

Case Studies

A set of case studies aimed at, first, further deepening understandings of the barriers and possible ways forward identified in the preceding research activities and, second, introducing a 'grass roots' perspective to the study.

Table 2: Case Study procedure

Stage	Activities/methods	Outputs
Logistics	Establish protocols for implementing case studies	Criteria for selection was two each of: independent Trusts, large centres and small centres
	Identify sites key informants and data sources. Contact key 'gatekeepers'. Arrange site visit	Six case studies agreed to take part in the study
Data collection	Draft questions according to research aims and findings from first round of Delphi study	Research tools drafted: key informant interview schedule, staff interview schedule, and focus group guidelines.
	Interviews with staff conducted: An interview with the 'key informant' (usually the Centre Manager) Interview with Head of Physics Interview with Head of Clinical Oncology Interview with Head of Radiotherapy	Interviews with at least four key staff undertaken at each site completed and written up
Analysis and	Profile each site	Six case studies produced

Synthesis	Assess key outcomes and impacts	Final report analysis

Benchmarking

A benchmarking analysis aimed at identifying 'best practices' in other contexts in order to derive transferable learning on how to overcome the barriers to a world-class service in the UK.

The benchmarking exercise incorporated two main data collection activities:

- A desk review of the UK radiotherapy system in relation to the comparator countries, themes and services selected, covering the structural, practices and performance elements;
- Interviews with a key informant with in depth knowledge of the comparators.

Following review of the literature and discussion with CRUK, three services were chosen which represented best practice internationally, both on a national and service level:

- International Cancer Research (Netherlands);
- Princess Margaret Cancer Center (Canada);
- Karolinska Institute (Sweden).

Interviews were structured around the benchmarking framework and were conducted with senior staff at each institute by phone. The results were analysed to create a good practice mapping output. This provides a summary of what the UK can learn in the areas of the organisational processes and strategic initiatives.

Patient interviews

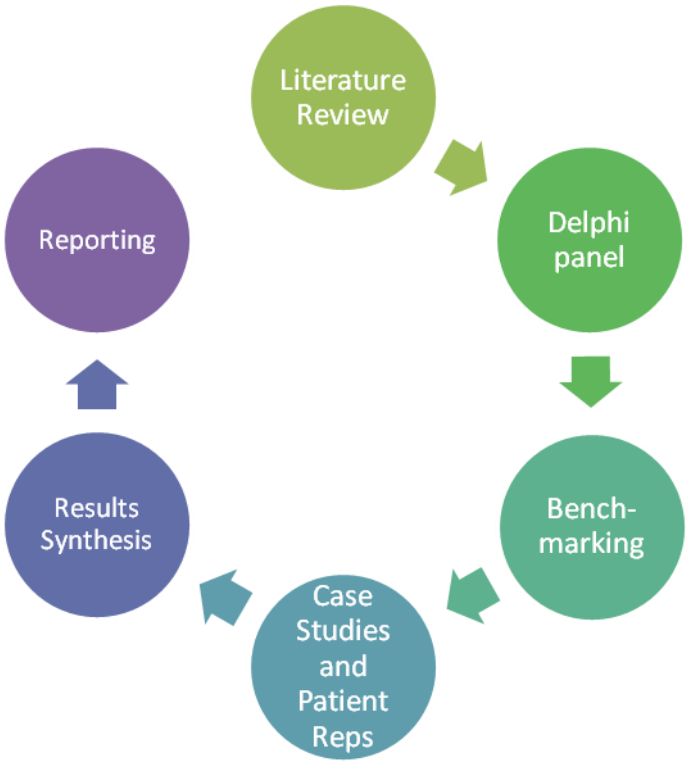
Interviews with patient representatives aimed at assessing the performance of UK radiotherapy based on patients' views. Two telephone interviews with members of the Patient and Public Involvement Group (PPLG) of the Society of Radiotherapist (SCoR) and NCAT. As long-serving members of these groups, involved in strategic decision making from a patient perspective, these interviews better contributed to learning on the decision making processes, and the extent of patient focus in radiotherapy in England. These interviews covered four themes:

- Personal experience of the UK radiotherapy service;
- Dealing with patients;
- National issues;
- National standards.

Finally analysis of the radiotherapy patient opinion survey was added to the document review when released to give a more general understanding of what patient's thought of radiotherapy in the UK.

The overall study methodology is illustrated schematically in Figure 3.

Figure 3: Study Methodology



Annex 2: Summary of Delphi panel results

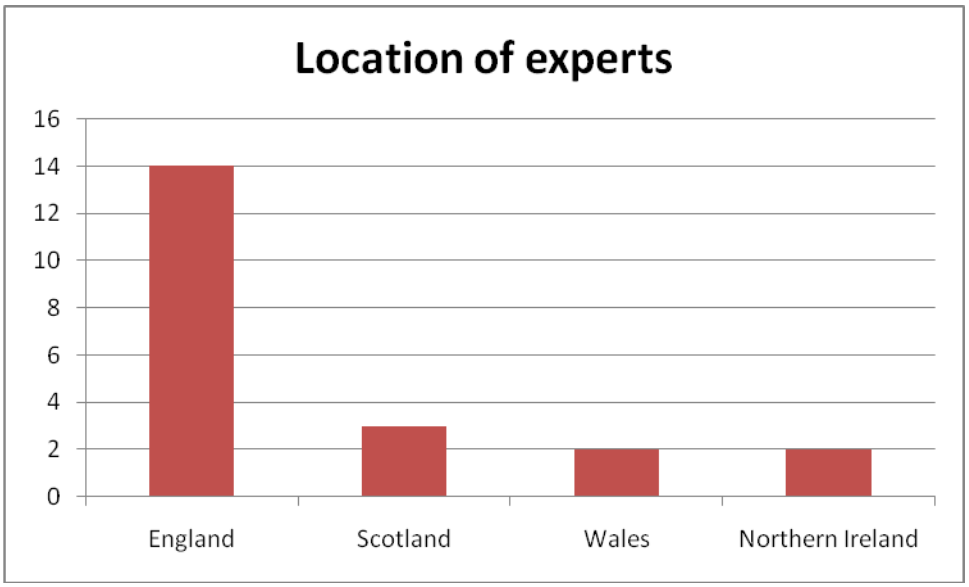
Purposes and Objectives
The main objectives of the Delphi Survey were:

- To further explore with a group of experts in the field the initial findings of the literature review on what constitutes a world-class radiotherapy service; what are the main barriers to developing a world-class radiotherapy service; and what are the main improvements necessary to promote a world-class radiotherapy service.
- To expose the underlying assumptions that shape the experts' perceptions of these issues;
- To identify the degree of convergence and divergence in experts' perceptions and opinions;
- To identify the different scenarios that could shape the development of a world-class radiotherapy service.

The Delphi Survey consisted of two rounds of surveys involving a panel of experts with high expertise and experience in radiotherapy.

