Grwp Cynghori Arbenigol Cenedlaethol Cancer

Cancer National Specialist Advisory Group

RADIOTHERAPY EQUIPMENT NEEDS AND WORKFORCE IMPLICATIONS 2006-2016 (UPDATE REPORT TO 2020)

The Welsh Medical Committee's Cancer National Specialist Advisory Group in collaboration with the Clinical Oncology Sub Committee of the Welsh Scientific Advisory Committee

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Executive summary

Purpose of this report

i. The report 'Radiotherapy Equipment Needs and Workforce Implications 2006 – 2016', subsequently referred to as the '2006 Report', estimated the need for new and replacement linear accelerators in Wales[1]. As such estimations depend on a number of variables a mid-term update was recommended which this report now provides.

ii. This report details the current workforce, changing roles and challenges but does not cover the workforce requirements associated with the expected number of new linear accelerators. This will depend on the service model/s implemented and will be covered in detail as each business case is developed. As in the 2006 Report, the purpose of these revised estimates is to inform Local Health boards (LHBs) in their future planning of radiotherapy services.

Context

iii. Survival continues to improve for the majority of cancers. However, research on international comparisons confirms that there remains a major gap between the survival achieved in UK and other similar, high income countries[2]. Reasons for the poorer outcomes in Wales, and across the UK, are suspected to be associated with more advanced disease at diagnosis and sub optimal treatment. Actions to address these issues in Wales are already being progressed as part of the implementation of 'Together for Health - The Cancer Delivery Plan'[3].

Radiotherapy

iv. There is a consensus across the UK on the continuing major role of radiotherapy in the treatment of cancer. Radiotherapy is a key component of approximately 40% of curative (radical) cancer treatment either used alone or combined with other modalities. This compares to about 50% for surgery and around 10% for chemotherapy and other systemic anti-cancer drug therapy[4].

Current capacity

iv a) The 'currency' used to measure capacity has changed from fractions to attendances and attendances per million population as this better reflects actual delivery of radiotherapy per patient[5].

Iv b) The 2006 Report noted that there were a total of 11 operational linear accelerators[1] in 2004/05. By 2011/12, this had increased to the equivalent of 12.5 operational linear accelerators representing approximately a 14% increase. This was associated with a 15% increase in activity, over the eight year period from 2004/05 to 2011/12 equivalent to an annual increase in activity of 1.8% (paragraph 15 & Table 2). This is in line with the annual increase in cancer incidence for the cancer sites commonly treated with radiotherapy of 1.9% (Table 4). Currently, in 2014, there are 14 linear accelerators in use.

iv c) More recently service improvement methodology has supported new ways of working to maximise capacity. This multi-professional, quality focussed approach needs to continue, alongside the commissioning of new linear accelerators, in order to meet the expected future demand for radiotherapy. It is important that Wales continues to develop all staff groups involved in providing radiotherapy services. Welsh Government and academic institutions need to support training in order to further develop existing and introduce new roles.

Future Demand

iv d) The 2006 Report estimated the need for at least six additional and eleven replacement linear accelerators by 2016, depending on the service model adopted. If these recommendations had been fully implemented at least six new linear accelerators would have been commissioned by 2013. To date however, only 2 new and 7 replacement linear accelerators have been commissioned. The inability to justify associated revenue costs, given linear accelerator increases were in line with actual increases in demand over the period, is thought to have been a major contributory factor.

iv e) Projections of radiotherapy demand up to 2020 presented in this Report have for the first time used a new modelling tool, Malthus Cymru, which brings together more detailed cancer incidence and demographic trends by Local Health Board (LHB) and Local Authority along with current best clinical practice radiotherapy protocols. These results confirm the 2006 Report's key recommendation for an increase in linear accelerators to meet the future demand for radiotherapy and also suggests that the previous projected demand may well have been under estimated.

iv f) At the all Wales level, and based on the new data presented, LHBs should plan to provide a total of 183,300 attendances per year by 2020 (Table 5). In 2011/12 approximately 90,957 attendances were recorded (Table 6) showing that activity is projected to more than double by the end of this decade, with a total of between 22 to 26 linear accelerators required by 2020 (Table 7).

[1] 2006 Report and Table 6

iv g) The level of radiotherapy activity reported in 2011/12 was about 40% less than that predicted by modelling (Table 6). The reasons for the seeming lower level of demand for radiotherapy are not clearly understood but are expected to relate to a number of factors covering both service and patient related issues. To address this, LHBs should urgently review the radiotherapy access rate for their population in relation to best clinical practice. All appropriate patients should be offered radiotherapy and more needs to be done to identify and address variations in access. Further detailed analysis at LHB level using data from Malthus and activity data from the Welsh radiotherapy dataset, once implemented later in 2014, will support this essential work.

New technological advances

iv h) Radiotherapy services in Wales are implementing several technological advances to improve patient outcomes whilst maintaining patient safety as paramount. Intensity Modulated Radiotherapy (IMRT) is an important new paradigm in radiotherapy planning and delivery. IMRT reduces late side effects and can improve cancer control for a number of cancer sites and is appropriate for a minimum of 35% of patients treated by radical radiotherapy. Stereotactic Body Radiotherapy (SBRT) improves local control for selected patients with lung cancer. Image Guided Radiotherapy (IGRT) improves accuracy of treatment delivery and is important to future advances. These require additional training, staffing and machine capacity. Future advances include incorporation of functional imaging e.g. Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) and will require further support from clinical radiologists, medical physicists and the IT infrastructure. LHBs also need to be aware of the future provision of proton beam therapy in England (Section C)

iv i) Research and Development, including participation in clinical trials, needs to continue to ensure radiotherapy services are at the cutting edge of new developments and comply with the requirements of the National Cancer Standards[6].

Information

iv j) Work is in progress to implement a radiotherapy dataset (RTDS) for Wales to provide information on radiotherapy services. See Appendix 5 for a summary of the data required. Activity by cancer site protocol, waiting times, and productivity are essential metrics for planning purposes and benchmarking best practice and clinical outcomes. LHBs should support the current development and implementation of this national radiotherapy dataset. Consideration should also be given to using new tools that model radiotherapy demand with workforce requirements.

iv j) With the introduction of more complex radiotherapy, the Clinical Oncology Sub Committee (COSC) should develop a set of quality measures that reflect the requirements of a quality focussed radiotherapy service that can be used for peer review.

Recommendations

LHBs are asked to note projected demand for additional linear accelerators and consider;

a) Undertaking an urgent review of the current level of attendances for their population and, with their radiotherapy centre/s, determine the appropriate service model to meet the future demand for their population.

b) Where attendances are higher or lower than expected, a review of potential causes to ensure all appropriate patients should be offered radiotherapy.

c) Supporting participation in UK wide audit and quality improvement of radiotherapy services using data from the Welsh radiotherapy dataset (RTDS) as soon as this becomes operational. The RTDS will include a set of process and outcome indicators, developed or adopted by COSC, that define a quality radiotherapy service and that will be included in the Cancer Peer Programme when applied to radiotherapy.

d) Implementation of modelling tools to inform workforce development and training for radiotherapy services.

e) Maintaining an all Wales, 10 year planning process for radiotherapy that underpins an approved, national capital procurement programme incorporating both new and replacement linear accelerators, associated equipment and works. The planning estimates should be reviewed at 3 yearly intervals.

Introduction

1. It is now eight years since the report ‘Radiotherapy Equipment Needs and Workforce Implications 2006-2016’, subsequently referred to as the ‘2006 Report’, was published by the Cancer Services Co-ordinating Group[1]. This work informed a national procurement framework for linear accelerators to 2012. The 2006 Report recommended that a mid term review was undertaken to review the initial projections of the number of linear accelerators required in NHS Wales by 2016. To achieve this, the Cancer National Specialist Advisory Group (Cancer NSAG) and Clinical Oncology Sub Committee (COSC), of the Welsh Medical and Welsh Scientific Advisory Committees respectively, formed a working group. The working group agreed to extend the time frame of the review to 2020.

2. Estimations of demand for radiotherapy have in the past only been possible at an all Wales level. Malthus is a new tool designed to better model radiotherapy demand. It brings together detailed, local information on trends in population incidence, population age profiles, cancer incidence with national radiotherapy best practice clinical guidelines for each cancer and was used to estimate demand for radiotherapy in England[5]. Malthus Cymru was commissioned by the Cancer NSAG in 2013 to support planning for radiotherapy demand in Wales. Brief details are summarised in Appendix 1 with a full paper published in 2013[7]. The use of this modelling tool is expected to result in the current demand estimates being more sensitive to the catchment population demographics of each radiotherapy centre.

3. The review of capacity and demand is set out in Section A with workforce developments addressed in Section B. An omission in the 2006 report was any consideration of the increasing complexity of technologies and treatment techniques. This is now seen as a major challenge for cancer services in Wales, in common with the rest of the UK, and is addressed in Section C paragraph 80.

4. The continuing importance of radiotherapy has been considered and developments in relation to both cancer policy and radiotherapy service delivery since 2006 are presented first to provide the context to the review of future capacity and demand.

Continuing Clinical Importance of Radiotherapy

5. There is a consensus across the UK, reflected in current policy advisory reports, of the continuing role of radiotherapy in the treatment of cancer. Radiotherapy is a key component of approximately 40% of curative (radical) cancer treatment either used alone or combined with other modalities. This compares to about 50% for surgery and around 10% for chemotherapy[4]. When viewed in context with the curative importance of radiotherapy discussed above, the cost effectiveness of this treatment modality is demonstrably very high[8].

Developments in Wales since the 2006 report

Policy developments since 2006

6. The 2006 Report was supported by an approved all Wales Capital procurement programme that ended in 2012. This was managed by Welsh Health Estates, along with revenue funding from the Health Boards and resulted in additional staff and equipment to support service expansion including linear accelerators, Computerised tomography (CT) simulators, treatment planning system workstations and dosimetric equipment for verification and quality assurance. In addition, the Welsh Government provided targeted funding from April 2009 to be used to increase radiotherapy capacity through extended working hours, with the aim of improving radiotherapy services in Wales. As a minimum, the working day was to be extended to an average of 9 hours of treatment time at each radiotherapy centre with at least 9,000 fractions delivered per year per linear accelerator.

7. The Welsh Government's cancer policy, 'Together for Health – Cancer Delivery Plan', published in June 2012, recognised the importance of radiotherapy[3]. Local Health Boards and Trusts are expected to work together to plan for the prompt and equitable introduction of new technologies, such as new radiotherapy techniques, where there is evidence to support their effectiveness. It is considered essential to continued excellence, and the reputation of NHS Wales, that cancer services are at the cutting edge of such developments.

8. Professional guidance from COSC on Intensity Modulated Radiotherapy (IMRT) was issued to LHBs in 2011 with a proposed implementation plan aiming to deliver this service to 20% of radiotherapy patients in a five year timescale[9]. To support implementation, the Welsh Government provided capital funding for computerised treatment planning systems and dosimetric quality assurance equipment. In 2012, COSC published additional guidance on Stereotactic Body radiotherapy and Image Guided Brachytherapy[10,11]. Further detail on IMRT, SBRT, IGBT and the respective clinical rationales are set out in Section C of this report

Service developments

9. Since the 2006 Report there have been a number of developments in staffing, equipment, ways of working and management of waiting times.

Workforce

10. There has been a significant and ongoing shift in the traditional roles of the three main groups of radiotherapy staff: clinical oncologists, therapy radiographers and physicists. New techniques in radiotherapy are time-consuming and increasingly site-specific, and changes in staffing and working practice are necessary to accommodate this. New technology has provided opportunities for development of

new skills and specialisation, and has provided flexibility in shifting some work in time and location. Probably the most striking change has been the expansion of the role of the radiographers to include certain areas of work previously performed by clinical oncologists and physicists, including radiotherapy target volume definition and dosimetry, planning and prescription of some radiotherapy treatments, on-treatment patient review clinics, and supplementary prescribing.

Clinical Oncologists:

11. The 2006 Report did not record the numbers of clinical oncologists in Wales however data on workforce across the UK is now regularly submitted to audits run by the Royal College of Radiologists. Their latest report, using data from the 2012 census, show a continued increase in the clinical oncology workforce across the UK[12]. The number of consultant clinical oncologists in Wales was reported at 42 people equating to 12.5 whole time equivalents per million population which was very similar to the previous year's audit. Further detail is provided in Table 8.

12. In 2011 the number of clinical oncologists in Wales stood at 41 with 31 whole time equivalents (WTE). By 2013, data from the radiotherapy centres showed that this had increased to 42 with one vacancy (Table 8).

