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Cohort profile: radiotherapy dataset (RTDS) in England

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ABSTRACT

Purpose The purpose of the Radiotherapy Dataset (RTDS) is to collect consistent and comparable data across all providers of National Health Service (NHS)-funded radiotherapy and to provide intelligence for service planning, commissioning, clinical practice and research.

Participants The RTDS is a mandated dataset requiring providers to collect and submit data monthly for patients treated in England. Data is available from 01 April 2009 to 2 months behind the calendar month.

The National Disease Registration Service (NDRS) started receiving data from 01 April 2016. Prior to this, the National Clinical Analysis and Specialised Applications Team (NATCANSAT) were responsible for the RTDS. NDRS holds a copy of the NATCANSAT data for English NHS providers.

The RTDS contains clinical information on the primary disease being treated, modality and intent of treatment, dose fractionation and hospital appointment details. Due to constraints in RTDS coding, linkage to the English National Cancer Registration dataset is beneficial.

Findings to date The RTDS has been linked to the English National Cancer Registration and Systemic Anti-Cancer Therapy (SACT) datasets and to Hospital Episode Statistics (HES) to provide a more complete picture of the patient cancer pathway. Findings include a study to compare outcomes for patients treated with radical radiotherapy, an investigation of factors influencing 30-day mortality, assessing sociodemographic variation in the use of treatment and a study to assess the service impact of the COVID-19 pandemic. A range of other studies have been completed or are ongoing currently.

Future plans The RTDS can be used for a variety of functions including cancer epidemiological studies to investigate inequalities in treatment access; provide service planning intelligence; monitor clinical practice; and support clinical trial design and recruitment. Collection is to continue indefinitely, with regular updates to the data specification to enable capture of more detailed information on radiotherapy planning and delivery.

INTRODUCTION

Radiotherapy is one of the primary modalities used in the treatment of cancer, and routine collection of activity is vital for population health research. In England, the Radiotherapy Dataset (RTDS) is a national information standard that requires all providers delivering radiotherapy for patients treated in the

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The key strength of the Radiotherapy Dataset (RTDS) is the detailed national coverage of all National Health Service-funded radiotherapy delivered in England.
⇒ The dataset has a high level of completeness and timeliness which are critical in disease surveillance.
⇒ Data can be linked to a variety of other datasets, enabling researchers to assess the full cancer pathway and to conduct tumour-specific analyses.
⇒ A small proportion of brachytherapy data and proton beam therapy activity delivered outside England is not currently available in the RTDS.
⇒ Some radiotherapy records are fragmented due to the specific technique being used and appear as two separate treatments with an uncommon dose fractionation.

National Health Service (NHS) to collect and submit standardised data monthly against a defined dataset. Data is collected on radiotherapy treatments (external beam (teletherapy) and brachytherapy) of adult and paediatric patients delivered in secondary and tertiary settings. Prior to the inception of the RTDS, radiotherapy data was sparse with a wide variety of definitions for activity. The dataset was established to collect consistent and comparable data across all NHS providers of radiotherapy to provide intelligence for service planning, commissioning, clinical practice and research. The national information standard is reviewed every 3 years to ensure it remains clinically relevant.

From 01 April 2009, all 51 NHS providers of radiotherapy services were mandated to submit data on all patients receiving radiotherapy for both malignant and benign disease treated in facilities under their direct management or for NHS patients treated in private facilities through contracts with the independent sector. Activity for private patients treated in NHS settings is not currently mandated, however, some providers may submit this data (approximately 7% of all radiotherapy episodes submitted each year).

Box 1 Radiotherapy treatment types in and out of scope of the RTDS

In scope

All radiotherapy of the following types, delivered in England to patients in NHS facilities or in private facilities where delivery is funded by the NHS:

⇒ External beam therapy (teletherapy)
⇒ Proton therapy
⇒ Radioisotope therapy (including radioiodine)
⇒ Brachytherapy given using automated remote afterloading machines
⇒ All other brachytherapy given for the treatment of malignant disease

Out of Scope*

⇒ Brachytherapy (using other than automated remote afterloading) for the treatment of non-malignant disease
⇒ Radiotherapy delivered outside of England
⇒ Radiotherapy delivered in a non-NHS setting and not funded by the NHS
⇒ Non-therapeutic exposures delivered using a radiotherapy machines (eg, imaging)
⇒ Non-patient exposures (eg, dosimetry exposures, blood or tissues, animals)

NHS, National Health Service; RTDS, radiotherapy dataset.
*Data may be submitted that is out of the mandated scope.