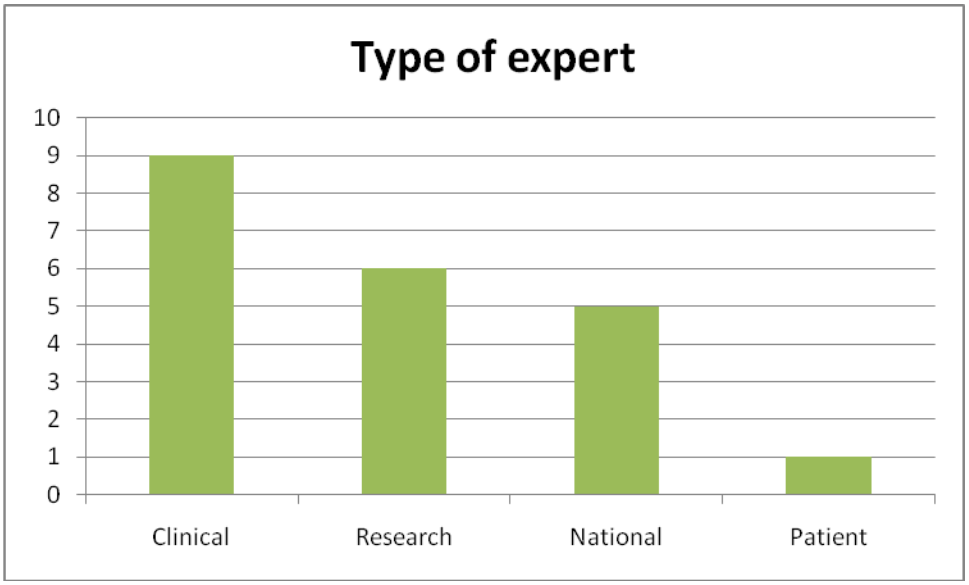
Profile of the Panel
During Round 1 of the Panel Survey, a total of 35 experts in England, Scotland, Wales and Northern Ireland were contacted who were deemed to be credible, experienced and qualified to answer the questions set. Given the requirements, the experts were the leading figures in the radiotherapy field across the whole UK. It is important to note that this was not a survey: the data received from experts was qualitative and was analysed as discourse rather than simply categorised and counted. However, it was important to have experts from each nation given the differences in policies and issues. This gave us robust and valid views from every national system. Twenty-one of these professionals completed the questions and comprised the Delphi panel for the study. The location of the experts is shown in the figure below.

Figure 4: Location of national experts who responded in stage 1



We attempted to have four broad areas of expertise represented: clinical, research, national and patient. Whilst only one patient representative with sufficient knowledge of radiotherapy could be found, the other categories were well represented, as shown below:

Figure 5: Primary expertise of experts who responded in stage 1



Their responses are summarised in the categories below.

Priorities for a world class service

The first question that the experts were asked was what are the priorities in your country in order to achieve a world-class radiotherapy service. The consensus is presented below.

Table 3: Key features of a world-class service by priority

Priority/Country			
England	**Scotland**	**Wales**	**NI**
1. Fully utilising the appropriate technology and equipment 2. Effective and efficient patient pathway 3. Emphasis on meeting patients' needs 4. Appropriate number of trained staff at centres	1. Fully utilising the appropriate technology and equipment 2. Effective and efficient patient pathway 3. Emphasis on meeting patients' needs	1. Fully utilising the appropriate technology and equipment 2. Quality, convenience and evidence-based practices 3. Involvement in research, and links with higher education	1. Equity and consistency of service 2. Centralisation of research, with evidence based pathways, and peer reviewed services 3. Engagement in clinical trials

In Round 2, these priorities were shown to the experts for their consideration. Through this, a broader issue was identified in the Round 2 responses – the perception that the 'sum' of a world-class radiotherapy service is greater than its constituent parts. In other words, although it is possible to identify a list of discrete elements that need to be in place to drive forward a world-class service – access to new technology; adequately trained staff; a supportive working culture, and so on - the responses from Round 2 highlight a recognition amongst the experts that the service

needs to be seen as a system providing 'holistic care'. All the key constituent elements of the system are interdependent. The absence, or ineffectiveness, of one element will have an effect on the other elements. This implies that the centres and trusts providing services to clients need to understand and measure the outcomes from their treatments. To do so, centres and trusts need to engage much more actively in developing and promoting a 'quality-driven' service that is focused on continual improvement.

For England, in Round 1, the four key priorities identified were largely reinforced by the responses in Round 2. However, a number of clarifications and additions to the previous responses can be highlighted. In particular, it was suggested that full and effective utilisation of technology and equipment is dependent on the capital investment approach adopted for a radiotherapy service. Radiotherapy, it is argued, is a cheap technology in the long term but requires high upfront service costs. Purchasing a new Linear accelerator takes up most of the annual capital of a service programme, thereby significantly reducing other spending options for that year. What is therefore required is a capital investment model that is centralised to reduce the capital impact of new equipment on local service budgets.

The Round 2 responses for Scotland and Wales reiterated the priorities identified in Round 1, but there was an increased emphasis on ensuring the continuous supply of appropriately trained staff to meet demand.

Barriers to a world class service

The second question that the experts were asked was what are the barriers in your country to achieving a world-class radiotherapy service. The consensus is presented below.

Table 4: Main barriers by country covered by priority

Priority/Country			
England	**Scotland**	**Wales**	**NI**
1. Appropriate commissioning 2. Sufficient funding 3. Up-to-date technology 4. The working culture 5. Lack of trained staff	1. Availability of advanced technologies 2. Division into 3 networks 3. Insufficient skilled staff	1. Sufficient skilled staff, 2. Availability of advanced technologies, 3. A strategic authority to coordinate services across Wales	1. Sufficient skilled staff, 2. The working culture

In their response to these priorities of barriers, the panel members still agreed that five main barriers could be identified: the lack of an appropriate commissioning structure and process; lack of sufficient funding, both for capital items (like new equipment) and for staff training; the variability in access to and effective use of up-to-date technology; problems with working culture in services (including professional and departmental 'silos'; ineffective leadership; attrition of key staff); the lack of trained staff. However, the consensus in Round 2 was that it was inappropriate to prioritise these elements in order of significance, since they were all interdependent. For example, access to and utilisation of up-to-date technology is dependent on developing and putting into place an

appropriate business model that can deal with the pressures placed on the annual capital budgets of centres and trusts as a result of investing in the high initial costs of purchasing new equipment. In turn, the business model implemented will reflect the overarching commissioning structure and process that is in place. At the heart of these issues is the work culture of the radiotherapy service. According to the Round 2 responses, there is a perception amongst those working in the field that the work culture is characterised by a number of problems. These include: professional 'silos' that militate against collaborative working between different professional constituencies and the exchange of knowledge and good practice; organisational inertia and resistance to change; and the absence of a 'modernisation' agenda linked to lack of leadership from professional bodies.

As with the English responses, the responses for Scotland and Wales in Round 2 broadly endorsed the main findings identified in Round 1, but with some clarifications. For Scotland, it was suggested that 'access to advanced technologies' – identified as a key barrier in Round 1 – is in reality only a barrier to progress because of the lack of trained staff available to use the technologies available. The technical equipment is available, but what is in short supply is the 'techniques' to use it. In addition, another key issue highlighted was the poor state of workforce planning - for example how to accurately assess the cost benefits of clinical versus medical oncologists; the lack of incentives including new distinction awards. This linked to the need to increase staff recruitment generally – particularly for medical oncologists and specialists in palliative care. Similarly, in Wales it was suggested that 'access to advanced technologies' will not be a barrier in the future. However, effective utilisation of new, high performance equipment will be dependent on two factors. The first factor is organisational support and effectiveness – in particular the willingness of centres to develop more efficient and effective ways of working, for example by adopting more flexible hours. The second factor relates to more extensive collaboration with research centres and higher education institutions. This is seen as essential to feed into driving forward quality and staff development agendas.