Medical Physicists:

13. The overall staffing establishment for medical physicists has increased by about 30% (Table 9). However, the workforce concerns identified in 2006 remain, and in some cases matters have deteriorated further. For example, the shortage of experienced scientists available for recruitment across the UK means that some senior posts in Wales remain unfilled, or are filled indirectly through the appointment of more junior staff. It is therefore essential that Wales retains a successful training and career development infrastructure for Clinical Scientists.

Therapy Radiographers:

14. The 2006 report noted that there were in total, 106.6 radiographer staff including helpers/assistant practitioners. The workforce at 2011 is summarised in Table 10 and shows a total of 163.2 WTE equating to an increase 53%. This increase is in line with increased workload and reflects the extension of role of radiographers and changes is treatment delivery. Recruitment is not a problem with Wales having a low vacancy rate although recruitment of senior specialised posts is still challenging.

Equipment

15. The 2006 Report noted a total of 11 linear operational accelerators in Wales. This has increased to 12.5 in 2011/12 (Table 2). This 14% increase in linear accelerators was associated with a 15% increase in activity over the 8 year period from 2004/5 to 2011/12. This equates to a 1.9% increase per year (Table 6). As at 2013, the total number of operational linear accelerators was 14 with 7 situated at the Velindre Cancer Centre, 4 at the South West Wales and 3 at the North Wales Cancer Treatment Centre (paragraph 27). Over the same time period, 7 older linear accelerators have been replaced.

16. All radiotherapy centres have installed and commissioned replacement and/or additional, state-of-the-art linear accelerators and associated equipment. For example;

    a. Intensity modulated radiotherapy is being rolled out across Wales.

    b. New linear accelerators now have integrated 'cone-beam' CT to allow IGRT capability as standard.

    c. Linear accelerators installed in Wales in the last 2-3 years are capable of providing the most up to date treatment techniques, with both the North Wales Cancer Treatment Centre and the Velindre Cancer Centre having introduced arc therapy clinically in 2013.

    d. Newer high-end linear accelerators already in place in the 3 Welsh centres can be adapted to deliver SBRT, and have the advantage of being able to deliver conventional radiotherapy as well. In early 2012 SBRT was introduced at the Velindre Cancer Centre, on a pilot basis, for the treatment of non small cell lung cancer and a South Wales service may remain focused at that centre in the near future, given the necessary concentration of expertise and the current limited number of indications. The Velindre Cancer Centre currently provides an intra-cranial stereotactic radiotherapy service for the treatment of secondary brain lesions across South Wales.

    e. Additional and/or more advanced treatment planning facilities have been procured and commissioned, including virtual simulation systems and IMRT planning workstations some with arc therapy planning capabilities.

    f. All three centres routinely use 3D CT based planning for the majority of patients treated radically.

g. Availability of functional imaging is limited, with a single Welsh Positron Emission Tomography (PET-CT) scanner based at the Cardiff University School of Medicine and a restricted number of funded indications.

New ways of working

17. The 2006 Report recommended that LHBs increased radiotherapy capacity and suggested a number of possible ways of achieving this, including the establishment of satellite centres, increasing the clinical hours in the working day and increasing the number of working days per week.

18. Staff involved in providing radiotherapy work increasingly as a team with traditional roles expanding to achieve the most effective use of resources and provide better patient centred care. For example, approval of treatment images was originally the role of the oncologist. This is now routinely performed by experienced radiographers. In the North Wales Cancer Treatment Centre radiographers attend head and neck MDT on a regular basis. Radiographers facilitate the necessary pre treatment procedures e.g. dental opinion for patients with head and neck cancer. This increases efficiency and avoids missed appointments.

19. All three radiotherapy centres are supporting a level of extended day working. Currently all radiotherapy departments provide operational working hours varying from 8am to 6.30pm. Departments provide Bank Holiday working, weekend working for on call and continuous hyperfractionated accelerated radiotherapy (CHART) and extended hours to cover breakdowns, with significant amounts of machine servicing in the radiotherapy centres undertaken out of hours, all in an effort to minimise the treatment course length and ensure the best outcomes for the patient.

Section A - Capacity and Demand

Current capacity and radiotherapy activity

20. Fractions, as the main ‘currency’ for radiotherapy activity, are now recognised as having limitations and the recent Department of Health (2012) Report on Radiotherapy Services in England has replaced fractions with ‘attendances’[5]. An attendance is defined as a visit for one or more fractions of radiotherapy. Attendances will therefore be slightly lower than fractions (approximately 0.85 – 0.89 attendances per radiotherapy fraction). From this point on in this report, 0.87 is used as the average conversion factor for fractions to attendances.

21. The 2006 Report recommended that ’Wales should aim to provide between 54,000 to 58,000 fractions of radiotherapy per million population by 2016’. This was in line with other international studies of the time, from England, Scotland, Netherlands, Australia and Canada. Using the conversion factor of 0.87, this equates to between 46,980 to 50,460 attendances per million population

22. Table 1 summarises the activity data by radiotherapy centre for 2004/5, as presented in the 2006 report alongside more recent data for 2011/12. In 2004/5, actual activity in the three radiotherapy centres totalled 90,841 fractions, equivalent to 79,032 attendances (26,882 attendances p.m.p). By 2011/12, this had increased to 90,957 attendances (29,725 attendances p.m.p) an increase over the intervening 8 years of approximately 15%, though there was considerable variation between centres.

23. The largest increase in activity was recorded in the North Wales Cancer Treatment Centre (51%), followed by South West Wales Cancer Centre (15%). It is important to note that in 2004/5, the radiotherapy service in North Wales was still being developed, and patients were still travelling into England for treatment which explains the high percentage increase; this cross border flow has now dropped significantly.

24. The slight decrease in activity noted for the Velindre Cancer Treatment Centre is likely to be due to an overestimation of the catchment population in 2004/5, with a corresponding underestimation in the catchment population of the South West Wales Cancer Treatment Centre. There may be a number of reasons for this including incidence and demographic variations in the population as highlighted in Figure 1. A small number of patients, principally from mid Wales, receive radiotherapy in England (Appendix 2).

Table 1 Comparison of linear accelerator activity for the financial years 2004/5 & 2011/12

Radiotherapy Centre	2004/5 [a)]			2011/12		
	[a]Fractions	[b)] Equivalent Attendances	Attendances per million population	Fractions	Equivalent Attendances	Attendances per million population
North Wales Cancer Treatment Centre	catchment population [C)] 0.73M			catchment population [d)] 0.69M		
	19,109	16,625	22,774	28,804	25,060	36,290
Velindre Cancer Centre	catchment population [C)] 1.46M			catchment population [d)] 1.48M		
	47,360	41,203	28,221	47,766	41,556	28,017
South West Wales Cancer Treatment Centre	catchment population [C)] 0.75M			catchment population [d)] 0.83M		
	24,372	21,204	28,272	27,979	24,341	29,254
All Wales	catchment population [C)] 2.94M			catchment population [e)] 3.06M		
	90,841	79,032	26,882	104,549	90,957	29,765

a) Data from Table 3 in the 2006 Report
b) 0.87 attendances per fraction
c) Data from Table 6 in the 2006 Report
d) catchment populations determined from Malthus modelling tool for 2011 rounded to 2 decimal places
e) the all Wales figure is the sum of the catchment populations of the three centres and excludes 55% (73,00 people) of PtHB residents received radiotherapy from English providers

Productivity

25. In the 2006 Report, the recommended first step was for each linear accelerator to provide at least 8,000 fractions, equivalent to 6,960 attendances. A further target of an average of 9,000 fractions (7,830 attendances) per linear accelerator was recommended as an outcome of the additional funds to extend the working day.

26. The first step target was achieved in 2011/12 with the average number of fractions per linear accelerator reported at 8,364 (equivalent to 7,277 attendances). However, whilst the overall target had been met there were significant differences between the three radiotherapy centres in Wales with only the North Wales Cancer Treatment Centre achieving the further target of 9,000 fractions (7,830 attendances) in 2011/12. In addition, one of the linear accelerators in South West Wales was only operated on a part time basis. (Table 2).

Table 2 Activity per linear accelerator 2011/12

Radiotherapy centre	Linear accelerators	operational linear accelerators	Fractions delivered	Average fractions per linear accelerator	Equivalent attendances per linear accelerator
North Wales Cancer Treatment Centre	3	3	28,804	9,601	8,353
Velindre Cancer Centre	6	6	47,766	7,961	6,926
South West Wales Cancer Treatment Centre	4	3.5*	27,979	7,994	6,955
All Wales	13	12.5	104,549	8,364	7,277

Data source: Radiotherapy centres
Key * One of the linear accelerators was beyond its planned replacement date, and was used on a part-time basis only

27. As at the end of 2013, the total number of linear accelerators has increased to a total of 14, with 7 at the Velindre Cancer Centre, and 4 and 3 at the South West Wales and North Wales Cancer Treatment Centres respectively. There is currently

a 4th linear accelerator in the North Wales Treatment Centre, which is awaiting decommissioning, but is used to provide cover for planned maintenance and breakdowns only.

28. It has been many years since radiotherapy in Wales was offered solely on a 9am to 5pm, Monday to Friday basis. Currently all radiotherapy departments in Wales provide extended opening times varying from 8am to 6.30pm. Departments already provide Bank Holiday working, weekend working for on call and CHART patients and extended hours to cover for machine servicing and breakdowns. This minimises the overall length of each treatment course and supports the best outcomes for patients. Moving to out of hours servicing of all machines, whilst keeping the existing level of reactive maintenance cover, would require major investment to expand the service team and the costs associated with additional 'unsocial hours' pay rates for those staff working outside 'standard hours'..

29. To further understand the issues around extended day working, contact was made with four radiotherapy centres outside Wales. Two were major radiotherapy centres and two were smaller satellite centres. It is clear, comparing the evidence provided by these radiotherapy centres with our current radiotherapy service provision, that working practices in Wales are broadly similar to the rest of the UK. However, it is clear that some centres are further developing extended working days, with staggered starting hours and shift working. Development of satellite centres has also clearly facilitated piloting and implementation of new initiatives. Further detail is summarised in Appendix 3.

30. It should be noted that recent developments in radiotherapy often reduce patient throughput, whilst increasing the quality of the treatment. The comparative figure for England for 2011/12 was 7,333 attendances per linear accelerator, which was considered to be in line with other countries. The Department of Health's (2012) report 'Radiotherapy Services in England', used a throughput indicator of 7,300 patient attendances per linear accelerator per year for machines working a standard day, five days a week. It is recognised that a focus solely on productivity could impede the introduction of clinically superior, but more time consuming techniques. Additional measures of a high quality service such as adherence to evidence based clinical guidelines (including new techniques such as IMRT), waiting times and patient safety should also be considered.

Waiting Times

31. Increasing waiting times are indicative of pressures on radiotherapy services and therefore useful to consider in relation to capacity. There are no recent Royal College of Radiologists (RCR) reports on radiotherapy waiting times and performance against the cancer waiting times to first definitive treatment is not reported by treatment modality. However, the National Cancer Standards relating to radiotherapy services require each radiotherapy centre to provide local audit data of their performance against the Joint Collegiate Council for Oncology (JCCO) waiting

times; data for the year 2012/2013 are summarised in Table 3. The data presented relate to the maximum waiting time considered acceptable with an expectation that radiotherapy services would work to reducing these waiting times for patients where clinically appropriate. The data relate to all patients receiving radiotherapy and are not restricted to radiotherapy given as the first definitive treatment. The North Wales Cancer Treatment Centre reported lower compliance with the maximum waiting times for palliative and radical radiotherapy. When analysed further by cancer site variation in compliance for radical treatment is seen across all the centres to varying degrees.

Table 3 Waiting times for emergency, palliative and radical radiotherapy 2012/13

Radiotherapy Centre	**Radiotherapy**		
	Urgent *good practice maximum wait 48 hours	Palliative *good practice maximum wait 14 days	Radical *good practice maximum wait 28 days
North Wales Cancer treatment Centre	100%	80%	70%
Velindre Cancer Centre	100%	99%	98%
South West Wales Cancer Treatment Centre	100%	100%	91%

Key * JCCO oncology good practice maximum waiting times

Estimating demand

32. National level planning for radiotherapy services is carried out in all the countries of the UK[5,13]. The access rate describes the proportion of cancer patients who should receive radiotherapy as part of their treatment. In the 2006 Report the access rate used was based on published research that had taken account of the radiotherapy indications for each cancer type and stage according to published evidence-based guidelines[14]. The recommended overall access rate of 52% in that study was also adopted by a subsequent international expert group report on planning radiotherapy services[15]. The most recent recommendations on access rates for England are

derived from detailed studies involving the 'Malthus' modelling tool involve an overall access rate of 40.6%[5]. The Malthus derived access rate is substantially lower than the international value but forms a stronger basis for planning projections, as derived from more local data sources rather than the international literature. An RCR report, published in 2009 using data from 2007, noted that the average access rate for the UK was 37.1%, with the highest rate of 37.9% in England, 36.6% in Wales and 35.3% in Northern Ireland 31.5% in Scotland[16].