Molecular radiotherapy (MRT) using unsealed radio-active sources is within the scope of the RTDS, however, completeness is low. As MRT services are often delivered in settings outside radiotherapy departments, the established approach in collecting radiotherapy data is not viable. Following a data collection feasibility study in 2018, MRT data items were included in the RTDS and an alternative method of data collection with associated rules and validations was implemented to improve data completeness.

Since 2008, patients eligible for high-energy proton beam therapy (PBT) have been able to access treatment abroad. This data is held by NHS England, outside of the RTDS. Two English NHS providers now deliver high-energy PBT; one of the two started to submit this data as part of the RTDS in December 2018 and it is planned that ultimately all PBT episodes will be submitted to RTDS. Treatment abroad will continue until both centres are fully operational.[1] Low-energy PBT activity for eye tumours (delivered at a single NHS provider) is currently collected via the RTDS. Details on the treatments in scope of the dataset are listed in box 1.

COHORT DESCRIPTION

The RTDS is collected and managed by the National Disease Registration Service (NDRS) at NHS England (formerly NHS Digital), which started receiving data from 01 April 2016. From 01 April 2009 to 31 March 2016, the management and delivery of the RTDS was the responsibility of the National Clinical Analysis and Specialised Applications Team (NATCANSAT). The RTDS recorded 905 921 treatment episodes between 01 April 2009 and 31 March 2016 and 672 135 episodes between 01 April 2016 and 31 March 2021. Management of the dataset is clinically led and has been designed to understand patterns in radiotherapy prescribing, including the outcomes of these treatments. Data is collected at patient level and can be linked to other data sources, such as secondary care activity and chemotherapy treatment, to provide a complete picture of the cancer patient pathway.

Data submission

The RTDS collects information held on Oncology Information Systems (OIS) for patients receiving radiotherapy. The radiotherapy treatment machines are linked to these systems supporting automatic data capture. Most of the information collected is generated by or entered into either a MOSAIQ or ARIA OIS. The majority of linear accelerators (LINACS) have a comprehensive link with the OIS and supply detailed exposure information such as the exact dose of radiotherapy delivered. For a small minority of treatment machines across 18 providers, data may have to be manually entered into the OIS or recorded separately. This is the case for some brachytherapy and molecular treatments where machines are not directly linked to the OIS. This has the potential of generating data entry errors.

Data is submitted monthly to NDRS through a secure online portal where it must pass a series of validations (see online supplemental table 1). A summary validation report is immediately sent to the data uploader to allow errors to be rectified, with support provided by the RTDS helpdesk (RTDS.Helpdesk@nhs.net). The RTDS portal normalises the data into a single holding format and then feeds through another validation process to the English National Cancer Online Registration Environment (ENCORE), where it is linked to cancer registration data.

Data structure

A snapshot of the data is taken from the ENCORE each month and transferred into a separate Oracle database (Cancer Analysis System (CAS)), from where it is used for analysis and data releases. A copy of the data submitted to NATCANSAT (April 2009 to March 2016) for English NHS providers has been audited and is also available in the CAS. Both the data submitted to NATCANSAT and NDRS are stored in four tables: Episodes, Prescriptions, Exposures and Outpatients Commissioning Dataset (OPCDS). A summary of the data variables available in the tables and any known data quality issues can be found in table 1.

The RTDS data tables have a one-to-many relationship (see online supplemental figure 1), where a patient may have one or more treatment episodes, which are defined as a continuous period of care for radiotherapy including preparation, planning and delivery of radiotherapy. If a patient is later diagnosed with a subsequent primary tumour or metastasis, then treatment relating to this lesion will form part of a new episode.

Table 1 Data field descriptions and data quality issues for variables collected for use in the RTDS

