Methodology Supplement for the National Bowel Cancer Audit State of the Nation Report 2024

Data sources

This is the first report by NBOCA where results for England are produced entirely using data submitted to the National Disease Registration Service (NDRS) and not collected directly by the audit. The previously used NBOCA dataset was based on data items within the COSD dataset curated by the National Disease Registration Service (NDRS) and so the largest change to NBOCA has been the data source and methodology required to obtain data items for England.

Three datasets have been obtained to form the main cohorts of people with bowel cancer that replace the data provided by this dataset, with NBOCA data being used as the source data for people diagnosed with bowel cancer in Wales prior to April 2022.

As in previous years these datasets are linked to other data to provide further information (Hospital Episode Statistics Admitted Patient Care (HES-APC), Patient Episode Database for Wales (PEDW), ONS mortality data, Radiotherapy Dataset (RTDS) and Systemic Anti-Cancer Therapy Dataset (SACT)).

English data

Two datasets for people with C18-C20 diagnoses were provided by NDRS, the National Cancer Registration Dataset (NCRD also known as “gold standard” data) and the Rapid Cancer Registration Dataset (RCRD).

The NCRD “Gold standard” data contains information on all cancers diagnosed and registered in England, including information from hospital pathology systems. RCRD contains proxy tumour registrations and some associated events on the cancer patient pathway (e.g. surgery, radiotherapy and chemotherapy) up to the most recently available data on cancer diagnoses. The RCRD data is more up to date than the NCRD but case ascertainment and data completeness for key variables is higher for the NCRD.

The NCRD dataset was used as the data source for 2-year overall survival and 18-month ileostomy after anterior resection. RCRD was used for all other analyses in this State of the Nation report.

NCRD

An extract from NCRD of people with C18, C19 and C20 tumours with a recorded diagnosis date between April 2014 and December 2021 was provided to NBOCA in 2023.

The NCRD tumour file consists of one record for each tumour in a specific location of the bowel, recorded as 4-character ICD-10 codes. People diagnosed with tumours in multiple sites of the bowel within the time frame of the extract will have multiple tumour records.

The NCRD treatment file was restricted to OPCS-codes representing major resection (Supplementary Table 1) and the record(s) for the earliest date of surgery retained. If more than one surgical procedure was recorded on the same date, the dataset was restricted to one surgical procedure in the following way.

> Initially, the most appropriate surgery for the recorded tumour location was kept e.g., right hemicolectomy for a right-sided colorectal tumour. If an individual had more than one tumour location and multiple procedures recorded, records where the tumour location, procedure and date matched a surgical record in HES-APC were kept. If multiple records per individual remained, the record with the most advanced TNM staging was selected, followed by records with the most advanced tumour grading or number of nodes examined, and finally, if multiple records still remained, the location furthest to the right side of the bowel was selected.

For people with rectal cancer, records that did not have a major resection allocated to them were linked to records for non-resectional surgery and the most appropriate procedure defined.

RCRD

An extract from RCRD of people with C18, C19 and C20 tumours between 01 January 2018 and January 2024 was provided to NBOCA in May 2024. In addition to the main tumour and events files, datasets of COSD items was also provided. The RCRD was also the source of performance status information.

The rapid tumour file consists of one record for each 3-character ICD-10 code diagnosis for each individual during the time period of the extract.

Surgical data was sourced from two datasets linked at individual level. The rapid events pathway file (event_type 14) and COSD data. These were separately searched for the OPCS-codes representing major resection (Supplementary Table 1) and then combined to obtain the first date of major resection for each tumour. Trust information was only present in the events file data and therefore if a surgical procedure was only present in the COSD data it was not allocated a trust and excluded from surgical performance indicators.

The same two datasets were used to obtain information about local excisions, and standalone formation of stoma in individuals with no recorded major resection.

Information about whether a person was seen by a Clinical Nurse Specialist (CNS) was obtained from COSD data. People with bowel cancer are considered to have seen a CNS if they are recorded as having seen a CNS within 90 days of the RCRD date of diagnosis.

Welsh data

Data for C18-C20 diagnoses occurring in Wales between 01 April 2022 and 31 March 2023 was supplied directly by the Wales Cancer Network from data collected (by MDTs) within the Cancer Information System Cymru (CaNISC) in 2024.

Data for C18-C20 diagnoses occurring in Wales between 01 January 2017 and 31 March 2022 were supplied in 2023.

These two datasets were combined and merged with the English dataset required for each analysis. Regardless of data source, records with a date of diagnosis that was more than three months after the recorded date of surgery have been excluded from surgical outcomes.

Creation of staging variables across datasets

All staging variables (stage and TNM) were converted to single digit forms eg M1 not M1a; Stage 3 not Stage 3a. In TNM staging any variable that was not numerical was considered to be missing eg Tx, T9, Nx, N9, Mx and M9. Welsh data was submitted directly as pre-treatment and pathological TNM with staging 1-4 created from pre-treatment TNM.

The following tables (1 and 2) show how pre-treatment and pathological TNM variables were created from RCRD and NCRD variables for people diagnosed in England.