33. There are several possible reasons for the shortfall and variation in the actual access rates achieved compared to the modelled predictions, with the main issues considered to be as follows:

a. Equipment procurement - lack of timely planning and commissioning of new and replacement linear accelerators, associated equipment and works to meet population requirements.

b. Geography - It is recognised that the uptake of radiotherapy diminishes with the distance that patients have to travel to a radiotherapy centre. The 2006 Report highlighted that the geography of Wales and social and economic factors means that some patients face a considerable journey to their nearest radiotherapy centre which may impact on uptake and outcomes. There are a number of initiatives that could help to ease the travel burden, including satellite units, the use of patient hotels, dedicated door-to-door transport and more suitable appointment times.

c. Patient demographics - There is evidence from the English Radiotherapy Data Set (RTDS) that uptake of radiotherapy in patients aged over 75 is lower than that in younger cancer patients. There is also evidence that lower access rates correlate with increasing deprivation which, in turn, may be associated with late presentation with advanced disease[15.] Whilst there may be good clinical reasons for this, such as co-morbidities, appropriate access is expected to be supported by effective, cancer site specific, clinical oncology input to MDT meetings. Analysis of compliance to the radiotherapy cancer standards for the financial year 2011/12 showed that clinical oncologist input to MDT meetings was variable across Wales and has been picked up by the first round of the Cancer peer Review Programme assessing lung cancer MDTs with one outcome being a move to fewer but better resourced MDTs.

d. Public and patient concerns and fears of radiotherapy – these have not been researched in Wales. However in England, the National Radiotherapy Implementation Group has led a major awareness campaign to address these issues over recent years.

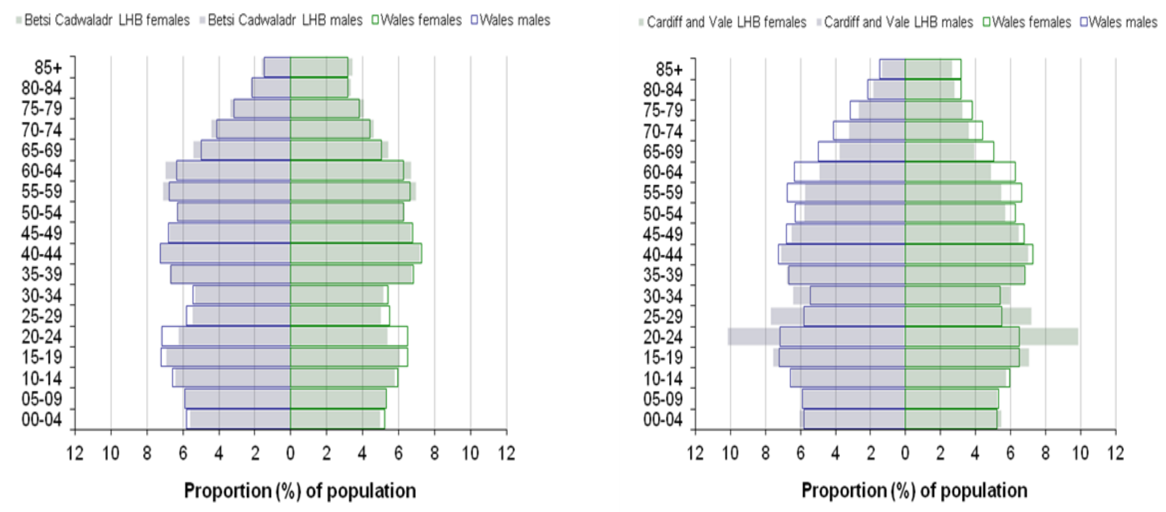
Trends in population growth and cancer incidence

34. Population growth, age profile and cancer incidence are the major factors considered in planning radiotherapy services. Wales, as with the rest of the UK, is experiencing a steady increase in the number of all cancers.

35. In relation to projections of population by LHB there are significant variations particularly in relation to age profiles and cancer incidence by age (Figures 1 and 4). Figure 1 compares the population age cohorts for Betsi Cadwaladr University Health Board (BCUHB) and Cardiff and Vales University Health Board (C&VUHB) and shows the relatively larger younger population of 15 to 35 year olds in C&VUHB with a larger older population of 45+ year olds in BCUHB.

Figure 1 Proportion of population by age and sex, for BCUHB and C&VUHB compared to the all Wales population, 2007

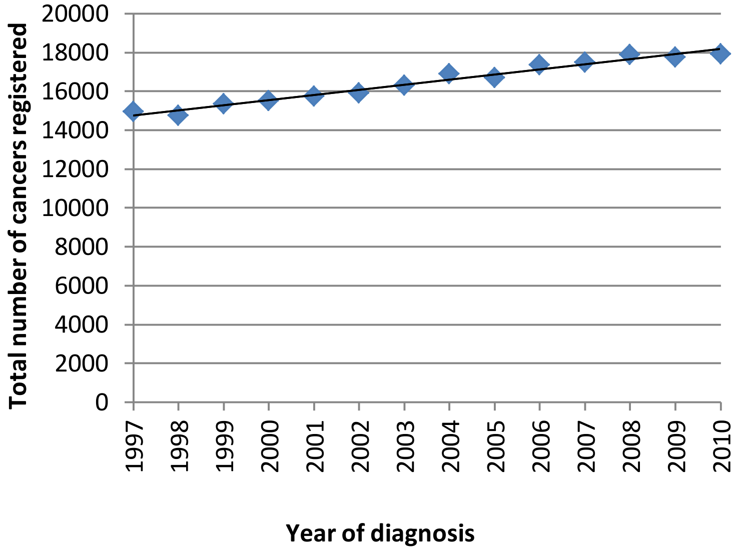
BCUHB C&VUHB



Data source: Wales Centre for Health and the National Public Health Service for Wales

36. Cancer incidence continues to increase in line with the linear trend at approximately 1.4% per annum. (Figure 2 and Table 4). The increase per annum for those cancers where radiotherapy is commonly used is higher at 1.9%/

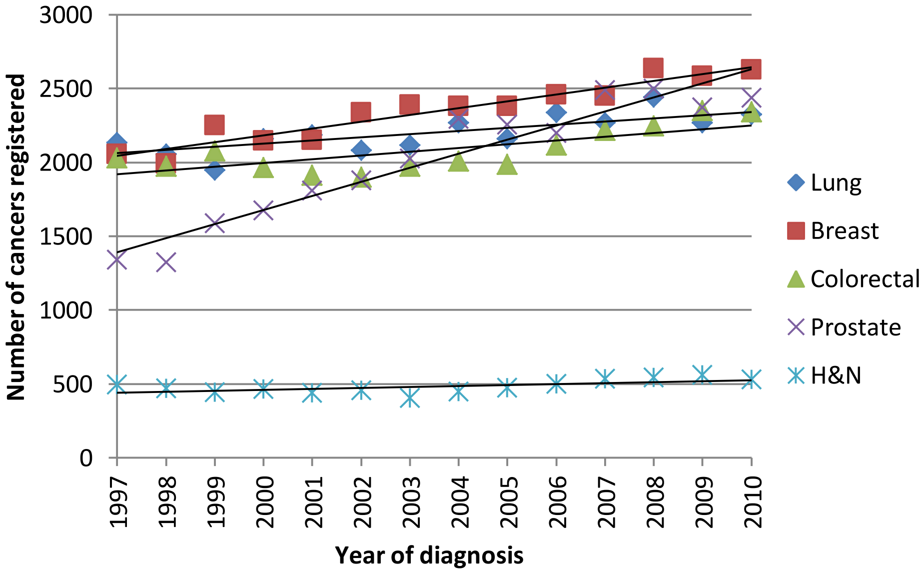
Figure 2 Change in incidence of all cancers, excluding NMSC, for persons from 1995 to 2010



Data Source: Wales Cancer Intelligence and Surveillance Unit

37. Incidence varies by cancer site with lung, breast, colorectal, prostate and head and neck cancers being the most commonly treated with radiotherapy (Figure 3). Changes in best practice relating to these major cancers would be expected to have a significant effect on demand for radiotherapy services. Table 4 uses the data presented in Figures 3 and 4 and forecasts the expected incidence for these cancers by 2020.

Figure 3 The numbers of cancer registrations for the five cancers most commonly treated with radiotherapy



Data Source: Wales Cancer Intelligence and Surveillance Unit

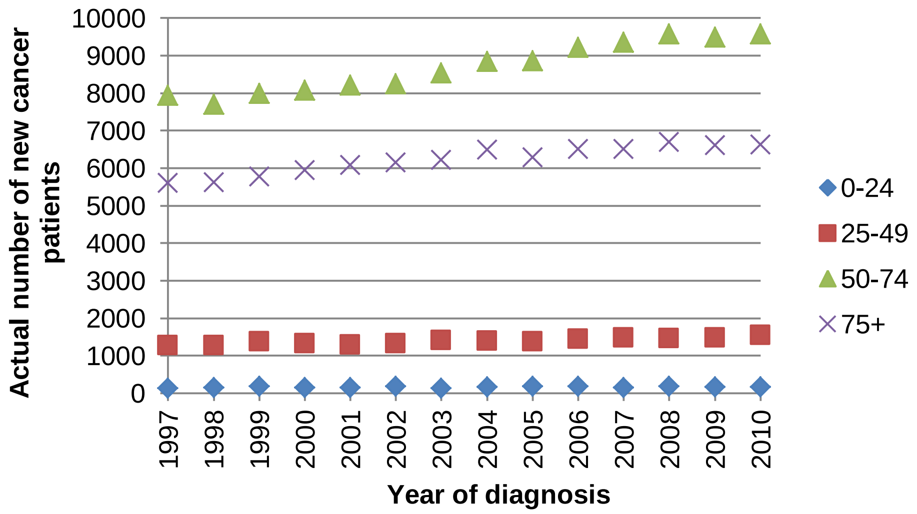
Table 4 Cancer Incidence in Wales 1995-2010 with estimated incidence to 2020 for all cancers and those most commonly treated with radiotherapy

Cancer Site	Actual Incidence 1995	Actual Incidence 2010	% Actual Increase from 1995 to 2010	Annual % actual Increase from 1995 to 2010	Estimated incidence at 2020 based on linear trend over time (Figure 2)
Breast	2,000	2,625	31.2	2%	3,114
Prostate	1,263	2,437	93.0	5.8%	3,575
Colorectal	1,873	2,340	24.9	1.6%	2,541
Lung	2,239	2,324	3.8	0.2%	2,557
Head & Neck	463	529	14.3	0.9%	601
All Sites	14,605	17,925	22.7	1.4%	20,809

Data Source: Wales Cancer Intelligence and Surveillance Unit

38. As already stated (Figure 1), the population age profile is important with the greatest increase in new cancer patients reported in the 50 to 74 year old age group (Figure 4). Older patients are fitter than previously and many 80+ are able to tolerate radiotherapy, particularly with modern toxicity sparing techniques.

Figure 4 Change in cancer incidence, excluding NMSC, for persons, by age, from 1995 to 2011



Data Source: Wales Cancer Intelligence and Surveillance Unit

39. In previous estimations of radiotherapy demand, the radiotherapy access rate was calculated at the all Wales level and then used in the calculations of demand for radiotherapy services. The Malthus Cymru simulation determines individual access rates for each Welsh LHB by cancer site based on detailed information of catchment populations, associated demographics and epidemiology and evidence-based best practice in radiotherapy. The same criteria have been used as for the Malthus estimations reported in the English Report. Further detail is provided in Appendix 1.