Data field	Description	Data quality issues
Episodes table		
Radiotherapy episode identifier	A unique identifier for each radiotherapy episode	Some identifiers prior to 01 April 2016 include a third component
Organisation code of provider	The organisation code of the radiotherapy provider	Includes defunct organisation codes
Attendance identifier	A unique identifier for each attendance	Missing for a small volume of records submitted in 2010
Appointment date	The date when the patient is seen by or is in contact with radiotherapy care professionals	Records from 01 April 2016 includes time patient was booked in
Decision to treat date	The date on which it was decided that the patient required a specific planned radiotherapy treatment (consultation between the patient and the clinician)	Missing for a small volume of records
Earliest clinically appropriate date	This is the first date that the patient would have been available to start radiotherapy	Missing for a small volume of records
Radiotherapy priority	The priority for the course of therapy as classified by the requesting clinician (emergency, urgent, routine or delay)	Missing for a small volume of records
Radiotherapy diagnosis (ICD-10)	The primary tumour diagnosis code for patients with cancer or the main condition being treated during the episode of radiotherapy for non-cancer diagnoses	No known issues
Radiotherapy intent	The intent of the delivered beam radiation (palliative, radical or other)	No known issues
Treatment start date	The start date of a radiotherapy episode	No known issues
Prescriptions table		
Prescription identifier	A unique identifier for each radiotherapy prescription	Some identifiers prior to 01 April 2016 include a fourth component
Radiotherapy treatment region	The specific area to be treated with radiotherapy (primary, primary and regional nodes, regional nodes, non-anatomically specific primary site, prophylactic or metastasis)	Missing for a small volume of records
Anatomical treatment site	The part of the body to which the dose is administered (OPCS Z codes). Only completed when the treatment region is non-anatomically specific primary site, prophylactic or metastasis	Missing for a small volume of records
Number of teletherapy fields*	The prescribed number of fields of a teletherapy treatment course	No known issues
Radiotherapy prescribed dose	The total prescribed absorbed radiation dose in Grays	No known issues
Prescribed fractions	The prescribed number of fractions or hyperfractions of a teletherapy treatment course	No known issues
Radiotherapy actual dose	The total actual absorbed radiation dose given in Grays	Missing for a small volume of records or only available on the last attendance
Actual fractions	The total number of fractions or hyperfractions of a teletherapy treatment course administered	Missing for a small volume of records or only available on the last attendance
Radiotherapy treatment modality	The type of treatment delivered during a radiotherapy prescription (teletherapy, brachytherapy or proton therapy)	No known issues

Continued

Table 1 Continued

Data field	Description	Data quality issues
Exposures table		
Machine identifier	A unique code ascribed to the radiotherapy equipment used to treat this exposure	No known issues
Radioisotope	The type of radioactive source used to deliver radiotherapy (brachytherapy only)	No known issues
Radiotherapy beam type	The prescribed type of beam of a teletherapy treatment course (photons, electrons, protons or other)	No known issues
Radiotherapy beam energy	Beam energy in MeV/MV/MVp	No known issues
Time of exposure	Time when the exposure was initiated	No known issues
OPCDS table		
Primary diagnosis (ICD-10)	The main condition treated or investigated during the relevant episode of care	No known issues
OPCS Procedure	The radiotherapy procedures (OPCS) carried out and recorded for CDS	No known issues
Procedure date	The date of the occurrence of the clinical intervention	No known issues
Site code of treatment	The organisation site code where the patient was treated	No known issues

*This field is not included in version 6 of RTDS, for a full list of fields in V.6, refer to https://digital.nhs.uk/ndrs/data/data-sets/rtds.
CDS, commissioning dataset; OPCS, operating procedure codes supplement; RTDS, radiotherapy dataset.

Each radiotherapy episode will have at least one prescription for a specific modality, that is, external beam (teletherapy) or brachytherapy, and will include information on the prescribed and delivered dose fractionation and the region of the body being treated (ie, primary, regional nodes). Each prescription will link to at least one treatment exposure, which is the delivery of one radiotherapy beam on a specific date.

An attendance is a visit by a patient to receive one or more fractions of radiotherapy. Details for each attendance, such as the date and time of the appointment, can be found across all four tables. An attendance may involve treatment given on different machines and to different areas of the body. A patient will attend for one or more attendances, which are not unique per prescription but per episode. A patient may have exposures related to different prescriptions delivered at the same attendance. There is no direct link between attendances and prescriptions, instead a link is inferred through a valid exposure being present.

Clinical and patient data

Completeness for the year 01 April 2020 to 31 March 2021 for each variable and for the most common radiotherapy diagnostic groups are shown in tables 2 and 3. Completeness for all diagnostic groups and by age group (at start of treatment) can be found in online supplemental tables 2 and 3. Isotope completeness is not presented as it is not possible to identify the records that should have an isotope recorded for this time period. In the recent redevelopment of the RTDS, treatment modality has been expanded to include a separate modality for radioisotope therapy.

Radiotherapy dosimetry planning information can be collected at a provider level through a platform called Elekta ProKnow. This is a cloud-based system where complete radiotherapy plans can be uploaded and stored, then used by providers to peer review radiotherapy plans. This data could, in the future, be linked to RTDS and other datasets for further analysis of treatment outcomes.