Areas of divergence and consensus

The table below summaries the differences of opinion and consensus between experts by their nation:

Table 5: Areas of divergence and consensus by country covered

Areas of consensus between countries			
Features of world-class service	Varies between countries. England and Scotland more similar	Prioritisation of barriers	Varies between countries. Wales and Scotland more similar
Areas of divergence between countries			
Features of world-class service	Limited divergence between England and Scotland. Greater divergence in Wales and NI	Prioritisation of barriers	Wide divergence between countries
Areas of consensus within countries			
Features of world-class service			
England	**Scotland**	**Wales**	**NI**
Low variation	Centralised v light-touch bureaucracy	Low variation	Low variation
Prioritisation of barriers			
Positive v negative perception of NHS reform National tariff improves outcomes v National tariff increases costs and reduces quality	Need for a single administration v open culture and listening to the patient voice	Low variation	Lack of sufficient capacity to meet demand; inadequate levels of IMRT; insufficient peer reviewing

Within countries, the resposes from England, Scotland and Wales showed a high degree of consensus on priorities listed. In terms of barriers identified, only Wales showed a high degree of consensus. In England, two main areas of disagreement between experts were highlighted: firstly, whether the NHS reforms were likely to have a positive or negative effect on radiotherpay services and, secondly, whether the introduction of Payment by results (PbR) would have a positive or negative effect. In Scotland, the main area of disagreement focused on service organisational structure – the need for a single overarching structure versus a more open, patient-led structure. In Northern Ireland, perceptions of the main barriers to developing a world-class service varied between an emphasis on lack of capacity to meet demand; inadequate levels of IMRT and the lack of an effective peer review process.

These areas of divergence were further explored in Round 2. In England, expert opinion was still polarised on the issue of the impact of NHS reforms, with different opinions expressed, as follows:

- The reforms will have a neutral effect on radiotherapy services;
- The reforms will have a mixed effect – on the one hand they will put pressure on services to implement certain targets, such as the provision of IMRT for a significant number of patients; while on the other, “over-performing” may be seen as a cost burden in some centres;
- It is too soon to tell what effects the NHS reforms will have;

- They will have a negative impact because: there is now no nationally defined radiotherapy programme and the ground gained since the NRAG report will be largely lost. Furthermore, in all areas of the NHS, it is clear that there are (in every speciality) a small number of providers who are pathfinders and leaders of vision, a large number in various stages of 'getting there eventually', and a number who, without support, drive and encouragement, will never make it.

For Scotland, Wales and Northern Ireland, there were insufficient responses in Round 2 to clarify further the areas of convergence and divergence identified in Round 1.

New opportunities

The Round 2 Delphi Survey elicited expert opinion on three innovations: the Radiotherapy Innovation Fund (to English experts), and the possible introduction of telemedicine and a split authority system (to Scottish and Welsh experts).

The English experts were divided in their assessment of the opportunities the Radiotherapy Innovation Fund would create for developing a world-class service. On the one hand, there is a perception that the Fund is providing positive opportunities for taking forward the service:

- The Fund is contributing to increasing the range of services provided for patients;
- It enables those centres not currently providing 'top quality' services to make modest upgrades in things like software and hardware.

However, there is also a perception that the Fund is providing limited or no opportunities:

- At £23 million, the fund is too small to provide major opportunities. To support major opportunities to develop a world-class service, year-on-year investment is required.

In Scotland and Wales, the specific opportunity areas explored by the Panel members in Round 2 were the adoption of a telemedicine system and satellite centre approach in radiotherapy and (with reference to the Dutch decision making system) the adoption of a 'split authority' system of national bodies with differing roles.

The consensus on telemedicine and satellite centres was that providing a remote service would have an impact for some types of service – for example breast, lung and prostate cancers, but not for others. It was also felt that the remote access issue was less important than more generic problems – like the provision of 'high end equipment' in research centres and HEIs.

Similarly, the consensus on a 'split authority' system was that it would introduce too much complexity, given the small size and population base of Scotland and Wales and the limited number of experts qualified to advise a diverse set of agencies.

Future scenarios

The Delphi panel also identified different possible scenarios for the future of radiotherapy services in the four countries surveyed, as follows:

Likely scenario in England

Scenario 1

"In the next decade, after implementing the tariff and national commissioning, standards improve across the whole service, costs are cut and the reputation of radiotherapy gradually improves"

Scenario 2

"In the next decade, after implementing the tariff and national commissioning, successful centres thrive, struggling centres become underfunded and inequity increases across England."

Five of the seven experts who took part in Round 2 thought that Scenario 2 was most likely. This is because of:

1. The magnitude of the existing gap in capacity and capability between successful and struggling centres;
2. The failure of leadership at the local level; the momentum lost by the abolition of NRIG;
3. The length of time taken to develop and implement the tariff by the PbR team.

However, it was observed that how this scenario would develop would depend on a number of factors, in particular the culture and leadership of individual centres.

Likely scenario in Scotland:

"In the next decade, with the continued slow recruitment of necessary staff, a gradual loose collaboration in the East (SCAN and NOSCAN) will evolve as challenges of recruiting specialists in the North get worse; WOSCAN remains too busy to work in partnership."

Whilst most experts preferred alternative scenarios, Scottish experts believed this scenario was likely to come about for three reasons:

1. There is no obvious clinical leader with the necessary combination of experience, honesty, and diplomacy;
2. Central political commitment to local delivery and regional networks, with vested interests between SCAN and WOSCAN, is preventing the set-up of single authority. The personalities involved would make such collaboration unlikely to occur;
3. Endemic staff shortages with no joined-up strategy to address this.

Likely scenario in Wales:

"In the next decade, with North Wales managing itself initially, Velindre will start leading cancer across Wales in the next five years and in particular radiotherapy services in Wales, allowing more strategic planning, engagement across services, better value contractual relationships with industry, access to latest technologies, and coordination of research improvement."

This scenario was viewed as a positive development given the current fractions of authority. Welsh experts saw this as likely to come about for these reasons:

1. Velindre has the highest concentration of radiotherapy expertise which makes it a natural leader, particularly for developing and accessing the latest technologies and coordinating research;
2. All relevant parties have a vested interest in keeping partnerships stable as this is agreed as being the most likely way to maintain the rate of service improvements.

Likely scenario in Northern Ireland:

"In the next decade, radiotherapy services will become more accessible, use more recent technology, and with greater capacity."

This scenario was viewed as a positive development and appears to be the most certain of the four scenarios. Northern Irish experts saw this as likely to come about for three reasons:

1. A new centre is opening in West Northern Ireland which will greatly increase radiotherapy capacity and access rates, providing treatment for 500,000 and including three linacs;
2. New machines have recently been commissioned which will deliver IMRT, IGRT, 4D CT, respiratory gating and stereotactic radiotherapy;

3. New service standards have been set which Northern Ireland will soon have the ability to meet.

Annex 3: Summary of Case Study results

Six case study visits were conducted as part of the study in order to understand how the barriers to improving radiotherapy services in England played out within radiotherapy centres. In order to have a robust sample, all the case studies were based in England to give in-depth and representative examples of practices. As radiotherapy centres have different issues depending on scale, the sample was divided into two cases each of independent Trusts, large centres, and small centres. In order to use the results to facilitate improvement, each case study chosen was a best practice example within its category. The sites were anonymised to allow sharing of barriers in a confidential manner and support the transfer of best practice.