40. Table 5 summarises the modelled projected demand for radiotherapy to 2020 both at the all Wales level and by each radiotherapy centre. Data are presented as the projected attendances per million catchment population and total attendances. Catchment populations have assumed the following:

   a. The North Wales Cancer Treatment Centre comprises 100% Betsi Cadwaladr University Health Board's (BCUHB) population.

   b. The South West Wales Cancer Treatment Centre comprises 100% of Hywel Dda Health Board (HDHB), 80% Abertawe Bro Morgannwg University Health Board (ABMUHB) and 25% Powys Teaching Health Board (PtHB).

   c. The Velindre Cancer Centre comprises 100% for each of Cwm Taf University Health Board (CTUHB), Aneurin Bevan University Health Board (ABUHB) and Cardiff & Vale University Health Board (C&VUHB) plus 25% PtHB and 20% ABMUHB.

   d. The remaining 55% of PtHB's residents access radiotherapy services in England.

Table 5 Malthus Cymru projected demand for radiotherapy to 2020

Year	Malthus Cymru projected attendances/million	Malthus Cymru projected Total Demand (Attendances)	Projected population (M)	Projected Access rate*
	North Wales Cancer Treatment Centre			
2011	53,150	36,700		
2016	61,150	43,200	0.71	41.0%
2020	66,300	47,800	0.72	41.1%
	Velindre Cancer Centre			
2011	44,500	65,900		
2016	50,300	76,200	1.51	40.1%
2020	54,600	84,300	1.54	40.3%
	South West Wales Cancer Treatment Centre			
2011	47,500	39,500		
2016	54,250	46,200	0.85	40.6%
2020	58,900	51,200	0.87	40.7%
	All Wales			
2011	47,300	142,100		
2016	54,000	165,600	3.06**	40.4%
2020	60,057	183,300	3.13**	40.6%

* rounded to 1 d.p.
**Including only 45% of PtHB resident having radiotherapy in Wales

40. The data summarised in Table 5 are based on radiotherapy best practice guidance, including re-treatment and aggregated for all cancer sites. The projected 'all cancers' access rates across the three radiotherapy centres are similar and by 2020 are estimated to be between 40.3% and 41.1%. It is important to note that access rates are specific to each cancer and it will be important for LHBs to investigate both their overall and cancer specific access rates for their population to ensure best practice is being followed.

41. Variation in radiotherapy treatment regimens by cancer site was reported a number of years ago both in England and Wales. It will be important to verify and, if necessary, standardise to best practice if this is still the case. This work will be facilitated by the planned implementation of an RTDS for Wales. With the introduction of more complex radiotherapy, which often takes more time to deliver per patient, the COSC should develop quality indicators for radiotherapy, to advise LHBs, which reflect the key requirements of a quality focussed radiotherapy service. This will support benchmarking with other radiotherapy centres in the UK and the Cancer Peer Review programme.

42. Table 6 brings together the original actual activity and projected demand taken from the 2006 Report, with activity data provided by the three radiotherapy centres for the financial year 2011/12 and the revised projections based on the Malthus Cymru simulation. This shows that in 2011/12, there were 29,765 actual attendances per million population, against a modelled demand of 47,340 attendances per million population which represents a significant shortfall in actual demand. More detailed analysis of the use of the Malthus programme in England has been recently reported, attributing such shortfalls in demand to a combination of sub-optimal access rates and dose fractionation regimes compared with evidence-based best practice[7]. LHBs will need to review the current level of attendances for their population and, with their radiotherapy centre/s, determine the appropriate service model to meet the future demand for their population.

43. Malthus Cymru modelling, suggests that by 2016 projected demand will be 54,000 attendances per million population, and 60,057 attendances per million population by 2020. The projected increase between the 2011/12 actual activity and modelled demand at 2020 of approximately 50% emphasises the need for a national planning and procurement programme to support radiotherapy services in Wales. The percentage increase in Wales is very similar to that noted in the recently published Department of Health report on radiotherapy which also used Malthus simulation to estimate future demand[5].

Table 6 All Wales activity data and projected demand presented in the 2006 Report with current and Malthus Cymru projected demand to 2020.

Year	Actual Activity		Actual Activity p.m.p		2006 Report Forecast activity p.m.p. for 2016		Malthus Cymru Projected Demand p.m.p. (Table 5)
	Fractions	Attendances	Fractions	Attendances	Fractions	Attendances	Attendances
2004/05+	90,841	79,032	30,300	26,882			
2011/12~	104,549	90,957	34,850	29,725			47,340
2016					58,000	50,460	54,000
2020							60,057

Key: +data from Table 1 ~data from Table 2

44. Table 7 indicates the implications for the numbers of linear accelerators required to meet the expected demand derived from Malthus Cymru (as set out in Table 5). The Table details three different scenarios, based on different levels of productivity per linear accelerator. The first scenario uses the baseline productivity of 7,300 attendances per linear accelerator per year. This was the level of activity used in the English report and allows us to benchmark productivity with other radiotherapy centres.

45. If productivity per linear accelerator could be increased through, for example, an increase in the length of the working day and/or the working week, then there would be a drop in the projected number of linear accelerators required. A 10% increase in productivity would mean that 24 linear accelerators would be required to meet the projected demand; if a 20% increase could be achieved, it would require 22 linear accelerators. These percentages are only used for illustrative purposes to indicate the degree of change that would impact on the proposed numbers of linear accelerators. Implementation of such innovations will need detailed consultation and support from all staff involved to be successful. Significant additional costs will also be incurred e.g. additional staffing costs. For example, the Department of Health Impact Assessment of A National Strategy for Cancer included a £20,000 per machine per year increase in costs to support servicing and upgrades outside normal working schedules[17].

46. To meet the estimated demand for radiotherapy in Wales, depending upon productivity, a total of between 22 to 26 linear accelerators will need to be in service by 2020 along with associated equipment and works. In addition, LHBs need to plan to replace each linear accelerator once it has been in service for 10 years.

Safety

47. The ‘Towards Safer Radiotherapy’ (TSRT) report published by the RCR in 2008 recognised that radiotherapy is a highly complex, multi-step process involving many different staff groups in the planning and delivery of the treatment[18]. TSRT reported that radiotherapy is generally very safe, although on the rare occasions when errors do occur the consequences can be significant for the patient. Safety of delivery remains paramount requiring ever increasing accuracy and precision in the delivery high curative doses to the patient. It will be important for each radiotherapy centre in Wales to continue to use the trigger codes to report errors and near misses to the UK National Reporting, Analysis and Learning System (NRLS).

48. Among the key recommendations were the following.

    i. All departments should have an externally accredited quality management system to monitor that radiotherapy is delivered as intended and in accordance with protocols, to maintain and continually improve the quality of the service and to investigate and learn from incidents, errors and near misses. This is already required by the Welsh National Cancer Standards.

    ii. Each department must have a system for reporting and analysing errors. The lessons learnt should be fed back to the staff in multidisciplinary meetings. It is recommended that the radiotherapy pathway coding system set out in this report is used to aid the sharing of information and learning between centres.

    iii. All healthcare organisations with radiotherapy facilities should continue to participate in the NRLS.

    iv. In vivo dosimetry, which is the use of detectors to measure the amount of radiation delivered, can detect some significant errors. It is recommended that all radiotherapy centres should have protocols for in vivo dosimetry and this should be in routine use at the beginning of treatment for most patients. An all Wales advisory report has been prepared by COSC in this regard[19].

49. With the introduction of more complex radiotherapy, which often takes more time to deliver per patient, the Department of Health have adopted a productivity matrix that addresses the overall requirements of a quality focussed radiotherapy service.

Table 7 Number of Linear Accelerators needed to meet projected demand

Year	Malthus Cymru projected attendances/ million	Malthus Cymru projected total demand Attendances	Productivity per Linear accelerator	Linear accelerators required	+10% Additional productivity		+20% Additional productivity	
					Productivity per linear accelerator	Linear accelerators required	Productivity per linear accelerator	Linear accelerators required
	North Wales Cancer Treatment Centre							
2011	53,150	36,700	7300	5	8030	5	8760	4
2016	61,150	43,200	7300	6	8030	6	8760	5
2020	66,300	47,800	7300	7	8030	6	8760	6
	Velindre Cancer Centre							
2011	44,500	65,900	7300	9	8030	9	8760	8
2016	50,300	76,200	7300	11	8030	10	8760	9
2020	54,600	84,300	7300	12	8030	11	8760	10
	South West Wales Cancer Treatment Centre							
2011	47,500	39,500	7300	6	8030	5	8760	5
2016	54,250	46,200	7300	7	8030	6	8760	6
2020	58,900	51,200	7300	7	8030	7	8760	6
	All Wales							
2011			7300	20	8030	19	8760	17
2016			7300	24	8030	22	8760	20
2020			7300	26	8030	24	8760	22

<u>Catchment population assumptions</u>:

N Wales: 100% BCUHB; **SE Wales:** 100%, ABUHB, 100% CTUHB, 100% C&VUHB; 25% PtHB; 20% ABMUHB (Bridgend); **SW Wales:** 100% HDHB; 80% ABMUHB; 25% PtHB55% of PtHB receive RT from English providers

Section B -Workforce development and new ways of working

50. The radiotherapy workforce has increased across the UK over recent years. Data on non-medical staff workforce has been published by the respective professional bodies. Information on the medical workforce is not as readily available not least because medical and clinical oncologists are covered by different professional bodies namely the Royal Colleges of Radiologists and Physicians with only clinical oncologists covering both radiotherapy and chemotherapy.

Clinical Oncology

51. The majority of non-surgical oncology treatment has traditionally been delivered by clinical oncologists and this continues to be the case. However, the nature of the specialty has changed as the therapeutic options have widened with increasing complexity of the components of oncology care (paragraph 80).

52. One of the major changes in Clinical Oncology practice over the past 10-15 years has been in the introduction of tumour site-specialisation. The Royal College of Radiologists recommendation is that consultants should treat two, or maximally three, tumour sites and that they should participate in multi-disciplinary team meetings for each site.

53. The current COSC guidance on implementation of IMRT is just a starting point but indicates the requirement for clinical oncologists to be able to deliver optimal treatment using advanced radiotherapy technology (Section C). Clinical oncologists must be able to use these techniques for the specialist tumour sites that they treat.

54. At the same time as radiotherapy technology advances, the role of systemic therapy has expanded and the range of agents extended, including biological and radiopharmaceutical agents (molecular radiotherapy). Combination chemotherapy (chemo-radiation) and the long time-span of many systemic therapy programmes have increased the clinical oncologist's workload.

55. Coincidental with the changes above, other specialties have become involved in delivering non-surgical oncology treatments and Clinical Oncology has increasing working relationships with, for example, interventional radiologists and nuclear medicine physicians.

56. In the setting of this burgeoning development in radiotherapy and systemic agents, there is a vigorous debate about the nature of Clinical Oncology as a specialty in the future.

57. Information on the clinical oncology workforce was collated from the Royal College of Radiologist Workforce Census 2011[12]. Key data are summarised in the Table 8. More recent data *in italics* have been provided by the radiotherapy centres in Wales.

Table 8 RCR Clinical Oncology Workforce data for Wales in 2011

	Velindre Cancer Treatment Centre	**South West Wales Cancer Treatment Centre**	**North Wales Cancer Treatment Centre**	**All Wales Totals**
Catchment population per million	1.462	0.889	0.685	3.037
Consultants	24	9	8	41
Full time	14	8	8	30
Part time	10	1	0	11
Consultants in 2013	*24*	*10*	*7+1 vacancy*	*42*
Consultant Programmed Activities	223	92	85	400
Consultant WTEs per million population	16.41	10.12	11.68	13.50

Data source: RCR 2011 workforce census

58. The 2011 RCR Census enables benchmarking for Welsh radiotherapy services. The following summarise the main findings;

i. Comparisons across the UK show that overall there are 10.9 WTE clinical oncologists per million population in the UK. Wales and Scotland had the highest levels of clinical oncologists at approximately 12.5 followed by Northern Ireland at 11.1 and England at 10.7 consultant WTEs per million population.

ii. The average number of consultant WTEs across the 59 radiotherapy centres in the UK is 11.3 per million catchment population ranging from 22.3 to 4.4.

iii. Analysis of site specialties showed that most consultant clinical oncologists, 41%, reported a special interest in two sites with 27% and 24% reporting and in one of 3 sites respectively. Only 8% reported having an interest in more than 3 sites.

iv. Overall almost 20% of consultant clinical oncologists work part time with an increasing number of female consultants, from 38% in 2008 to 43% by

2011. The same is observed for Wales with 24% of staff working part time.

v. There was a wide variation across the UK regarding numbers of clinical oncology specialist registrars with decreases reported in 5 of the 13 UK regions between 2010 and 2011. It is of note that Wales, along with the North East of England had the lowest numbers of specialist registrars and lower than that reported for Northern Ireland and Scotland at 15 and 25 respectively.