The primary disease or condition being treated during the episode of radiotherapy is coded using the International Classification of Disease 10th Revision (ICD-10), published by the WHO. Planning, preparation and delivery codes are collected using the OPCS Classification of Interventions and Procedures (OPCS-4.9). The list of OPCS codes commonly used for radiotherapy treatments are described in online supplemental table 4. The anatomical treatment site receiving radiotherapy (only required when treatment is to the non-anatomically specific primary site, prophylactic or for metastatic disease) is coded using OPCS Z-codes (see online supplemental table 5). When a new treatment or technique is rolled out to radiotherapy providers, we work with NHS England's Specialised Commissioning team to provide coding guidance to ensure all activity is collected in a consistent manner to aid reporting of activity accurately.

Table 4 provides a comparison of the RTDS primary diagnosis to the diagnosis recorded in the English National Cancer Registration Dataset[2] for patients diagnosed with cancer in 2019. Eighty-nine per cent of the

Table 2 Data completeness for each variable collected in the RTDS for all episodes which started during the period 01 April 2020 to 31 March 2021

Variable	Number of unique values	% complete
Patient identifier	115 430	100
Organisation provider code	51*	100
Attendance identifier	1 374 524	100
Appointment date	497†	100
Decision to treat date	1332	99.0
Earliest clinical appropriate date	782	90.8
Radiotherapy priority	4	93.3
Radiotherapy ICD-10 code (three-digit)	158	100
Treatment intent	3	99.9
Radiotherapy episode identifier	124 805	100
Treatment (episode) start date	365	100
Prescription identifier	152 430	100
Treatment region	6	95.3
Anatomical site	310	96.6
Number of teletherapy fields	46	100
Prescribed dose	3352	100
Prescribed fractions	40	99.8
Actual dose	4968	96.3
Actual fractions	61	100
Treatment modality	2	99.7
Machine identifier	384	99.7
Beam type	5	100
Beam energy	55	100
Exposure time	46 014	100
Primary diagnosis ICD-10 code (three-digit)	158	100
OPCS procedure code	50	100
Procedure date	497†	100
Hospital site of treatment	57*‡	100

*Two satellite sites are reported under their commissioning provider.
†There are 497 unique records for procedure and appointment date as an appointment can span beyond the year that the episode of treatment started.
‡Radiotherapy providers submit a mix of the organisation provider code (three-digit) and the hospital site code of treatment (five-digit).
OPCS, operating procedure codes supplement; RTDS, radiotherapy dataset.

RTDS codes were an exact match or matched the first three digits of the registry ICD-10 code. The radiotherapy diagnosis groups that make up a substantial proportion of the mismatches are haematology (28%), head and neck (33%), bone and soft tissue (33%), other non-invasive tumours (42%) and cancer of unknown primary (88%). Eighty-seven per cent of head and neck and 96% of haematology-mismatched ICD-10 codes had the same broad diagnosis group in the registration dataset. Bone, soft tissue and haematological cancers are more commonly defined using the International Classification of Diseases for Oncology third edition (ICD-O-3), which is not available in the RTDS. Other causes of mismatches are the use of ICD-10 code C79 in the RTDS, which is for 'secondary malignant neoplasm of other and unspecified sites'. This code may be accurate but is also known to be a data quality issue when the exact ICD-10 code of the primary site is not known. Manual entry errors on the OIS can also occur. Regular data improvement and quality reports are disseminated to provide a constant feedback loop with providers. Data liaison managers work with submitting providers to identify and rectify data quality issues, therefore reducing the mismatches where possible.

Patient and public involvement
The Radiotherapy Information Strategy Group (RISG) was established in 2015 to support the development of the RTDS. The main purpose of the group is to promote effective data collection, provide expert advice, monitor patterns in cancer care and ensure the dataset evolves over time to remain fit for purpose. The membership of this group includes two nominated lay representatives, whose role is to bring a broader perspective on the direction of the RTDS and to ensure its outputs are meaningful to patient care.

FINDINGS TO DATE
The RTDS is used for a variety of functions, including research, clinical performance monitoring and health service provision. The dataset is used to underpin the strategic objectives for the future development of radiotherapy in England set out in the Achieving World Class Cancer Outcomes Strategy[3] and the NHS Long Term Plan.[4] NHS England commission NDRS to provide data on Quality Innovation Productivity and Prevention initiatives (QIPP), a national programme to improve the quality of care while making efficiency savings which will be reinvested in frontline care.[5–7] The QIPPs report on the fractionation used by providers for the treatment of bone metastases, breast and prostate cancer.