The findings from these case studies are split into four sections: adherence to service level agreements, examples of best practices, barriers for improvement, and impact of the NHS reforms. The key findings from this exercise are:

- Leadership and culture in radiotherapy centres has a determining factor on the successful implementation of new technologies, with bold leadership and a flexible, learning-orientated workforce enablers in adopting new techniques;
- Staff issues are strongly related to the scale of the organisation where large centres struggle to retain staff whilst small centres struggle to hire senior staff. Both issues lead to capacity issues and overworking;
- Larger centres with a large research capacity appear to be given a reduced income from the national tariff;
- Critical mass and scale allows the creation of world-class radiotherapy practices at large centre which, when operating as part of a national system, can be filtered down to other centres, improving the whole system.

Adherence to service level agreements

Table 6: Summary of case studies' adherence to SLAs

Key information				
Staff numbers	Independent Trust: Average 146.5 staff			
	Large Centre: Average 132 staff			
	Small Centre: Average 60 staff			
Patient turnover	Independent Trust: Average 7050 patients			
	Large Centre: Average 5500 patients			
	Small Centre: Average 2729			
Equipment used	Independent Trust: Average 13.5 linacs + 1 research linac			
	Large Centre: Average 9 linacs + 1 research linac			
	Small Centre: Average 4 linacs, 0 research linacs			
Catchment area	Independent Trust: Average 2,410,000			
	Large Centre: Average 2,245,000			
	Small Centre: Average 449,500			
Service level reached				
SLA		**Achieved**	**Not achieved**	**Comment**
24% of radical fractions delivered by inverse planned	Independent Trust	✓✓		
	Large Centre	✓	✓	Capacity given as reason for not achieving this.

IMRT	Small Centre	✓	✓	One exceeds significantly, the other is at about 16% due to lack of resources.
94% of patients seen within 31 days	Independent Trust	✓✓		
	Large Centre	✓✓		
	Small Centre	✓✓		
6.8 linacs per million population	Independent Trust		✓✓	Not considered to be a relevant metric for one centre.
	Large Centre		✓✓	4.5 linacs per million for one and trying to get more out of machines. The other centre is not close to this SLA as “our population is huge.”
	Small Centre		✓✓	
No machines over 10 years old	Independent Trust		✓✓	Difficult due to mass replacement.
	Large Centre	✓	✓	One machine aged 10.5 years.
	Small Centre	✓✓		
All new machines IMRT and IGRT enabled	Independent Trust	✓✓		
	Large Centre	✓✓		
	Small Centre	✓✓		
Throughput of 7300 fractions per machine per year	Independent Trust	✓	✓	
	Large Centre	✓	✓	“Nowhere near” this for centre not achieving figure.
	Small Centre	✓	✓	“NRAG figures aren’t representative at all; they’re a disservice to the profession. Complex IMRT it’s just not possible at that rate. Mutually exclusive complex and throughput, it doesn’t help anyone.”
Four tier model of therapeutic radiographer implemented	Independent Trust	Partially achieved for both		Difficult to appoint consultants for both, assistants seen as unsuccessful for one.

	Large Centre	Partially achieved for both		Assistant practitioners are "a dying grade" at one centre, at the other there are no consultant radiographers "as the Medics do not want them."
	Small Centre	One fully achieved, other partly achieved		No consultant radiographers at the moment at one centre.
Reducing staff attrition levels	Independent Trust	✓✓		This is not a problem in these services.
	Large Centre	✓	✓	One centre believes they are a victim of their own success: they train people very well and a good exposure to the service and move on to higher positions.
	Small Centre	✓	✓	Difficult to attract and retain talent at smaller centres.

Slow but progressive approach to IMRT

Whilst being pioneers of the development of IMRT, the managers of most centres have taken a gradual approach to increasing IMRT fractions. This is in part as staff do not feel confident in using these functions and appear somewhat risk-averse. Due to the additional time it takes for physics to plan IMRT sessions, the utilisation of IMRT has been slow although it is steadily increasing.

Patchy implementation of four-tier model

Generally, radiotherapy managers found that the four-tier model was not entirely workable in practice: one Independent Trust found it worked badly with some lack of career progression for the bottom tier and role confusion for consultant level. Another found that oncologists were unhappy to share clients with radiotherapists: "there are no consultant radiographers as the medics do not want them, they may detract from the volume of work for doctors on rotations."[107] At these centres, management appear to have accepted that the model does not work and have no plans to fully implement it.

Examples of best practices

Management led innovation has excellent results: After IGRT training service in one small centre, the management leads decided that IMRT had to be delivered to all patients for which it was relevant. The burden fell mostly on senior physicists in planning who were initially far over capacity but gradually grew to plan quickly and efficiently. To date since then all treatments for certain cancer sites have been delivered using IMRT. The same centre has also provided IGRT with every delivery of IMRT in the same fashion and though this is burdensome on all staff this is likely to give patients some of the best chances of survival in the UK. This example shows that even understaffed services can provide high levels of IGRT and IMRT if led well and decisively. The service manager of this site stated that "I don't

[107] Manager interview, large centre case study.

pretend to enjoy the management work, but having responsibility for the work environment is a necessary duty. You need someone with a vision and drive, that's how you get things done."[108]

Importance of staff flexibility: Staff flexibility is a key factor to success in times of fundamental changes in technologies, funding and commissioning. In case studies where provision of IMRT and IGRT was high, the interviewees stated that a key strength of their staff was flexibility and willingness to adapt to new innovations.

Multidisciplinary working

Staff at all case study sites stated that they work very well as interdisciplinary teams, are flexible and adapt to each other, which saves staff time and allows a full operation on a lower staff capacity. This has been bolstered with complex treatments which require closer working relationships between the three professions. It is likely that teams with poor interdisciplinary collaboration would struggle to implement complex treatments.

Locating three professions as close as possible assists with multidisciplinary working. The only example of a difficult relationship between radiotherapists and physicists was when "the physicists are in a different department in a different location, which poses challenges for the service. We have been working on this issue and are introducing a system of staff rotation in treatment planning".[109]

Bridging the professional gap can be done in several ways. In one centre, for instance the radiotherapy physics department makes efforts for staff to understand different perspectives using challenging training techniques: "we make new physics staff spend a few days in the first weeks of training as radiographers as I think it helps with that relationship."[110] Others use agreed protocols between departments to help smooth the patient pathway. Such techniques are important as there is little common ground in the backgrounds of physicists, oncologists and radiotherapists, and this needs to be created to some extent.

Redundancy of functions

There were several examples of workforce planning used to create a redundancy of functions. One Independent Trust had a physics staff trained in multiple functions, so that work could still continue as normal if some staff were not available. This reduced risk of absence or resignation, allowed sharing of practice, and gave more variety to job roles.

Critical mass: Some centres interviewed were amongst the largest radiotherapy centres in the world with a large number of staff, linacs and funding. These centres are better placed to deal with common issues such as machine faults, due to their spare linac capacity. Larger centres can also provide more research opportunities; can commission their own linacs through bespoke training contracts, and are better at attracting, retaining and continuously training staff.