59. The changing working patterns with almost 20% of consultants and specialist registrars choosing to work part-time alongside an increasingly consultant led service will need to be considered in future planning of radiotherapy services.

Radiotherapy Physics

60. The physics role remains central to the safe delivery of high quality radiotherapy and builds upon a workforce comprising clinical scientists, dosimetrists, /technologists and engineers. The requirements include a combination of direct support to patient treatment, quality assurance of services, quality control of treatment related technology and the development and implementation of the latest treatment procedures. The need for appropriate physics staffing has been recognised and reinforced worldwide in the analysis of adverse incidents where inadequate staffing has been implicated[20,21,22]

Current Physics Staffing Levels and Projections

61. The Institute of Physics and Engineering in Medicine (IPEM) has analysed the workload associated with providing professional physics services to radiotherapy. It has recently updated its guidelines based upon a grid model that accounts for the number and complexity of treatment techniques, equipment inventory, and department-wide factors related to administration, radiation protection and quality assurance[22]. Table 6 below summarises the radiotherapy physics staff available in Wales as at December 2011. Since publication of the 2006 Report, the overall staffing establishment has increased by about 30%. The increase in current establishment reflects various factors, including the number of linear accelerators in Wales increasing by approximately 30%, increasing complexity of technology and clinical procedures, skill-mix and modernisation of practice and the introduction of an extended treatment day in recent years.

62. The current establishment for clinical scientists appears, at first sight, comparable to the IPEM recommended level. However, local figures include unregistered ‘supernumerary’ scientists still in training and if these are removed the scientific establishment is about 78% of recommended levels. This falls to 66% if vacancies

are included. The overall number of scientists in post remains relatively low and the low number of experienced scientists available remains of particular concern.

63. It is evident that the growth in the number of scientists over the last few years of 21% has been moderate when compared with countries such as Canada and Australia[23,24]. The ongoing implementation of new technology and support for advanced techniques indicates that further growth will be required in Wales. Along with Wales, other countries are expecting that physics staffing needs will need to grow by up to 33% in the next decade[23].

64. The recruitment of dosimetrists and engineers with the appropriate qualifications and experience has been less difficult; for the former this is, in part, through the combined efforts of the Swansea University and NHS Radiotherapy Physics Departments across Wales in providing education and training via a science degree in Clinical Technology. In the case of engineering, it is evident that there is a continuing need for workforce expansion and development due to increasing complexity of linear accelerator technology and in particular the management and support of information technology. Oncology information systems, Picture Archiving and Communications Systems (PACS), treatment planning, virtual simulation and imaging systems and the associated clinical computer networks are examples. Experience to date across Wales has demonstrated that a certain level of 'in-house' engineering support provides cost-effective service cover compared to that available from external service contracts, though partnership agreements are appropriate in some cases.

Workforce Modernisation, Role Development and Training

65. There is good evidence of workforce modernisation and the implementation of changing roles for physics staff across Wales. A reduction in the ratio of scientists to dosimetrists has occurred during the last six years from 1.6:1 to 1.2:1, although this change may also reflect the response to managing financial pressures within departments. Dosimetrists and clinical scientists are respectively undertaking the delineation of target volumes and approval of treatment plans for certain tumour sites on a delegated basis from clinical oncologists.

66. In the coming years the Radiotherapy Physics workforce in Wales will be subject to considerable changes in structure, training and career pathways as a result of the implementation of the 'Modernising Scientific Careers' (MSC) programme[25]. It is essential that Wales retains a successful training infrastructure for Clinical Scientists, Dosimetrists and Engineers under MSC with academic provision from bodies such as Swansea University and clinical training via the NHS Radiotherapy Physics Departments.

Table 9 Radiotherapy Physics Staff in Wales

Centre	Recommended Establishment[a]			Current Establishment[b]			Vacancies		
	CS[c]	Dos.[d]	Eng.[e]	CS	Dos.	Eng.	CS	Dos.	Eng.
Velindre Cancer Centre	14.6	16.5	9.6	12.7 (3)	12.0	9.0	2.1	0	0
South West Wales Cancer Centre	8.3	8.9	5.3	8.1 (1)	7.6	3.5	1.8	1.2	0
North Wales Cancer Centre	7.3	5.7	5	4.1 (3)	6.1	3.5	0	0	0
Total	30.2	31.1	19.90	24.9 (7)	25.7	16.00	3.9	1.2	0
Total 2006[f]	33.7	21.2	18.4	26.3	16.4	14	2.1	2	1

Key:

a. From IPEM 2009 recommendations for fully trained staff to provide a radiotherapy physics service for a standard eight hour working day (see note 2)
b. The 'Current Establishment' includes staff to provide extended day working equivalent to one additional hour per linear accelerator per day; these staff are not included by IPEM but could amount to an underestimate of up to 10% in the figures given above for the 'Recommended Establishment'
c. Clinical Scientists - the 'Current Establishment' includes those unregistered scientists (in brackets) still in training, the 'Recommended Establishment' assumes only scientists that are qualified.
d. Dosimetrists (treatment planners, staff preparing patient related accessories and undertaking patient immobilisation, QC, in vivo dosimetry etc.)
e. Engineers (electronic, mechanical preventative and corrective maintenance, information technology network, computer server)
f. Figures from the 2006 CSCG Report

Therapeutic Radiography

Radiographer's role

67. Therapeutic radiographers play a vital role in the delivery of the whole radiotherapy service. Their role covers both core and non core responsibilities with core responsibilities being the planning and delivery of accurate radiotherapy treatment. They are the only healthcare professionals qualified to do so. They constitute the largest component of the oncology workforce, accounting for over 50%.

68. The therapeutic radiographer role also covers a variety of other aspects of the radiotherapy patient pathway (Table 10). In Wales, these aspects include;

- On treatment patient review including supplementary drug prescribing
- Imaging specialists, skin mark up, breast planning, palliative mark up
- Information and support, informed consent
- Research, development and clinical trials
- Quality assurance
- 4D-CT volume outlining of organs at risk and tumour volumes
- Brachytherapy
- IV contrast administration.

69. Some of these roles were previously undertaken by Oncologists. It is more efficient for these tasks to be performed by radiographers who are based in the radiotherapy department and trained specifically in radiotherapy treatment and side effects. Oncologists can use the time gained for the significantly increased time requirements of technical radiotherapy planning especially IMRT. The target of 40% of all radical treatments to be delivered using IMRT can only be achieved if radiographers develop their roles in this way.

70. The Society of Radiographers has recently published an overview of the scope of practice of therapy radiographers in the UK. Below is a table describing a sample of some of the ways in which radiographers are developing and expanding their scope and how Wales is performing in comparison. It is clear that whilst a lot of good work has and continues to be done in this area, there is much yet to do.

Table 10 Current roles and the degree of implementation in Wales compared to that reported across the UK

Post/Activity	Overall percentage* across UK	Wales			Comment
		NWCTC	VCC	SWCTC	
Consultant radiographer	16%	0	0	0	These roles are required to develop radiotherapy services
On treatment review	81%	No	Yes	Yes	Development in progress in NWCTC
Supplementary prescribing	30%	Prescribing under PGD	Yes 2 WTE	Yes 2 WTE	Need to address deficit in legal framework
Radiographer led follow up	30%	No	Yes	No	Area of potential development
Research	70%	Yes 0.5 WTE	Yes 3.5 WTE	No	
Information and support	58%	No	Yes 1WTE	No	
Counselling	16%	No	Yes 0.6WTE	No	
Quality management	91%	Yes	Yes	Yes	
Consenting	37%	No	Yes for certain sites	No	Area for potential development
Radiographer led planning	67%	No	Yes for breast cancer	No	Area of significant developmental need
Outlining	40%	Yes Normal structures only	Yes Normal structures and some organs at risk	No	Area of significant developmental need
Dosimetry	50%	Yes 2.8 WTE	No	No	Area of significant developmental need
Image review		No dedicated staff	Yes 1.6WTE specialist posts	No dedicated staff	Need to make this mainstream for radiographers and part of student training in the future

*refers to percentage of UK departments undertaking the specified role

Data Source: Society of Radiographers & Radiotherapy Service Managers

Therapeutic radiographer workforce

71. In 2006 the currency for radiographer staffing levels was the number of linear accelerator hours provided, utilising the Society and College of Radiographer's guidance. As the role of the therapy radiographer develops and progresses this currency becomes less valuable as more non core roles are required. It is important to maintain a focus on the radiotherapy pathway and the roles that the therapy radiographers undertake.

72. The 2006 Report noted, in total, 106.6 radiographer staff including helpers/assistant practitioners. This included 1.8 WTE radiographers working in dosimetry. The current workforce is summarised in Table 11 and shows a total of 163.2 WTE equating to an increase of 53%. This is associated with the expansion in roles and changes in treatment delivery. Band 2 to 4 staff are expected to comprise 10% of the radiographer workforce.

Table 11 Therapeutic Radiographer Workforce (WTE in 2012)

Grade	North Wales Treatment Centre	South West Wales Cancer Treatment Centre	Velindre Cancer Treatment Centre
Band 8 – core Band 8 – non core	5.7 1.9	3 0	4 3
Band 7 – core Band 7 – non core	7.8 1	8.8 1.6	18.5 6.7
Band 6 – core Band 6 – non core	6.6 0	11.2 1	20.6 3.9
Band 5 – core Band 5 – non core	7 0	8 + 3 vacancies 0	17.4 + 1 vacancy 1
Band 4 – core Band 4 – non core	2.1 0	0 0	2 1
Band 3 – core Band 3 – non core	3.6 0	3 0	2 + 1 vacancy 0
Band 2 – core Band 2 – non core	1 0	1 0	2.8 1
TOTAL including vacancies	36.7	40.6	85.9

Source : Radiotherapy Service Managers

73. Recruitment of junior radiographers has not been an issue in Wales with Cardiff University providing an excellent pool of potential radiographers. However, there are a limited number of experienced therapeutic radiographers from which to recruit in order to develop the specialised radiotherapy services required in Wales. A solution to this is to develop and train therapeutic radiographers within the radiotherapy departments. The significant risk in this is the currently limited opportunities for postgraduate courses in Wales at Masters level. A major commitment to radiographer role development is required in order to deliver the aspirations contained within this report.