RTDS data was used in one of the first studies to assess the impact of the COVID-19 pandemic on radiotherapy services in England and has been published in *The Lancet Oncology*.[8] The research revealed that there was a decrease in radiotherapy treatment courses. In addition, shorter radiotherapy courses were delivered, treatments were delayed where it was safe to do so and there were some increases for indications where radiotherapy appears to have been used to compensate for reduced surgical capacity.[8]

Table 3 Data completeness for the most common radiotherapy diagnostic groups for each variable collected in the RTDS for the period 01 April 2020 to 31 March 2021

Diagnostic group	Breast	Urology	Respiratory	Lower GI	Head and neck
Number of patients	29 224	25 486	13 983	7427	7027
Number of providers*	50	50	50	50	49
Number of hospital sites†	53	56	52	53	52
Number of episodes	30 349	27 495	15 810	7859	7252
Number of prescriptions	41 058	30 867	18 210	8854	8173
Attendance ID, %	100	100	100	100	100
Appointment date, %	100	100	100	100	100
Decision to treat date, %	98.4	99.3	99.1	99.0	99.3
ECAD, %	93.8	92.9	82.3	94.2	92.3
Radiotherapy priority, %	93.6	95.1	94.5	93.9	94.3
Treatment intent, %	99.9	99.9	99.9	99.9	99.8
Treatment start date, %	100	100	100	100	100
Treatment region, %	95.5	97.0	94.9	97.2	96.1
Anatomical site, %	98.6	97.3	97.7	97.6	96.0
Number of fields, %	100	99.1	100	100	100
Prescribed dose, %	100	100	100	100	100
Prescribed fractions, %	100	99.9	100	100	100
Actual dose, %	99.6	97.5	99.2	94.4	95.3
Actual fractions, %	100	100	100	100	100
Treatment modality, %	100	100	100	100	100
Machine ID, %	99.8	99.7	99.7	99.8	99.6
Beam type, %	99.3	99.1	100	98.9	100
Beam energy, %	100	99.1	100	100	100
Exposure time, %	100	100	100	100	100
Primary diagnosis, %	100	100	100	100	100
OPCS code, %	100	100	100	100	100
Procedure date, %	100	100	100	100	100

ICD-10 codes: Breast (C50); Urology (C60-C68); Respiratory (C33-C34, C37-C39, C45); Lower GI (C17-C21, C26); Head and neck (C00-14, C30-C32).
*Two satellite sites are reported under their commissioning provider.
†Radiotherapy providers submit a mix of the organisation provider code (three-digit) and the hospital site code of treatment (five-digit).
ECAD, earliest clinical appropriate date; GI, gastrointestinal; Gynae, Gynaecological; Haem, Haematology; OPCS, operating procedure codes supplement; RTDS, radiotherapy dataset.

A suite of reports available on CancerStats2,[9] an online repository of information on datasets managed or supported by NDRS (access restricted to those on the NHS network), have been produced to support providers and commissioners during the response to the COVID-19 pandemic. They allow users to compare radiotherapy activity (counts of episodes, prescriptions or attendances) from two separate time periods by provider, Cancer Alliance and radiotherapy network. The data can be filtered by tumour site, age and treatment intent. A second set of reports, looking at dose fractionation schedules, can be compared by month and filtered by provider, age, tumour site and treatment intent. It is intended that these reports support radiotherapy providers during COVID-19

recovery and help services plan a return to a new normal way of working. An overview of the radiotherapy delivered in England from 2009 to 2021 and during the COVID-19 pandemic is publicly available on CancerData[10] (https://www.cancerdata.nhs.uk/COVID-19/rtds), an open access tool providing a range of information for public users with an interest in cancer or cancer services.

The RTDS has also been used to compare outcomes for patients diagnosed with stage I non-small cell lung cancer treated with radical radiotherapy using either stereotactic ablative body radiotherapy (SABR) or fractionated radiotherapy.[11] The study showed that those treated with SABR had a survival benefit and although use of SABR increased in England over the study period, it still had not reached

Table 4 Match level of the radiotherapy ICD-10 code compared with the cancer registration dataset by diagnosis group for patients diagnosed in 2019