Trusts and large centres have a strong research culture

Larger services are able to ensure that senior clinicians are allowed to pursue their research interests and are supported to develop wider links in their professions. Maintaining a reputation for research attracts staff interested in research to the centre. Research linacs allow services to remain ahead of the curve, and allow developing and training in new techniques such as SBRT. Excellent research capacity is used to drive forward quality standards, where "Research is looked at as proxy for quality."[111]

Satellite centres work better when staff from the main centre are rotated in

In one Independent Trust, radiotherapy physics use a floating workforce system to ensure satellite services are not dislocated from the rest of the service. This works well for the following reasons:

[108] Manager interview, small centre case study.
[109] Manager interview, small centre case study.
[110] Physics manager, independent Trust case study.
[111] Manager interview, large centre case study.

"Satellite staff aren't as busy. If they were permanent they might become demotivated. You need less staff doing it this way, people might leave if you didn't rotate, as the work isn't as rewarding… The nice thing for physics is its all part of one group, then you get an 'us and them' dynamic. Traditionally the satellites become dislocated. It's works well so far. The patients get the same treatment locally as here."[112]

Satellites can be used as pilot sites for larger centres: One Independent Trust has two satellites which are used to trial innovations in a more controlled manner. This prevents potential difficulties which might crop up when rolling new techniques out at a larger scale.

Barriers for improving

Funding for new machines

At one centre with a lower number of linacs than required, funding for new linacs is very difficult to come by: "There simply isn't enough money in the system to bring us all up to the standard of Leeds or other places where they have new bays and new machines."[113] This prevents the centre from even approaching their target of delivering radiotherapy to 52% of cancer patients as there is insufficient capacity.

Time competition with chemotherapy

At some centres, Clinical Oncologists have little time for learning about and researching radiotherapy due to the competition with the funding and research provided by chemotherapy drug companies. The lower status of radiotherapy across the country does not help this competitive dynamic. In addition, links between chemotherapy and radiotherapy centres are weak: usually chemotherapy is based in a separate block with different management structures for reporting and planning. Rectifying this lack of engagement in radiotherapy is also difficult as oncologist training is less planned and there is a shortage in practical experience for new techniques.

Small centres lack strong relationships with linac manufacturers

Large centres have built solid relationship with machine manufacturers which results in good training and timely replacement. These links were not noted at any small centres. Now that radiotherapy is commissioned nationally, this may allow collective bargaining with manufacturers. This should allow smaller centres who rarely purchase equipment from manufacturers to be given better training in machine use by suppliers.

Little use of VERT

Only one case study championed the use of VERT where it is used for training. They suggested that the benefits were that it gives oncologists a realistic experience of operating linacs. This is particularly important for centres without research linacs. For others case studies, VERT is "Not really fit for purpose, it operates like a tick box exercise"[114] and "It's not for the clinicians, just for the radiographers."[115] However, as Oncologists have no opportunity to use linacs but have a key role in radiotherapy planning; it is useful for Oncologists in training to understand the workings of linacs and the role of radiotherapists.

Lack of time due to understaffing

All case studies emphasised their lack of time due to understaffing. One large centre is understaffed in all three professions and not close to recommended staff levels. At the same time, radiotherapy provision has been increasing by 5% per year for the past five years. The clinical lead of another centre

[112] Physics manager, Independent Trust case study.
[113] Physicist interview, large centre case study.
[114] Oncologist interview, large centre case study.
[115] Oncologist interview, independent Trust case study.

stated that “everyone works flat out! There are risks if people are working when they are tired or under stress. Essentially we are at capacity and without more bunkers, we cannot fit more people in – we work 8 to 6 most days anyway.”[116] As a result, staff have no time to consider the service as a whole due to time pressures.

Oncologists generally overburdened with little time to plan

Oncologists were noted across all sites as being understaffed and frequently late in delivering treatment plans: “If your oncologists are too busy to do contouring on time and reflect on what they’re doing, having planning meetings, follow up meetings, they have no time to look at new techniques. And that has an impact on us and everyone else.”[117] Too few oncologists means that patients are often left waiting for extended periods for their treatment plans as each oncologist has too many patients for their time plans. Oncologists have a high rate of burnout due to overworking and a culture which does no support reflective practice.

Lack of research in small services

In small centres, research was a low priority due to the procedural focus of the service. Often the lack of research was an enforced decision: for one service, they are focused on service delivery and management decided that, as a small centre, it would be better to not engage in research. The centre manager stated that “we don’t have time to do research, not sure how appropriate it is at our level, more development work for new techniques. It’s not necessary for the whole NHS to all do that. We focus on the main task.”[118] However, this appears to have an impact on retention of physics and oncology staff who are keener to be involved in research.

Staff require leadership to makes changes

In UK radiotherapy centres, staff were often reactive rather than active in improving the service: “The UK has a far less “Can do” attitude than our USA counterparts. There is a lot of waiting for change and direction from above and less experimentation and initiating change.”[119]

In this context, management and leadership skills are lacking. With the pace of changes at present unprecedented, older staff are not used to speed of change and struggle to lead others. Technical training needs are covered but currently management training was not much in evidence. Some staff noted it was a need for them but they prioritised other aspects: “I would like to have more leadership and financial training, but I’ve already done some developmental training.”[120]

Impact of the reforms

For larger trusts with higher research, the national tariff is expected to have a negative impact

At both Independent Trusts, there is a lot of worry and anxiety as it is likely that they will have lower funding as a result of the national tariff. As a consequence, the Independent Trusts may hire staff to provide more accurate data which will divert some resources away from patient care. Currently, the tariff provided targets but no advice on how to reach those targets, “At the moment, it feels like they are giving targets but not suggesting how to get there.”[121]

Smaller services may receive more but get little to invest

Financially, the two smaller services are both likely to receive £1m extra a year as a reward for complex procedures. At each case study site, there was doubt over whether the extra money would go to

[116] Clinical cancer lead, large centre case study.
[117] Physicist interview, small centre case study.
[118] Manager interview, small centre case study.
[119] Oncologist interview, large centre case study.
[120] Oncologist interview, independent Trust case study.
[121] Physicist interview, Independent Trust case study.

investment in radiotherapy or siphoned to other areas in the Trust: “If we get the extra money, we can do extra things and have scope to be flexible. But the money might go somewhere else in the Trust, even though we earned it by making our service efficient. We bail them out!”[122]

Radiotherapy Innovation fund insufficient though helpful

Whilst the Radiotherapy Innovation Fund was helpful (to the surprise of almost all interviewees) in expanding the capacity of centres to deliver IMRT, “the cost of upgrading the machinery is prohibitive, and with the new innovation funds, it was helpful money but nowhere near enough!”[123]

Uncertainty

According to responses from some interviewees, everyone, even on the NHS Commissioning Board, are unclear on how the new structures will work out. “There are too many variables for us to be clear about how the changes will be implemented from the commissioning structure, in my 30 years in the NHS this is the most uncertain that I have experienced things to be.”[124]

Tariff unhelpful in developing emerging technologies

New techniques such as stereotactic radiotherapy are not currently in the tariff and funding will be decided locally. According to interviewees, this makes roll out of these treatments difficult as each centre makes a business case for developing new techniques.