Section C - Radiotherapy Developments

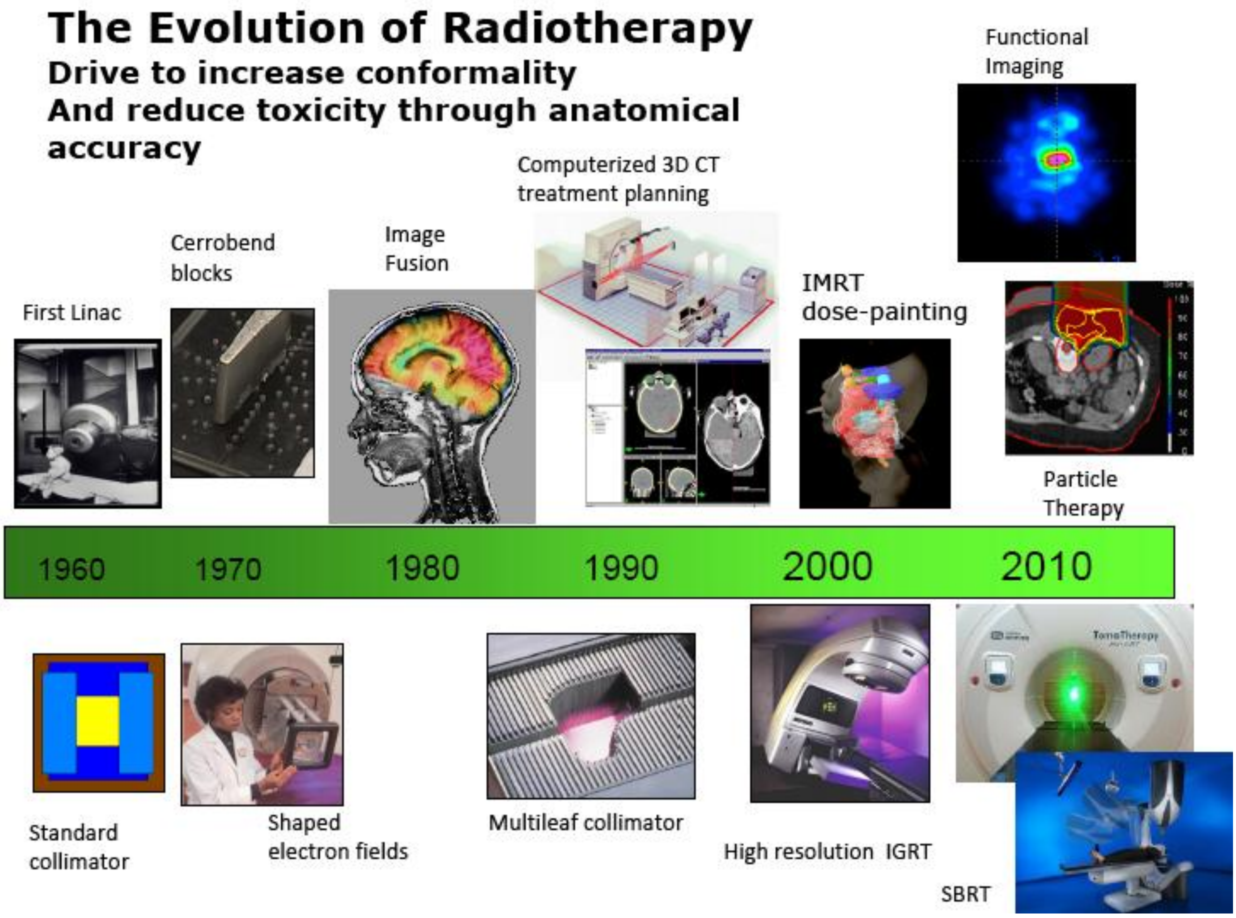
Context

74. In order to understand the direction of radiotherapy development over the next 10 years it is helpful to look at the trends of the recent past, set out pictorially in Fig. 5. The principal drive in the development of radiotherapy over the last 50 years has been to increase the accuracy and conformity of treatment. In other words, to improve our ability to define the tumour accurately, conform the radiation dose to the shape of the tumour and increase the accuracy of radiation dose delivery (both dosimetrically and geometrically). These improvements are likely to increase the probability of tumour control and to reduce ‘collateral damage’ to surrounding healthy normal tissues and organs and thus reduce side effects and maintain quality of life. The increased accuracy of treatment may also in some cases allow the entire curative treatment dose to be delivered in a much smaller number of (highly targeted) treatment fractions. This is more convenient both for the department and for patients, especially those that have to travel a long way to the radiotherapy centre.

75. To a large extent, the three Welsh radiotherapy centres will spend the next few years trying to incorporate fully the post-2000 developments portrayed in Fig.3.1, most of which are now regarded as standards of care internationally. Routine use of IMRT, Image Guided Radiotherapy (IGRT) and Stereotactic (Ablative) Body Radiotherapy are safe predictions as basic requirements for the short-medium term. These techniques are initially time-consuming to introduce to routine practice, though once implemented the time and cost requirements are likely to reduce to some extent. It is uncertain how far improvements in computing power and radiotherapy software will further streamline the various processes involved, though there is a clear commercial imperative for this.

76. With regard to particle therapy, it has been announced that 2 proton therapy facilities will be commissioned in England (in London and Manchester) in the next few years. It is not expected that there will be the need for a proton facility in Wales before 2020, but provision to support treatment of Welsh cases in England will be necessary.

Figure 5 Principal developments in radiotherapy in last 50 years



(Illustration courtesy of Profs Tim Maughan & Gillies McKenna, Oxford)

Radiotherapy Development Major Themes

77. The following section looks in detail at some specific technical developments in the three main stages of the radiotherapy process, namely planning, delivery and verification. Some of the newer techniques are already in use in Wales to a certain extent, generally treating small numbers of patients, often within clinical trials, as is the usual case with newly introduced technology. The next decade will undoubtedly see these techniques enter routine use. This will have a significant effect on the resource requirements of the three radiotherapy departments in Wales.

78. It is important to appreciate that these techniques are undergoing continual refinement. There is constant development in planning (PET and other functional imaging, image fusion, automation software, dose calculation, biological modelling) and hardware (faster and cheaper computers, linear accelerators with micro-multileaf collimators, cone beam CT, arc therapy capability).

79. Whilst the majority of radiotherapy is delivered using 'external beams' via linear accelerator technology, significant developments are also anticipated in the planning and delivery of brachytherapy using implanted radioactive sources.

Complexity

80. The wholesale shift from "conventional" to "technical" radiotherapy, which has already begun, and which will continue to happen over the next 10 years represents a step-change in the way that Radiotherapy is planned and delivered that is unlikely to be repeated in the foreseeable future.

81. In 2013 radiotherapy is mainly 3D, computer-aided, and digital. It is vastly more sophisticated and complex than just 10 years ago. The majority of radiotherapy planning is done using imaging information from a 3D CT scanner. The oncologist, using computer treatment planning software, manually contours the tumour and the treatment volumes on the planning CT scans, a process that may take 3 hours for a particularly complex case, compared to perhaps 15 minutes a decade ago. A physicist may require a day to produce an acceptable plan. Treatment itself commonly involves multiple bespoke radiation beams, and requires rigorous QA: this can significantly extend the standard 15 minute treatment delivery slot.

82. The jump in complexity, and related human resource requirements is particularly noticeable when radiotherapy departments start to use IMRT routinely. It is probable that this will be the biggest service change over the next 5 years. Other developments, such as those related to IGRT, will be no less complex, but (allowing for the usual learning curves) are likely to be introduced more incrementally than will be the case with IMRT.

83. It is probable that some of the laborious work involved in planning complex radiotherapy will become more automated over the next few years. An example of this is the increasing sophistication of automatic segmentation software, which can, to a variable extent, automatically contour body organs in a planning CT scan. This is currently a manual procedure which can take hours per case. To date though the automatic segmentation systems on the market do not meet the aspiration of being fully automatic – operators are still required to review and edit contours generated by these systems.

84. The complexity of radiotherapy treatment will continue to increase and hence the time taken to image, plan and verify. There are 3 components to this complexity:

85. Target volume definition:

This will increasingly involve co-registering of diagnostic imaging such as MRI and PET-CT and multi-disciplinary input into RT radiotherapy planning from radiology. This will be the case routinely for both external beam and brachytherapy treatments. Currently most of the input is from the clinical oncologists only, but routine involvement of diagnostic radiologists is likely as the radiology becomes more complex.

86. Dosimetric treatment planning:

This is increasingly using computer software to sculpt radiation delivery to treat the target volume and spare normal tissues at risk. This may allow higher dose delivery to the target and improve cure rates or reduce toxicities from radiotherapy by sparing normal tissues. Planning may also take into account temporal changes in shape or movement of the target volume in the form of '4D CT' planning, which requires more extensive imaging procedures to record and account for motion effects.

87. Treatment set up, verification and radiotherapy delivery:

This will be affected by the complexity of beam arrangements, new technology to accurately image on set what is actually being treated and adapting the treatment delivery to changes in target volume shape or position either by resetting fixed treatment fields, 'tracking' in real time or 'adapting' to changes on tumour position or shape identified by repeated imaging during treatment

88. Preparation, delivery and verification of radiotherapy will be affected by the complexity of beam arrangements, new technology which can accurately image what is actually being treated and adapting the treatment delivery to changes in target volume shape or position, either by resetting fixed treatment fields or 'tracking' in real time. Currently we are not routinely able to track movement of the targets hence we treat larger areas, which means more normal tissue morbidity and limits our ability to give higher curative doses.

89. Treatment set up, verification and radiotherapy delivery will be affected by the complexity of beam arrangements, new technology to accurately image on set what is actually being treated and adapting the treatment delivery to changes in target volume shape or position either by resetting fixed treatment fields, 'tracking' in real time or 'adapting' to changes on tumour position or shape identified by repeated imaging during treatment. Currently we are not routinely able to track movement of the targets hence we treat larger areas, which means more normal tissue morbidity and limits our ability to give higher curative doses.

90. All of the above may add to the time taken to outline (usually clinical oncologist +/- clinical radiologist), plan (usually physicist time), verify (radiotherapy treatment time) and deliver (radiographer and physicist, and possibly clinical time if re-planning required). It must also be said however, that improvements in computer planning technology, experience, workforce planning and treatment delivery technology will also lead to more efficiencies to most of these areas. The current main areas of technological development are:

Intensity Modulated Radiotherapy (IMRT)

91. IMRT is a highly conformal radiotherapy technique which can be delivered using the modern linear accelerators installed in the 3 Welsh radiotherapy centres. The ultimate goals of IMRT are improved tumour control and reduction in both early and particularly long-term radiation-induced side effects. One of the main aims is to maximise the quality of life of cured patients.

92. IMRT differs from standard 3D conformal radiotherapy in using sophisticated computer algorithms to calculate multiple beam exposures which incorporate MLC movement during treatment delivery. This allows for very highly conformal 'dose painting', with potential sparing of adjacent normal tissues. It also permits the delivery of concave dose volumes which is very difficult with conventional techniques and sometimes safety-critical, e.g. in the case of a tumour in close proximity to the spinal cord.

93. A recent development in IMRT is volumetric modulated arc therapy (VMAT), which incorporates linear accelerator gantry movement and variable dose rates during the exposure. VMAT confers certain dosimetric advantages and significant practical challenges. Early reports suggest that treatments are at least as conformal as 'static gantry IMRT' but that delivery times are significantly shorter. Linear accelerators installed in Wales in the last 2-3 years are VMAT-capable and both the North Wales Cancer Treatment Centre and Velindre Cancer Centre have started to deliver IMRT with rotational arc delivery.

94. IMRT is resource intensive in both the use of clinician time for outlining and the use of clinician, physics and/or radiographer time for complex planning. The tumour target and all relevant healthy tissue structures must be individually identified and outlined on every slice of a planning CT scan. The plan must be reviewed in detail by the clinician and then adjusted to optimise the dose distribution. There is also much more detailed quality assurance to ensure that the correct dose is given to the correct part of the patient with millimetre precision. Linear accelerator treatment time may actually be reduced, because of the high degree of automation of the IMRT process, especially with VMAT.

95. IMRT is seen as a major clinical implementation priority for oncology, where COSC's professional advice (WSAC 2011) is that Wales lags significantly behind best practice in the UK. IMRT is now regarded as the standard of care for certain cancer sites such as head & neck. The English National Radiotherapy Implementation Group (NRIG) has set the target that IMRT will be available for the appropriate clinical indications within all the English cancer networks by 2012[26].

96. In practice, expansion of IMRT capacity in Wales cannot be achieved immediately and it is essential that those clinical groups most likely to benefit are prioritised in the first few years. The clinical priority for IMRT in Wales has been head and neck cancer. It is also vital that cancer patients in Wales have access to clinical trials involving IMRT. The estimated proportion of patients who should be treated with IMRT and a proposed implementation schedule is detailed in Appendix 4.

Image Guided Radiotherapy (IGRT)

97. IGRT is the use of imaging during radiotherapy treatment to improve accuracy and adjust for tumour movement or change[27]. This adaptive capability improves accuracy and allows smaller volumes to be treated, thus reducing toxicity. It is an important adjunct to precision techniques such as IMRT. SBRT discussed in detail below is a natural progression of IGRT in which the accuracy of planning and treatment delivery is so high that treatments can be delivered in a very small number of fractions as the volumes of normal tissue irradiated is greatly reduced. The term IGRT encompasses a number of techniques, including the following:

- The use of Cone Beam CT on a linear accelerator.
- On-line treatment verification – imaging taken prior to radiotherapy and used to modify treatment for that day.
- Use of fiducial markers to identify and track tumour position, e.g. using prostate gold seeds.
- Adaptive planning (re-planning in response to changes seen on imaging using (e.g.) CBCT)
- Functional imaging (using PET-CT).

98. IGRT protocols are being developed for a number of tumour sub-sites, particularly where movement is a particular problem such as in peripheral lung tumours, bladder, and the prostate.

99. Clinical use of IGRT has, to a significant extent, been led by treatment radiographers who are familiar with on-line treatment verification and the use of cone beam CT, but it is essential that fully effective IGRT implementation involves a multidisciplinary approach. It is likely that adaptive radiotherapy techniques will become more sophisticated and automated as time goes on, but in the short-medium term adaptive re-planning of patients adds considerably to workload of radiotherapy planning services.