Radiotherapy diagnostic group	Match level to registry	Number of records	Percentage
All cancers	Exact match	43 088	45
	Partial match	42 227	44
	No match	10 918	11
Brain and CNS	Exact match	655	22
	Partial match	1967	66
	No match	344	12
Breast	Exact match	7934	26
	Partial match	20 872	68
	No match	1979	6
Lower GI	Exact match	4381	72
	Partial match	809	13
	No match	885	15
Endocrine	Exact match	196	77
	Partial match	5	2
	No match	53	21
Gynaecological	Exact match	2615	63
	Partial match	1000	24
	No match	514	12
Haematology	Exact match	1319	36
	Partial match	1313	36
	No match	1039	28
Head and Neck	Exact match	2600	41
	Partial match	1698	27
	No match	2098	33
Respiratory	Exact match	2913	25
	Partial match	8671	74
	No match	196	2
Bone and soft tissue	Exact match	233	23
	Partial match	454	44
	No match	335	33
Skin	Exact match	1194	38
	Partial match	1706	54
	No match	269	8
Upper GI	Exact match	938	26
	Partial match	2292	62
	No match	447	12
Urology	Exact match	17 651	93
	Partial match	1018	5
	No match	335	2
Cancer of unknown primary	Exact match	186	8
	Partial match	88	4
	No match	1979	88

Continued

Table 4 Continued

Radiotherapy diagnostic group	Match level to registry	Number of records	Percentage
Other	Exact match	273	26
	Partial match	334	32
	No match	445	42

A partial match is defined as a three-digit match of the ICD-10 code when the Cancer Registry and/or RTDS ICD-10 code is four digits.
CNS, central nervous system; GI, gastrointestinal; RTDS, radiotherapy dataset.

levels seen in other countries. The NHS Long Term Plan[4] set out a priority to expand access to faster, smarter and effective radiotherapy, which includes a commitment to support all centres who choose to deliver SABR. Once the SABR expansion has been rolled out, this analysis will be repeated to highlight any improvements in patient outcomes.

A range of studies have used the RTDS to address clinically important questions. For example, Spencer[12] conducted a retrospective population-based study using cancer registration data to investigate factors influencing 30-day mortality following palliative radiotherapy and whether it can be used as a clinical indicator to assist in decision making for palliative radiotherapy treatment fractionations. This work showed that 30-day mortality varied significantly with primary diagnosis, the site being irradiated, gender and fractionation. Results supported the use of 30-day mortality in assessing clinical decision making in palliative radiotherapy. John et al[13] used the RTDS to assess the 1-year survival of patients diagnosed in England with non-metastatic muscle invasive bladder cancer according to treatment modality, stage of disease and sex. Henson et al[14] used the RTDS to investigate socio-demographic variation in the use of chemotherapy and radiotherapy in patients diagnosed with stage IV lung, oesophageal, stomach and pancreatic cancer. White et al[15] used the RTDS to quantify geographic variation in the use of lymphadenectomy and external beam radiotherapy for endometrial cancer in England. Morris et al[16] showed that wide variation exists in the use and type of radiotherapy delivered in the management of rectal cancer across the English NHS.

The RTDS also supports the national Breast Screening After Radiotherapy Dataset (BARD), a database created to identify women in England who have received radiotherapy involving breast tissue before the age of 36.[17 18] As patients treated with radiotherapy for an earlier cancer are at an increased risk of developing a subsequent primary, BARD has been designed to optimise screening by ensuring appointments are sent out at the appropriate time. At present BARD only captures the radiotherapy activity for women with a lymphoma diagnosis.

Strengths and limitations

Strengths

National coverage

The key strength of the RTDS is the detailed coverage, from 2009, of all NHS-funded radiotherapy in England. Population-based datasets such as the RTDS can be used to examine variations in delivery of, and inequalities in access to, different treatment modalities[19] in addition to providing substantial long-term follow-up of patients. The ability to link treatment and cancer registration data at a patient level allows assessment of regional variation supporting research and quality improvement to assist in the planning of radiotherapy services, change practice and improve outcomes. NDRS also provide a similar data processing service for radiotherapy providers in Wales and Scotland, enabling comparable cross-country analyses, subject to appropriate controls and permissions.

Timeliness

Providers are required to collect and submit data monthly, in line with the submission schedule. The RTDS is available from April 2009 to 2 months behind the calendar month, that is, in June 2021, radiotherapy data is available up to the end of April 2021. NDRS Data Liaison Leads based in each regional office support providers in the upload process and are available to offer technical support.

Linkage to other datasets

The RTDS can be linked to a variety of other datasets, such as the National Cancer Registration Dataset,[2] Routes to Diagnosis,[20] Hospital Episode Statistics (HES)[21 22] and Systemic Anti-Cancer Therapy (SACT).[23] This enables researchers to assess the full cancer pathway, understand potential outcome mediators/confounders and therefore conduct tumour-specific analyses by patient and treatment characteristics to provide a better understanding of the specific role of radiotherapy in improving outcomes. A full list of the datasets available for linkage are published online.[24]

Limitations

Data quality and completeness

A majority of the data quality issues (see table 1) are a direct result of the RTDS being collected at point of treatment or due to specific features of the systems being used to generate the information. The RTDS portal highlights data validation errors prior to submission, which are reported back to the provider to correct. However, due to resource demands, submissions are only required to pass the critical tests listed in online supplemental table 1. Within one OIS used by several providers, there is no direct link between the appointment data containing the OPCS code and the prescription. Therefore, the RTDS importer must infer which appointment and OPCS codes are attached to each prescription by date. If a patient has two prescriptions on the same day, there will be two separate OPCS planning codes and both codes will be attached to each prescription, duplicating the OPCS reporting. This impacts a small number of patients and can be mitigated by grouping patients by episodes.