Dissolution of NCAT a worry for managers

Managers were concerned that the dissolution of NCAT will have a negative impact as this body was at the forefront of pushing service improvements in the past 8 years. The personnel of NRIG will continue to operate but there will at least be an initial gap in national strategy. Dissolution of NCAT will have repercussions for national leadership and provision of IGRT. Whilst professional bodies are likely to pick this leadership up they have limited capacity to do so.

Potential for competition with independent healthcare providers

The Health and Social Care Bill carries a danger of independent healthcare providers starting and picking up easier cases of cancer: “The worry would be having an independent healthcare provider, who would attract radiotherapy and physics staff. There is some potential for partnership though. We have a need to build a satellite centre but no funding: a private healthcare provider could build this for us and operate as our satellite centre. They would treat prostate and breast.”[125]

Fewer rewards for research

One centre with extensive research links suggested that cuts to research are likely to impact on collaboration: “the reforms are financial; there are comprehensive cuts to research, though we didn’t personally have any.”[126]

[122] Manager interview, small centre case study.
[123] Manager interview, large centre case study.
[124] Manager interview, large centre case study.
[125] Oncologist interview, large centre case study.
[126] Manager interview, large centre case study.

Annex 4: Summary of Benchmarking results

Summary and review of interviews

Characteristics of a world-class radiotherapy service

The benchmarking process identified the main characteristics of a world-class radiotherapy service from an international perspective. These characteristics were compiled from the results of the interviews carried out with experts in the countries covered, i.e. Canada, the Netherlands and Sweden, Each expert highlighted the features of the radiotherapy services in their respective countries that they saw as essential attributes of a world class service. There was a high degree of commonality in the attributes identified, although some differences were highlighted between the countries covered, and some factors were seen more important than others. According to the experts consulted, the key elements for a world-class service are (in no particular order):

1. Critical mass of activity,
2. State-of-the-art equipment;
3. Enough trained staff;
4. Training;
5. Multidisciplinary teams;
6. Research;
7. Measurement and evaluation culture;
8. Sharing and learning: good radiotherapy practices and standards, and;
9. Quality assurance.

Key principles from the benchmarking countries

Quantity means quality

There was a consensus amongst international experts of the relevance of achieving a sufficient "critical mass" in terms of personnel, patients, and equipment in order to deliver a world-class radiotherapy service. The activity volume is considered not only a quantitative aspect but also a qualitative one. Relatively big services – for example large centres such as Princess Margaret's Cancer Center in Canada – help to achieve the other 'world-class characteristics' identified, as they require more resources (equipment, research capacity and trained staff) to cover a high number of patients. If policies which aim to create more capacity are implemented, this may lead to an improvement in service quality in the short, medium and long term in several ways, such as:

- Developing sufficient critical mass to create systems that support inter-professional and inter-service collaboration, thus reducing the fragmentation and professional silos often found in radiotherapy;
- Enabling services to include the full range of different staff roles which support leadership and quality;
- Facilitating the training of staff through the use of state-of-the art equipment;
- Providing big enough sample sizes to support robust research and hence the development of evidence-based improved radiotherapy treatments.

Management of human resources

The international benchmarking results showed a high correlation between effective human resource development and the quality of service provision. The experts consulted were clear that a world-class radiotherapy service cannot be delivered through state-of-the-art radiotherapy equipment alone. In order to deliver a high quality service, the equipment needs to be supported

with other resources, including facilities like rooms and IT equipment, and above all by human capital.

Effective, relevant training and continuous education were highlighted by the experts as key attributes of a high-quality radiotherapy service. This is seen as essential to high levels of staff retention – another key attribute of a world-class service highlighted by those interviewed. Research was also seen as an important driver of service quality. High-quality research facilities and activities attract competent staff; enable the delivery of effective training and professional development, and keep staff motivated and engaged. Finally, through applying the results of research to practice, research is seen as having a decisive impact on driving service quality.

Training and professional development are seen by the experts consulted as playing an important role in developing multidisciplinary teams as it encourages communication and mutual understanding among different practitioners from different fields. Multidisciplinary teams allow patients to receive a better treatment and services to improve, as different perspectives are incorporated in diagnosis, treatment, monitoring and research. All the world-class services analysed included this characteristic and they present different ways and mechanisms to make cross-discipline working function properly. This showed the relevance of both the availability of diverse and highly qualified professionals and the structures or policies to make them collaborate.

The experts observed that universities play an important role in delivering high-quality training and are therefore an important ingredient in a world-class service. Universities are seen as effective vehicles for supporting the creation and diffusion of multidisciplinary perspectives in radiotherapy and encourage close relations between the clinical and scientific world. They also define how academia is integrated into health services. Indeed, some of the experts consulted suggested that “a world-class radiotherapy service should be a hospital-based organisation”.

Combining empirical, medical and research expertise is an important component to a quality service. Research supports analysis and evaluation of different models of service delivery as well as evidence-based practice; and investment in research contributes to breakthroughs in technical and operational innovations.

Quality culture

From the radiotherapy service perspective, quality includes considering the side-effects of treatments and their patients’ situation and wellbeing. However, how can this be specifically taken into account? How do professionals recognise that their performance is having the desired effect? In this context, the experts highlighted the importance of measurement and embedding an evaluation culture as key drivers of a world-class service**.** They stressed that evaluation culture and practice should focus on delivering evidence to measure service quality, rather than focusing more narrowly on accountability purposes (although this remains an important function of evaluation). In turn, although not explicitly highlighted by the experts as a characteristic of a world-class service, dissemination of evidence was also seen as an important part of supporting a quality culture in radiotherapy services by providing relevant information to continue on the pathway of constant improvement.

Measuring all radiotherapy activities provides useful data not only related to the organisation and its processes, but also in relation to assessing treatment effectiveness. These measures are essential for research and evidence-based services of high quality. Moreover, they provide the possibility of error detection and improve the quality of the service.

The practice of sharing, learning and implementing good radiotherapy practices and standards was considered essential. These standards and practices may come from both inside the organisation and from a broader framework, such as professional organisations or national or international bodies. This may include elements such as: external quality and QA protocols, guidelines, continuous education and training, and complication and waiting time registries.

Transferable learning: strategies and methods used

This section of the report on the results of the benchmarking exercise focuses on the strategies and mechanisms the experts highlighted to enable the essential attributes of a world-class radiotherapy service, as described in the preceding section, to be put into place. The experts interviewed were asked to identify the kinds of policies, structures, tools and designs which they considered could be transferred to the UK in order to help promote a world class radiotherapy service in the UK countries. These examples of 'transferable learning' are described below for each element of the key characteristics of a world class service identified by the experts.

Sufficient volume of activity

To bring together a critical mass of radiotherapy expertise the service needs to be considered as a 'whole system' that supports:

- Creation of regional networks to establish quality guidelines and cancer registries. Analysing the registries and trends derived from the networks may help to organise professional capacity development according to these measures and trends to gain volume;
- Creation of consultant teams from radiotherapy service to provide analysis and give advice to general regional hospitals. One service giving support to different hospitals helps to create a critical mass;
- Focusing radiotherapy in bigger centres and smaller ones dealing with surgery. If the referred hospital of the patient has no radiotherapy service, it should guarantee a flexible relation with a radiotherapy service in another one.

State-of-the-art equipment

- Investment in radiotherapy machines and matching linacs to required volume;
- Technology can be integrated and transferred with little difficulty.