Stereotactic Radiotherapy

100. Stereotactic radiotherapy is a special class of high precision radiotherapy that has historically been applied to treatment of intra-cranial lesions. Treatment delivered within a single fraction is termed stereotactic radio surgery, while treatment over a series of fractions is known as stereotactic radiotherapy. In recent years extra-cranial techniques have advanced to the point at which stereotactic body radiotherapy offers significant advances in treatment efficacy in certain sites, as detailed below.

Intra-Cranial Stereotactic Radiotherapy

101. Velindre Cancer Centre currently provides an intra-cranial stereotactic radiotherapy service for the treatment of secondary brain lesions using a high resolution 'micro-

Multi Leaf Collimator' system attached to one of the linear accelerators at the centre when required. Service has remained at a level of treating one patient per month for some years, though there would be the possibility of service expansion with the appropriate level of investment. There is currently no provision for stereotactic radio surgery in Wales.

Stereotactic Body Radiotherapy

102. Stereotactic body radiotherapy (SBRT), also referred to as Stereotactic Ablative Radiotherapy (SABR), is a high precision technique which allows a small number of very high dose treatments to be given to certain sites in the body with curative intent. It is a development which fully utilises IGRT as the level of daily positional accuracy required is very high. In SBRT the margins usually placed around the tumour to allow for daily variations in position can be reduced. This leads to such a reduction in the volume of normal tissue being irradiated that the dose delivered can be increased and the treatment can be delivered in a very low number of fractions (typically 3-5, compared to conventional CFRT which delivers 20-40 fractions according to tumour site). This means that although additional time is required for the preparation and planning phases, and each treatment takes longer, the overall treatment time may not be increased. This will vary between the different tumour sites being treated.

103. SBRT can be delivered with standard linear accelerators with in-room online IGRT facilities or with specially designed devices that may have advantages in terms of accuracy.

104. There is already an identified role for SBRT in some relatively uncommon clinical sites, the most prevalent of which is surgically resectable Non-Small Cell Lung Cancer (NSCLC) in a medically unfit patient. There is also great interest in the potential use of SABR in the treatment of early stage prostate cancer, one of the main sources of work in any radiotherapy department. A randomized UK trial is currently being set up to compare a 5 fraction SBRT regime with standard radical prostate radiotherapy, given in 37 fractions. If this trial demonstrates equivalence or superiority of SABR then there will be a very strong incentive in cost and capacity terms to provide prostate SABR in every centre.

105. The level of clinical interest in SBRT is rising rapidly as SBRT-capable machines are now in most UK radiotherapy departments. It is probable that the number of evidence-based indications for SBRT will increase significantly over the next few years, as will the number of clinical trials, justifying implementation of SBRT in all 3 Welsh centres. The potential clinical applications are enormous – for example SBRT may replace conventional radiotherapy i.e. IMRT and IGRT for localized prostate cancer – and several clinical trials protocols are in development at the moment.

106. COSC recommends that each Health Board/Network/Cancer Centre develops a strategy for ensuring equitable access to SBRT for appropriate routine indications and for clinical trials involving SBRT[10]. Local service configurations and technical solutions will, however, be different.

Brachytherapy

107. There are two main areas of likely development in Wales in the near future. One involves the introduction of Image Guided Brachytherapy (IGBT) and the second relates to high dose rate (HDR) prostate brachytherapy.

Image Guided Brachytherapy (IGBT)

108. IGBT uses modern imaging technology (such as MRI, ultrasound and x-ray CT) to guide placement of high dose rate brachytherapy sources to where the known disease is. This has been shown to reduce toxicity and allow dose escalation to improve local disease control. IGBT is a way of delivering brachytherapy which is much more accurate than has previously been possible. IGBT allows for improved coverage of the tumour volume while at the same time minimising dose exposure to organs at risk. This has a positive bearing on patient outcomes both in terms of local tumour control and in terms of late morbidity. Patients with gynaecological cancers will have access to the same range of treatments i.e. IGBT, as those offered to patients in England. The implementation of IGBT in Wales will therefore ensure that a fairer and more equitable service is provided to Welsh patients[11].

HDR Prostate Brachytherapy

109. High dose rate (HDR) brachytherapy for prostate cancer involves inserting a temporary source of high-dose radiation into the prostate gland under general anaesthetic. It delivers a high dose of radiation to the prostate gland and, because the radioactive source is placed in the prostate, the risk of radiation damage to normal surrounding tissue is minimised. HDR can be used to boost the dose of radiotherapy in patients with localised prostate cancer after external beam radiotherapy. A recent study carried out in the UK has shown that patients treated with external beam radiotherapy plus an HDR boost were more likely to be cured of their disease compared to patients treated with radiotherapy alone[28]. There is also good evidence that HDR can be used as the sole treatment for patients with higher risk localised prostate cancer. Patients treated in this way have the same chance of cure as those patients treated with external beam radiotherapy, but a lower incidence of side effects[29]. Currently, NICE recommend 37 fractions of external beam radiotherapy to treat localised prostate cancer. HDR can deliver an equivalent chance of cure with 4 treatments given over 2 days. In addition, when HDR is used as a boost, the number of external beam radiotherapy treatments is reduced. Consequently, the introduction of an HDR prostate service would release a significant amount of radiotherapy machine time for other patients to be treated. A

growing number of centres in the UK have a HDR prostate brachytherapy service, and it should be equally available to patients in Wales.

Proton Therapy

110. There are already several proton units operational in Europe, but at present in the UK protons are restricted to a single low-energy unit in at the Clatterbridge Cancer Centre, Merseyside used for treating eye tumours. Currently a small number of mainly paediatric cases are sent to the USA for proton treatment after assessment by a central UK panel.

111. Two proton therapy facilities will be commissioned in London and Manchester in the next few years. It is not expected that there will be the need for a proton facility in Wales before 2020, but provision to support treatment of Welsh cases in England will be necessary.

Expansion of Research / Clinical Trials Activity

112. It is anticipated that radiotherapy related clinical trials and research activity will continue to increase; this will have implications for radiotherapy services across Wales. It is therefore a real benefit to NHS Wales that research is undertaken in Cardiff University at undergraduate level for therapy radiographers in preparation for future research practice. There is a UK-wide initiative supporting radiotherapy related research which is led by the National Cancer Research Institute (NCRI) Clinical and Translational Radiotherapy Research Working Group (CTRad). This initiative is expected to increase the number of radiotherapy trials and to increase the complexity of radiotherapy within these trials.

113. Wales is playing an important leadership role in the exciting re-invigoration of UK radiotherapy research and trials activity that has occurred with development of CTRad. The current trials are looking at four main areas:
    - Radiotherapy in new clinical scenarios e.g. RT-arm of STAMPEDE
    - Optimising drugs used in addition to radiotherapy e.g. SCOPE1 and SCALOP and COPERNICUS.
    - The ability of high technology radiotherapy to reduce toxicity or improve tumour control e.g. PIVOTAL and COSTAR
    - Altered radiotherapy dose scheduling to improve tumour control or reduce patient attendances e.g. CHHiP and FAST FORWARD

114. Leadership is coming in four main ways:
    - Wales-based clinicians working with Wales Cancer Trials Unit (WCTU) and other NCRI approved CTU to develop and run national trials. These clinicians are all supported by NISCHR research fellowships
    - The development of the Cardiff National Cancer Research RT Quality Assurance Group as a collaboration between Velindre and WCTU, part funded by NISCHR

- Recruitment to a wide portfolio of CTRad's trial portfolio
- Publication in national and international peer review journals.

115. It is strongly recommended that Wales becomes fully committed to increased radiotherapy related research in order to give Welsh patients the same access to clinical trials as those in the rest of the UK. The key requirements to participate in these trials are to have the correct modern technology, trained staff and sufficient treatment capacity. Current or planned trials are investigating many of the developmental areas highlighted previously in this report, e.g. IMRT, IGRT, SBRT and use of PET-MRI in radiotherapy planning in multiple tumour sites.

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APPENDIX 1

Malthus Cymru modelling tool for radiotherapy demand

The model uses information on treatment schedules and radiotherapy referral rates based on published clinical evidence and clinical consensus amongst clinical oncologists, combined with cancer incidence and population statistics at a Local Health Board level provided by the Wales Cancer Intelligence and Surveillance Unit (WCISU). It uses the ONS population projections to 2031 together with the Cancer Research UK / Association of Cancer Registries model for the annual change in cancer specific incidence.

Malthus Cymru is a Monte-Carlo integration based stochastic model using local cancer incidence and evidence-based decision trees reflecting UK practice.

The accuracy of the estimates depends on a number of factors:

- Reliable cancer incidence data for each locality: This has been obtained from WCISU.
- Decision trees for 23 tumour types which reflect evidence based UK practice and fractionation regimens for each clinical scenario, accounting for factors such as tumour type, stage, operative status and patient factors: these have been tested by developing a clinical consensus with over 100 clinical oncologists in the UK.
- Fitness for treatment and performance status. There are no reliable national data on this for most malignancies so estimates have been derived by developing a clinical consensus.
- Evidence-based fractionation has been derived from national guidelines and key publications and trials
- Access rates vary for each tumour type based on the decision trees rather than using a single access rate for all cancer types.

Malthus Cymru is only intended to model the treatment of adults with cancer by external megavoltage radiotherapy. It therefore does not include:

- Orthovoltage treatments
- Brachytherapy requirements
- Treatment of benign disease, e.g. keloid, heterotrophic ossification etc.
- Benign intracranial lesions such as craniopharyngioma and pituitary tumour
- Cancer in children

APPENDIX 2

Welsh residents receiving radiotherapy in English centres

Local Health Board of Residence	Provider Attended	Count of Unique Patients from the English RTDS for 2011/12
Abertawe Bro Morgannwg University HB	University Hospitals Bristol NHS Foundation Trust	2
	University Hospitals Birmingham NHS Foundation Trust	1
	Royal Berkshire NHS Foundation Trust	1
Aneurin Bevan University HB	University Hospitals Bristol NHS Foundation Trust	5
	Gloucestershire Hospitals NHS Foundation Trust	4
	The Royal Marsden NHS Foundation Trust	2
	University College London Hospitals NHS Foundation Trust	1
	Taunton and Somerset NHS Foundation Trust	1
	Royal Berkshire NHS Foundation Trust	1
	Imperial College Healthcare NHS Trust	1
	East and North Hertfordshire NHS Trust	1
Betsi Cadwaladr University HB	The Clatterbridge Cancer Centre NHS Foundation Trust	237
	The Christie NHS Foundation Trust	43
	Shrewsbury and Telford Hospital NHS Trust	10
	University Hospitals Birmingham NHS Foundation Trust	2
	Sheffield Teaching Hospitals NHS Foundation Trust	1
	The Royal Marsden NHS Foundation Trust	1
	Cambridge University Hospitals NHS Foundation Trust	1

Cardiff & Vale University HB	The Clatterbridge Cancer Centre NHS Foundation Trust	2
	University Hospitals Bristol NHS Foundation Trust	1
	The Royal Marsden NHS Foundation Trust	1
Cwm Taf University HB	Gloucestershire Hospitals NHS Foundation Trust	1
	University College London Hospitals NHS Foundation Trust	1
Hywel Dda HB	The Christie NHS Foundation Trust	3
	The Royal Marsden NHS Foundation Trust	3
	Guy's and St Thomas' NHS Foundation Trust	1
	Royal Free London NHS Foundation Trust	1
	Royal Surrey County Hospital NHS Foundation Trust	1
Powys Teaching HB	Shrewsbury and Telford Hospital NHS Trust	128
	Gloucestershire Hospitals NHS Foundation Trust	89
	University Hospitals Birmingham NHS Foundation Trust	7
	University Hospital Of North Staffordshire NHS Trust	2
	The Christie NHS Foundation Trust	2
	Oxford University Hospitals NHS Trust	2
	Royal Surrey County Hospital NHS Foundation Trust	1
	The Royal Marsden NHS Foundation Trust	1
	The Royal Wolverhampton NHS Trust	1
	University Hospitals Bristol NHS Foundation Trust	1
	Barts Health NHS Trust	1
	Royal Devon and Exeter NHS Foundation Trust	1
	TOTAL	566

APPENDIX 3

Benchmarking ways of working with Radiotherapy centres outside Wales

To further understand the issues around extended day working, contact was made with four radiotherapy centres in Scotland and England. Two were major radiotherapy centres and two were smaller satellite centres. Comparing the evidence provided by the four radiotherapy centres with current radiotherapy service provision in Wales, it is clear that working practice in Wales is broadly similar.