Beyond the monthly critical tests, regions and providers are supported to improve their data submissions when errors are identified. If more systematic data quality issues arise, the data liaison and technical teams prepare and issue guidance enabling ongoing improvement and work individually with providers to support them in implementing the required change(s).

The primary diagnosis or main condition being treated is coded using ICD-10. Some tumour groups are more commonly defined using ICD-O-3 which is not available in the RTDS. For these groups and for those where the primary diagnosis is not known, data can be supplemented by linking to the English National Cancer Registration dataset.

Radiotherapy treatment intent was mandated from 2014 onwards, prior to this completion varied by provider. Interpretation on how this field is completed can vary by clinician as the recorded intent can differ from the intent indicated by the prescribed dose fractionation.

The complexity of radiotherapy delivery has increased, however, the data collected in the RTDS has not previously captured a full picture of treatment complexity. The national information standard is reviewed every 3 years and work is currently underway to implement the latest update (V.6). This will enable capture of information regarding planning technique, motion management, delivery technique and online imaging.

NDRS do not have access to the raw data submissions for the RTDS prior to April 2016 and may not be able to thoroughly investigate any data quality issues for this time period.

Missing data

It is known that a small proportion of brachytherapy data is missing. An exercise to quantify and collect this missing data is currently being undertaken. NHS-funded stereotactic treatments being delivered in a private sector are missing for two providers. NDRS are working with these providers to collect this data. Activity for private patients treated in a private setting is not mandated; however, NDRS are actively working with the independent sector to capture this data.

PBT activity delivered outside of England is not currently available in the RTDS. NDRS are looking to implement a process to collect this information from NHS England.

Fragmented records

Some radiotherapy records are fragmented due to the specific technique being used and appear as two separate treatments with an uncommon dose fractionation. The dose fractionation for these treatments will need to be added together to form the correct prescription. An example of this is for the treatment of breast cancer with the use of bolus for chest wall treatments.[25] A similar issue can also occur if the patient is re-planned during

the planned treatment course (eg, for weight loss/gain or tumour progression/regression), as some providers will resubmit the entire prescription while others will only return the remaining dose fractionation to be delivered. The recent redevelopment of the RTDS will resolve this as it will allow for a new plan to be recorded.

COLLABORATION

Access can be granted to individuals who demonstrate that there is a justified purpose for the data release and that there is an appropriate legal basis with safeguards in place to protect the data. Dependent on the request, ethical approval may be required. The process is managed by the NHS England Data Access Request Service (DARS). If a cost is associated with the data release, it will be agreed before work commences. Full details, including data dictionaries, are available on the website.[24] Pre-application advice can be sought from (data.applications@nhsdigital.net).

The following acknowledgement statement should be used when using RTDS data: 'This work uses data that has been provided by patients and collected by the NHS as part of their care and support. The data are collated, maintained and quality assured by the National Disease Registration Service, which is part of NHS England'.

In addition to data releases, NDRS supports collaborations with academic and other institutions. Enquiries should be directed to (NDRSenquiries@nhs.net).