Sufficient trained staff

This characteristic constitutes a challenge even in the already recognised world-class services, because, even if it is achieved at some points, cuts and scarce funding may jeopardize the results. The lack of sufficient specialists is considered a political problem and not a challenge which can be resolved at hospital level. At national level, the following mechanisms have proved successful:

- National strategic plans which include investment on education and equipment, and national educational targets. For this, a government initiative is needed. Centres are seen as potential leaders, but they must have a voice and act as relevant stakeholders, explaining the arguments against reducing resources for training;
- Negotiation and collaboration among stakeholders.

However, at an organisational level, there are also different possibilities recognised:

- Direct introduction of already successful educational programmes, as these are easily transferred. Moreover, mutual learning programmes, exchanges, and similar activities may have a positive impact.
- Internal training programme to up-skill service personnel. Create or assure an internal professional development funding programme and encourage staff to participate in it.
- Internal training and accreditation; supporting international mobility and exchange programmes. Identify potential future colleagues from participation in training and mobility programmes.

Multidisciplinary teams

- Integrating radiotherapy services in the oncology departments, which may also include the pharmaceutical treatment services. The focus is to promote multidisciplinary discussions to determine the most appropriate treatment.
- Creating spaces and time for debate, by formal meetings or cross-departmental bodies which meet regularly.

Research

- Assess the impact of research funding, as this allows breakthroughs at a relatively low cost. Evidence-based arguments may help in the negotiation process with commissioners.
- Create a national registration system which includes the local registrations, covering every cancer patient at national level. Thus, long-term follow-up studies and retrospective and prospective studies would be possible.
- Long-term follow-up studies support evidence-based practice and transferable learning.
- Integrate academic positions in the service.

At the organisational level, some policies may also support research:

- Reserve budget and staff time for research activities and keep this as a priority;
- Thinking and acting strategically, treating research objectives in different time frames from the short, through mid- and long-term.

Quality and learning

This set of learning examples supports evaluation culture, the sharing and learning through practices and standards, and quality assurance. The most relevant instruments identified by the benchmarking exercise are:

- Systematic peer-reviewing;
- Creating an organisation responsible for collecting information from all departments at national level. This information should focus on assessing capacity and need issues and providing guidelines for treatments;
- Benchmarking as a learning process whose purpose is to create a real national compilation centre and a national registry, in order to compare different centres. If there are differences between hospitals, the objective would be to explain why this is happening and try to identify factors to improve performance or identify contextual factors that may explain differences in performance;
- Introducing QA testing and practices;
- External auditing.

At the organisational level, other relevant mechanisms were identified:

- Creating bodies, positions or spaces for critical thinking: being able to think about current and future situation of the organisation, as an independent body and as a part of a more complex system..
- Measuring process and outputs through surveys and performative evaluations;
- Introducing practice standards and educational resources;
- Creating a culture of error detection and a no-blame culture to support learning from the error. Sharing information about errors among the staff as a regular practice based on a monitoring system;
- Clarifying the objectives of the service and the measurement: quality and safety as drivers for user satisfaction.

The care system is recognised by experts to be a whole process and a combination of different characteristics is what assures a world-class service. To guarantee that this happens, the presence of three key factors is necessary:

- Strategic roles: a role to lead management, try to increase efficiency to best allocate resources in the system;
- Boards which provide an overview of the clinical paths;
- Electronic system tracking treatment for patients which may give a full insight of when steps in the treatment process happen and enable the modification of critical steps with this information.

Conclusion

The overall results of the benchmarking activity supports the idea of an open 'systems model' – that organisations do not exist in a vacuum and are affected by the context they are in. Given current developments abroad, particular lessons may be considered to support a change path towards a world-class radiotherapy service.

First, not only quantitative measurement is needed, but also compliance with standards and guidelines. These may prompt a reflection on what should change to improve and not only if some particular standards are achieved. A focus on quality and promotion of monitoring should not mean focusing not only on evidence-based evaluation but also on improving services. Both processes and results should be considered.

Second, we found that in Canada, Holland and Sweden cost-effectiveness measures are seen as subordinate to quality measures. Indeed, there was a consensus amongst the experts interviewed that an emphasis on cost-saving is likely to be to the detriment of achieving quality. The perception is that there is always a tension between cost and quality in all the world-class services analysed. However, increasing transparency may help to support communication and negotiation among stakeholders, helping them to find a balance between cost-effectiveness and quality. It is precisely this idea of collaboration instead of confrontation between public and private sectors and funders that is seen to have produced better results in countries introducing reforms in the funding system.

Third, regarding the optimal level of centralisation, there is no single answer between decentralisation and central control. Instead competences and authority should be held at local, regional and national levels which should work together to deliver a world-class radiotherapy service.

Annex 5: Summary of Patient Interviews

As part of the research we conducted two interviews with members of the Patient and Public Liaison group (PPLG) of the Society of Radiographers (SCoR) and National Radiotherapy Implementation Group (NRIG). This was in order to understand the role of patients in shaping the radiotherapy service and to ensure that the patient voice was a part of the recommendations from the report. This work package was in line with research findings which suggested that a patient centred service was the ideal for the UK. The key findings from these interviews are presented below:

Role of the PPLG

Patient representatives have become an important component in developing strategy in SCoR in the past eight years. Examples of this include co-designing the recent National Radiotherapy Patient Experience Survey, being consulted on the potential uses of VERT, changing publications in order to make them more readable by the public, and running workshops at national radiotherapy conferences.

Representatives are able to bring their own concerns to meetings and also are given topics by SCoR which require the PPLG's input.

Patient-focused services

The patient-related skills of radiographers were noted as being good: "I think the survey gives an indication of how patients are important to radiotherapists. When you look at the results you can see people are satisfied by and large. The results that we've had are largely positive. The quality of care seems to be very good. I think their patient skills are quite good. It seems to me that radiographers are doing things well. The guidance from the College, it does filter down to centres."[127]

The patient-centred approach in radiotherapy had not been reached from the perspective of one interviewee. As an ex-patient, she said that: "Equipment has a finite lifetime, but many are lying idle as opening hours are only 9-5. If it meant I could have my treatment sooner, I wouldn't have minded going at 9pm at night. But for patients they want the surgery tomorrow and treatment the day after… I think there's a lot of rhetoric about a patient-centred approach recently, but I don't think saying it makes it so."[128]

Concerns

The interviewees had experience of NRIG as public representatives and were worried about the impact of abolishing the NCAT: "One of the things that has had an impact was setting up of NCAT. It's such a shame it's going. The success of having the 31-day wait time, the 7-day working, all this has come about because of NCAT… IMRT and IGRT and Stereotactic therapy, mentoring programmes and e-learning for health all helped by NCAT. I get the impression from being on NRIG that the improvement has been quite vast."[129]

Overall the interviewees believed that whilst radiotherapy had been steadily improving in England since 2007 with the support of Sir Mike Richards, it was too soon to say what the future impact of the NHS reforms would have on radiotherapy: "There's a lot of uncertainty from the 1st April… I

[127] Interview with patient representative.
[128] Interview with patient representative.
[129] Interview with patient representative.

think a period of stability is really what's needed. We need time to see things through… Having worked with the NCAT, they're so dedicated I hope people don't get disillusioned."[130]

[130] Interview with patient representative.