Specific topics discussed were;

- Some radiotherapy centres are considering extended week working and further extension of roles
- New satellite centres were well placed to pilot new approaches.
- All four centres reported treating patients from 8:00 or 8:30am but only one of the two major centres continued treatment to 7pm with cover to 8:00pm when necessary.
- Various patterns of shift working involving physics and radiography staff were in place in all centres to support extended day working
- Run up of machines at the start of the day was undertaken by physics staff in one centre and radiographers in the others.
- All had implemented review radiographers with two satellite centres supporting a review team with an SpR, review radiographer and review nurse.
- All had one or more consultant or equivalent radiographers
- The satellite centres had trained all radiographers to work under Patient Group Directions to administer drugs and had developed the role of administrative staff to include clinical support to the Health Care Assistant level

APPENDIX 4

Five-year implementation plan for IMRT in Wales (WSAC 2011)

	Estimated percentage of radically treated patients						
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	NRIG target
Head & Neck	~6%	40%	80%	80%	80%	80%	80%
Prostate	0%	0%	12%	50%	50%	50%	80%
Breast	0%	0%	7%	25%	30%	30%	30%
Trials/ others	~4%	4%	8%	10%	20%	20%	20%
% Radical Patients	2%	5%	15%	30%	35%	35%	42%
% Total Patients	1%	3%	9%	17%	20%	20%	24%

Source: Welsh Scientific Advisory Committee 2011 advice

APPENDIX 5

The Radiotherapy Data Set

A total of 37 data items are required in the proposed dataset as outlined below:

Radiotherapy Dataset Items:	**Definition**	**Business Justification**
NHS Number	It is mandatory to record the NHS number for each patient. The NHS number is allocated to an individual, to enable unique identification for NHS health care purposes.	Used for unique identification to match records from different providers. To allow 'tracking' through the clinical pathway.
Birth date	Date of birth of patient.	Used for unique identification to match records from different providers. Used to enable age at diagnosis to be established for epidemiological and survival analyses.
Sex	This is the sex of person, employee or patient.	Used for unique identification to match records from different providers. Used to enable sex to be established for survival analysis. Assists in the correct identification of gender specific primary cancer sites.
GP practice code	A code which uniquely identifies the GP Practice of the GP. Code as listed for Practices in Wales.	To enable analysis by GP practice code.
Case record number	This is the patient's case record number which is unique to that patient within a hospital or health care provider.	Used for unique identification to link events within a single service provider. To allow 'tracking' through the clinical pathway.
Patient's name(s)	This will be the patient's preferred name. The patient is the arbiter of his/her name.	Used for unique identification to link records where the new NHS number is not available. To assist 'tracking' through the clinical pathway.
Patient's address (at date of diagnosis) usual	This is the usual address nominated by the patient at the time of admission or attendance.	Used to enable the address at diagnosis to be established for epidemiological and survival analyses.

Patient's postcode (at date of diagnosis) usual	The postcode applied to the usual address nominated by the patient at the time of admission or attendance,	Used to enable the postcode at time of Radiotherapy treatment to be established.
Radiotherapy Dataset Items:	Definition	Business Justification
Source of (cancer) referral	This is a classification which is used to identify the source of referral of each episode or referral.	To allow 'tracking' through the clinical pathway
Consultant code (referred to)	This item relates to the consultant to whom the referral is made and who is responsible for the overall care of the patient. If the referral is to a team, then this refers to the first consultant seen. GMC Code	To monitor the proportion of cancer patients to each cancer site specialist.
Date of receipt of cancer referral	This item uses the nationally agreed form for consultant code or Independent Nurse. It is the General Medical Council (GMC) code for the Consultant or locum Consultant, which is the unique identifier.	To establish the start date for the specialist-based diagnosis and management process. To identify length of delay in the handling or referrals.
Date of diagnosis (cancer registry definition)	The definition provided conforms to the requirements specified by Cancer Registry. The date of the first event (of the seven listed under permissible values) to occur chronologically should be chosen as the incidence date.	To link radiotherapy treatments to the appropriate incidence of primary cancer site & diagnosis.
Primary cancer site	The primary cancer diagnosis for which the patient is receiving care. (ICD10)	To link radiotherapy treatments to the appropriate incidence of primary cancer site & diagnosis.
Radiotherapy Procedure Date(s)	To enable analysis of radiotherapy procedures	To enable analysis of radiotherapy procedures

Radiotherapy Procedure(s)	The radiotherapy delivery method as specified in the OPCS classification	To determine the type of radiotherapy delivery to enable analysis of radiotherapy related data. To measure the effectiveness of radiotherapy procedure performed and to be used as a measure for clinical outcomes.
Attendance identifier	Sequential Number or time of day used to enable attendance to be uniquely identified	To link radiotherapy treatments to the appropriate incidence of primary cancer site & diagnosis.
Organisation Code	The healthcare organisational code which identifies an organisation uniquely	To monitor the proportion of cancer patients referred to a cancer site. To be able to report by hospital code.
Radiotherapy Dataset Items:	Definition	Business Justification
Appointment Date	An arrangement for a patient to be seen by or be in contact with one or more care professionals i.e. Date of patients attendance for radiotherapy	To link radiotherapy treatments to the appropriate incidence of primary cancer site & diagnosis.
Radiotherapy episode identifier	Any identifier that is unique for each radiotherapy episode	To link radiotherapy treatments to the appropriate incidence of primary cancer site & diagnosis.
Decision to treat date for radiotherapy	The date on which the clinician and patient agreed this course of radiotherapy is to be given.	To analyse the waiting times for radiotherapy treatment against the waiting time standards determined by the Joint Council for Clinical Oncology Standards.
Earliest clinically appropriate date	The first date the patient is available to start radiotherapy treatment. This is usually the same date as the decision to treat date for radiotherapy unless there was an elective delay for clinical or social reasons.	To identify delays and for analysis of the waiting times for radiotherapy treatment.

Radiotherapy priority	This is the priority for the radiotherapy treatment course as classified by the requesting clinician.	Required for casemix and outcome analysis.
Treatment start date (radiotherapy)	The date of first fraction of radiotherapy in this episode.	To determine the time interval between referral and diagnosis by the specialist team and the start of treatment. Required to be able to the measure survival time from the start of treatment. To enable the date of first definitive treatment to be recorded.
Prescription identifier	An identifier that is unique for each radiotherapy prescription.	To identify radiotherapy prescription where multiple exist for a patient.
Radiotherapy treatment region	The specific areas to be treated with radiotherapy. P - Primary PR - Primary & Regional nodes A – non-anatomically specific primary site O – Prophylactic (to non-primary site) M - Metastasis	To analyse treatment patterns and outcomes.
Anatomical treatment site for radiotherapy	The part of the body to which the actual dose is administered (OPCS coding classification)	To analyse treatment patterns and outcomes.
Radiotherapy Dataset Items:	Definition	Business Justification
Number of teletherapy fields	The prescribed number of fields of a teletherapy treatment course.	To allow analysis of treatments prescribed.
Radiotherapy prescribed dose	The total prescribed absorbed radiation dose given in Grays.	To allow analysis of treatments prescribed.
Prescribed fractions	The prescribed number of fractions or hyper-fractionation of a teletherapy treatment course.	To allow analysis of treatments prescribed.
Radiotherapy actual dose	The total actual absorbed radiation dose given in Grays.	To assist audit of treatment protocols.

Actual fractions	The total number of fractions or hyper- fractionation of a teletherapy treatment course administered	To analyse planned versus actual fractions administered
Radiotherapy Treatment modality	The type of radiotherapy administered; Teletherapy or Brachytherapy	This data item is required to distinguish which type of radiotherapy is administered to a patient.
Radiotherapy field identifier	To identify radiotherapy exposures where multiple exist for a patient. Any identifier that is unique for each radiotherapy exposure.	To identify radiotherapy exposures where multiple exist for a patient.
Machine identifier	A unique code ascribed to the radiotherapy equipment used to treat this exposure.	To identify the linear accelerators at each centre across Wales and to assist take up analysis.
Teletherapy beam type	The prescribed type of beam of a teletherapy treatment course.	Required for treatment and outcome analysis.
Teletherapy beam energy	The prescribed energy of a teletherapy treatment course.	Required for treatment and outcome analysis.
Time of exposure	Time when the exposure was initiated.	To demonstrate the pattern of use of linear accelerators.

For reference, the National Radiotherapy Dataset agreed in England, Dataset V3.7 can be accessed from the following webpage: http://www.canceruk.net/rtservices/rtds/home.htm

APPENDIX 6

Glossary of terms

4D-ART: 4D Adaptive Radiotherapy	4D-ART refers to the ability to adjust the delivery of radiotherapy both in the 3 geometric dimensions and in time. This relates to real time positional changes of both the patients and tumour volume. It accounts for both intra- and inter-fraction variation.
Access rate	The proportion of cancer patients who should receive radiotherapy as part of their treatment
Arc therapy: VMAT: Volumetric modulated arc therapy/**Rapid Arc/VMAT:** intensity modulated arc therapy	Arc therapy delivers radiation by rotating the gantry of a linear accelerator through one or more arcs with the radiation continuously on. As it does so, a number of parameters can be varied – gantry rotation, dose rate and MLC speed
Attendance	A visit for one or more fractions of radiotherapy
Brachytherapy	*Brachytherapy is a type of radiotherapy that is given* by placing radioactive material directly in or near the target, which is often a tumour or tumour bed
Clinical oncologist	Clinical Oncologists are the doctors who specialise in non-surgical forms of cancer treatment, utilising radiotherapy, chemotherapy, hormone therapy, radioactive isotopes and other special techniques to treat patients with cancer
Cone beam CT	A diagnostic energy X-ray machine is mounted with the linear accelerator and by rotation acquires a three dimensional image of the tumour with the patient in the treatment position
CT simulator	CT simulator is the equipment which is used to determine the exact location and size of the area to be treated by radiotherapy.
Fiducial markers	Fiducial markers are small radio opaque markers which can be inserted directly into the tumour and then visualised by imaging and used to ensure accuracy of positioning from day to day
Fraction	A fraction is a single dose of radiotherapy. A treatment course is often made up of a number of fractions
Functional imaging	Imaging of the physiology of the body to detect disease or monitor the activity of that disease

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.
Image fusion	*Image fusion* is the process of combining relevant information from two or more images into a single image
IMRT: Intensity Modulated Radiotherapy	IMRT is a high precision form of radiotherapy. It enables the shape and dose of the radiation to conform precisely to the volume of tumour tissue that needs to be treated.
IVD: in vivo dosimetry	*In Vivo dosimetry* refers to measuring the dose received by the patient during treatment
Linear accelerator	A *linear accelerator* is a machine that is used in radiotherapy for cancer treatment
MDT: multidisciplinary team	A group of healthcare professionals who meet to discuss oncology cases of a particular tumour site
Medical physicist	The medical physicist is the professional who applies the principles and methods of physics in medicine in order to ensure the quality of services provided and the prevention of risks to the patients. The medical physicist plays a fundamental role in all fields of application of physics to medicine but particularly in the diagnosis and treatment of cancer
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 therapy:	Proton Beam Radiotherapy uses a high-energy beam of protons rather than high energy X-rays to deliver a dose of radiotherapy. Proton beam treatment directs the radiation dose to precisely the depth where it is needed, with minimal damage to surrounding tissue. The treatment is therefore particularly suitable to complex childhood cancers.

Radiotherapy	Radiotherapy is the treatment of disease (primarily cancer) by means of ionizing radiation; tissue may be exposed to a beam of radiation, or a radioactive substance/source
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 associated with the use of high radiation dose in a small number of fractions
Therapy/therapeutic radiographer	Therapeutic radiographers are the healthcare professional responsible for the management and care of patients undergoing radiotherapy before, during and immediately after radiotherapy treatment. Working as part of the multidisciplinary cancer team, therapeutic radiographers support patients and their families through the entire cancer journey.

Appendix 7

Project key stages and consultation process

Stage	Dates
Sign off WSAC chair	11/03/2014
Final sign off COSC chair	05/02/2014
Sign off Chair and clinical oncologist of each Cancer NSAG cancer group	29/11/2013
Consultation with COSC members	14/12/2012; 28/10/2013; 24/01/2014
Updates at COSC meetings	15/03/2013; 13/07/2013; 04/10/2013; 17/01/2014
Draft report to COSC members	28/10/2013; 13/11/2013; 20/01/2014
Collation of data and papers by editing sub group	During 2011, 2012
Telephone conference call with senior staff from RT centres in Scotland and England	06/09/2012
COSC editing sub group meetings	30/09/2011; 09/02/2011; 17/02/2012; 30/05/2012