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REFERENCES

1 NHS England. Proton beam therapy. Available: https://www.england. nhs.uk/commissioning/spec-services/highly-spec-services/pbt/ [Accessed 30 Sep 2022].
2 Henson KE, Elliss-Brookes L, Coupland VH, *et al*. Data resource profile: National cancer registration Dataset in England. *Int J Epidemiol* 2020;49:16–16h.
3 Independent Cancer Taskforce. Achieving world-class outcomes: a strategy for England 2015-2020. 2015. Available: https://www. cancerresearchuk.org/sites/default/files/achieving_world-class_ cancer_outcomes_-_a_strategy_for_england_2015-2020.pdf [Accessed 22 Sep 2022].
4 NHS England. NHS long term plan. Available: https://www. longtermplan.nhs.uk/ [Accessed 22 Sep 2022].
5 NHS. Clinical commissioning policy: Hypofractionated external beam radiotherapy ion the treatment of Localised prostate cancer (adults). Available: https://www.england.nhs.uk/publication/ clinical-commissioning-policy-hypofractionated-external-beam- radiotherapy-in-the-treatment-of-localised-prostate-cancer-adults/ [Accessed 22 Sep 2022].
6 NHS. Clinical commissioning policy: palliative radiotherapy for bone pain. Available: https://www.england.nhs.uk/wp-content/uploads/ 2018/07/Palliative-radiotherapy-for-bone-pain.pdf [Accessed 22 Sep 2022].
7 NHS. Clinical commissioning policy proposition: radiotherapy after primary surgery for breast cancer. Available: https://www.engage. england.nhs.uk/consultation/ spec-services-clinical-commissioning/ user_uploads/b01x04-rt-bc-polcy-prop.pdf [Accessed 22 Sep 2022].
8 Spencer K, Jones CM, Girdler R, *et al*. The impact of the COVID-19 pandemic on radiotherapy services in England, UK: A population-based study. *Lancet Oncol* 2021;22:309–10.
9 National Disease Registration Service. Cancerstats. Available: https://cancerstats.ndrs.nhs.uk/ [Accessed 18 Jan 2022].
10 National Disease Registration Service. Cancerdata. Available: https:// www.cancerdata.nhs.uk/ [Accessed 18 Jan 2022].
11 Phillips I, Sandhu S, Lüchtenborg M, *et al*. Stereotactic Ablative body radiotherapy versus radical radiotherapy: comparing real-world outcomes in stage I lung cancer. *Clinical Oncology* 2019;31:681–7.
12 Spencer K. *Early mortality, quality of life and cost-effectiveness of palliative radiotherapy for bone metastases in the English NHS [dissertation]*. Leeds: University of Leeds, 2019.
13 John JB, Varughese MA, Cooper N, *et al*. Treatment allocation and survival in patients diagnosed with Nonmetastatic muscle-invasive bladder cancer: an analysis of a national patient cohort in England. *Eur Urol Focus* 2021;7:359–65.
14 Henson KE, Fry A, Lyratzopoulos G, *et al*. Sociodemographic variation in the use of chemotherapy and radiotherapy in patients with stage IV lung, Oesophageal, stomach and Pancreatic cancer: evidence from population-based data in England during 2013–2014. *Br J Cancer* 2018;118:1382–90.
15 White B, Nordin A, Fry A, *et al*. Geographic variation in the use of Lymphadenectomy and External-Beam radiotherapy for endometrial cancer: a Cross-Sectional analysis of Population-Based data. *BJOG* 2019;126:1456–65.
16 Morris EJA, Finan PJ, Spencer K, *et al*. Wide variation in the use of radiotherapy in the management of surgically treated Rectal cancer across the English national health service. *Clinical Oncology* 2016;28:522–31.
17 The Christie NHS Foundation Trust. Breast screening after radiotherapy Dataset. Available: https://www.christie.nhs.uk/bard [Accessed 22 Sep 2022].
18 Public Health England Screening. Breast screening after radiotherapy (BARD) new Dataset. Available: https://phescreening.blog.gov.uk/ 2019/07/26/breast-screening-after-radiotherapy-bard-new-dataset/ [Accessed 22 Sep 2022].
19 Hoskin PJ, Forbes H, Ball C, *et al*. Variation in radiotherapy delivery in England: evidence from the National radiotherapy Dataset. *Clinical Oncology* 2013;25:531–7.

20 Elliss-Brookes L, McPhail S, Ives A, *et al*. Routes to diagnosis for cancer - determining the patient journey using multiple routine data SETS. *Br J Cancer* 2012;107:1220–6.

21 Herbert A, Wijlaars L, Zylbersztejn A, *et al*. Data resource profile: hospital episode Statistics admitted patient care (HES APC). *Int J Epidemiol* 2017;46:1093–1093i.

22 NHS Digital. Hospital episode Statistics. 2020. Available: https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/hospital-episode-statistics [Accessed 22 Sep 2022].

23 Bright CJ, Lawton S, Benson S, *et al*. Data resource profile: the systemic anti-cancer therapy (SACT) Dataset. *Int J Epidemiol* 2020;49:15–15l.

24 NHSRequests for national disease registration service (NDRS) data - detailed guidance. Available: https://digital.nhs.uk/services/data-access-request-service-dars/requests-for-national-disease-registration-service-ndrs-data-detailed-guidance [Accessed 22 Sep 2022].

25 Ordonez-Sanz C, Bowles S, Hirst A, *et al*. A single plan solution to chest wall radiotherapy with bolus *BJR* 2014;87:20140035.