Annex 6: Triangulation of results

The table below shows there is a high degree of coherence in the perspectives of a world-class radiotherapy service that were identified by the four main research methods used in the study. The research highlights nine common elements that need to be implemented to deliver a world-class service:

- Strategies and mechanisms to increase and sustain capacity;
- Strategies and mechanisms to deploy and utilise state-of-the-art technologies;
- Effective staffing and training policies and arrangements;
- Appropriate and effective funding and commissioning mechanisms;
- Mechanisms to consolidate and grow research capacity;
- Evaluation and Quality systems;
- Changes in work culture and organisational structures.
- Ensuring equity and consistency of service provision;
- Promoting a coherent national vision and strategy.

Table 7: The pre-requisites of a world-class radiotherapy service

Literature Review	Delphi panel	Case Studies	Benchmarking
COMMON ELEMENTS			
Capacity			
Radiotherapy capacity needs to increase considerably	Increase radiotherapy capacity	Increase capacity	Developing sufficient capacity and activity volume to create a critical mass
Technology			
Effective utilisation of new equipment	Full utilisation of appropriate technology and equipment	Access to latest technologies Full utilisation of technology	Ensuring access to state-of-the-art equipment.
Staffing and training			
Staff levels need to be brought more into line with targets in all three professions Address high levels of attrition and	Ensuring a continuous supply of an appropriate number of trained staff at centres	Address high rates of attrition and low rates of retention Identify skills gaps and training needs	Provision of enough trained staff to meet demand Providing effective and relevant training

low retention		Improve levels of recruitment and reduce vacancy rates – particularly in medical physics Address skills shortages in use of specialised and complex treatments More balanced and effective training approach (hands-on; VERT; CPD)	
Funding			
Capital investment in equipment, staffing, training, linked to the introduction of an appropriate business model and commissioning structure development	Capital investment with an appropriate business model and commissioning structure	Flexibility in PbR tariff – to cover new complex techniques More autonomy to generate income	Reform of funding mechanisms Collaboration instead of confrontation between public and private sectors and funders
Research			
Increasing research capacity	Promoting evidence-based practice utilising research results Centralisation of research, with evidence based pathways, and peer reviewed services, and more extensive engagement in clinical trials (Wales; NI) Build more effective bridges with HEIs (Wales). Shifting resources to more innovative approaches to developing and testing new technologies in radiation therapy (SC)	Research capacity and skills Capacity in Research planning and set-up Close links with HEIs Promoting evidence-based practice through research	Supporting Research and the transfer of research knowledge into practice
Evaluation and Quality Systems			
Supporting common quality standards	Implementing an effective evaluation culture	Embedding quality standards in service provision	Developing and implementing an evaluation culture and robust

	Applying robust and specific measurements to assess outcomes and impacts Developing and promoting a 'quality-driven' service, supported by robust evaluation methods and measurement tools (NI) Driving forward quality standards in service delivery (Wales)		measurement tools Embedding quality in service provision
Work culture and organisation			
Joined up approach to workforce planning for RT and shared elements of education and training for cohesive workforce Promoting bold leadership	'Joined up' workforce planning	Better and more co-ordinated planning More coherent and co-ordinated referral system Multi-disciplinary teams Reduction in overworking culture – linked to more flexible hours to respond to demand patterns and more control over the workload Effective Management and leadership	Deploying multidisciplinary teams Supporting 'sharing and learning': good radiotherapy practices and standards
ADDITIONAL ELEMENTS			
Addressing inequalities in service provision (access for patients; acquisition of equipment; funding; staff)	Equity and consistency of services (NI) Ensuring services are accessible and convenient for patients (Wales)		
Promoting a coherent national vision	Development of a joined up national strategy and single authority (Scotland)		

Annex 7: Glossary

A list of common terms in radiotherapy[131]:

4D-ART: 4D Adaptive Radiotherapy

4D-ART is the ability to take account of the tumour shape in the three physical dimensions plus the fourth dimension of change with time. It can work well for tumours in areas of the body that may move during treatment, for example due to breathing.

Dosimetrist

Specialist radiotherapy staff usually employed as clinical technologists. Their work includes patient immobilisation, treatment planning, in vivo dosimetry, general dosimetry, etc.

Fraction

A single attendance for treatment. Therefore, a three field breast (two tangential fields plus a supra-clavicular field) would count as a single fraction of treatment, as would a multiple area palliative patient.

Hypofractionation

Involves giving patients larger doses of radiotherapy, but fewer times, reducing the number of visits to hospital for treatment. In addition, the total dose of radiotherapy over the course of treatment is usually lower.

IGBT: Image Guided Brachytherapy

Image guided brachytherapy (IGBT) uses cross-sectional image data to create 3D models. This allows clinicians to more precisely plan and deliver the radiation to the target while sparing surrounding health tissues.

IGRT: Image Guided Radiotherapy.

IGRT is any imaging at pre-treatment and delivery, the result of which is acted upon, that improves or verifies the accuracy of radiotherapy. IGRT encompasses the whole range of imaging, from simple to more complex imaging, that allows direct visualisation of the tumour and surrounding tissue. Using scanning during treatment enables verification of tumour position in relation to adjacent soft tissue organs.

IMRT: Intensity Modulated Radiotherapy.

IMRT is a high precision form of radiotherapy. It moulds (conforms) the shape and dose of the radiation precisely to the volume of tumour tissue that needs to be treated, reducing exposure to healthy surrounding tissue. Doses can also be varied to different areas at variable risk of harbouring tumour deposits.

Linac: Linear accelerator

A treatment machine generating megavoltage x-rays or electrons.

[131] Most definitions derived from the Vision for Radiotherapy (NHS England and CR-UK) and the DH report Radiotherapy in England 2012. For further definitions see http://www.osl.uk.com/rte.asp?id=33.

MRI: Magnetic Resonance Imaging

MRI is a medical imaging technique, which makes use of the property of nuclear magnetic resonance (NMR) to image nuclei of atoms inside the body. This allows greater clarity of soft tissue structures.

PET: Positron Emission Tomography

PET scanning is a nuclear medicine imaging technique that produces a three-dimensional image or picture of functional processes in the body.

Proton beam therapy:

Proton Beam Radiotherapy uses a different type of radiation beam called a proton beam. Protons differ from conventional radiotherapy because the beam stops at a certain depth within the body. This can be used to minimise the dose to the tissues of the body outside the tumour target area. This is only available in the UK to treat cancer of the eye. The NHS England Proton Overseas Programme does send some highly selected patients overseas for treatment.132 The aim is to expand this programme prior to opening the UK proton beam service in early 2018.

SBRT: Stereotactic Body Radiotherapy (also called SABR: Stereotactic Ablative Radiotherapy).

SBRT or SABR refers to the precise irradiation of an image defined extra cranial lesion (not in the brain) and is associated with the use of a high radiation dose delivered in a small number of fractions. The technique requires specialist positioning equipment and imaging to confirm correct targeting. It allows sparing of the surrounding healthy normal tissues. SABR is currently supported by a national clinical policy for non-small cell lung cancer133. Other indications are being evaluated.

[132] http://www.england.nhs.uk/ourwork/d-com/spec-serv/bpt/
[133] http://www.england.nhs.uk/wp-content/uploads/2013/08/b01-p-a.pdf

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