Table 1: Staging from NCRD

	Pre-treatment TNM			Pathological TNM			
	Primary Source	**If Primary Source missing updated from**		**Primary Source**	**If Primary Source missing updated from**		
		1	**2**		**1**	**2**	**3**
T	T_best	T_img	T_path	T_path	T_best		
N	N_best	N_img	N_path	N_path	N_best		
M	M_best	M_img	M_path	M_path	Derived pre-treatment M	M_best	Stage_best 1-3 = M0 4 = M1

TNM_best TNM stage flagged by the registry as the 'best' TNM stage
TNM _img pre-treatment TNM
TNM _path pathology TNM
Stage_best best 'registry' stage at diagnosis of the tumour

Table 2: Staging from RCRD

	Pre-treatment TNM [a]			Pathological TNM [b]			
	Primary Source	**If Primary Source missing updated from***		**Primary Source**	**If Primary Source missing updated from****		
		1	**2**		**1**	**2**	**3**
T	T_best	T_img	T_path	T_path	T_best		
N	N_best	N_img	N_path	N_path	N_best		
M	M_best	M_img	M_path	M_path	Derived pre-treatment M	M_best	Stage_rapid 1-3 = M0 4 = M1

[a] Pre-treatment TNM derived from the RCRD pathway dataset event_type 21
* If date of record within 62 days of diagnosis
[b] Pathological TNM primary source is COSD with TNM_best from the RCRD pathway dataset event_type 21and stage_rapid from RCRD tumour dataset
** 2 days prior to surgery to 62 days after surgery

Linked Data Sources

Hospital Episode Statistics Admitted Patient Care/Patient Episode Database Wales (HES-APC/PEDW)

HES-APC and PEDW are administrative databases that contain information about all hospital admissions and are derived centrally from data submitted by the hospital that they were admitted to. Linking audit data to HES-APC/PEDW allows the audit to obtain additional information about outcomes for people with bowel cancer such as emergency readmissions, returns to theatre, chemotherapy use, severe acute toxicity after chemotherapy, and stoma provision.

The mode of admission (elective or emergency) and number of co-morbidities (reported according to the RCS Charlson co-morbidity score) are both derived from HES-APC/PEDW for use in risk-adjustment. Ethnicity information for people diagnosed with bowel cancer in Wales is only available from PEDW.

Office for National Statistics (ONS)

Mortality data from the ONS was provided directly by Wales, whereas it forms part of both NCRD and RCRD. Cause of death is used within the measurement of cancer-specific survival to classify deaths as cancer-related or other.

Radiotherapy Dataset (RTDS)

RTDS contains detailed information about radiotherapy treatment received in England, including anatomical site, treatment intent, first appointment date, number of attendances, prescribed and actual doses, and which type of radiotherapy was used. Information on the complete dataset can be accessed here.

Systemic Anti-Cancer Therapy (SACT)

The SACT dataset contains information about chemotherapy treatment received in England, such as regimen type, planned and actual number of cycles, dose, and route of administration. Information on the dataset can be accessed here. SACT is not available for patients treated in Wales and so all chemotherapy information for Wales has been taken from PEDW.

Information from SACT was supplemented with HES-APC/ PEDW data to identify adjuvant chemotherapy use in patients undergoing major resection for stage III cancer, according to the OPCS-4/ ICD-10 codes in Supplementary Table 2.

Regimen start dates in SACT/ HES-APC/ PEDW were compared to dates of diagnosis and surgery to determine whether chemotherapy was given in the neo-adjuvant or adjuvant setting, or as standalone treatment.

Inclusion /Exclusion Criteria

People are potentially eligible for inclusion in the audit if they have one of the following ICD10 diagnostic codes for bowel cancer within their cancer registration record:

- C18 Malignant neoplasm of colon*
- C19 Malignant neoplasm of rectosigmoid junction
- C20 Malignant neoplasm of rectum

* C181 (Appendix) records were excluded from the NCRD dataset but not from RCRD (which only provides 3-character ICD-10 codes)

The following groups were excluded from all datasets

- Age <18 years at the time of diagnosis
- Presence of a specified morphology code indicating sarcoma, lymphoma, melanoma, neuroendocrine/carcinoid tumours, or others listed in Supplementary Table 3
- English data : FINAL_ROUTE (RCRD) recorded as “death certificate only” or BASISOFDIAGNOSIS (NCRD) as “Death certificate”

The main cohort analysed in this report is those with a recorded date of diagnosis of bowel cancer between 01 April 2022 and 31 March 2023. Individual performance indicators have their own reporting period (based on date of diagnosis or surgery as appropriate), but in general the reporting period for each indicator has moved on one year to follow on from the State of the Nation report published in February 2024.

Statistical analysis

Most results in this audit report are descriptive. The results of categorical data items are reported as percentages (%). The denominator of these proportions is, in most cases, the number of eligible people for whom the value of the data item was not missing.

All statistical analyses were performed using Stata version 17.0.

Data completeness

Data completeness is defined as the proportion of people undergoing major resection for bowel cancer with complete data for the variables age, sex, performance status, pathological TNM stage (tumour, node, metastasis staging) and site of cancer (the seven variables used for risk-adjustment present within cancer datasets). Note that previously ASA grade was used for risk-adjustment and not performance status. This change is because of poor data completeness for ASA grade in the English cancer datasets (NCRD and RCRD). Justification for this change is given in Section 9

Amongst people with bowel cancer undergoing major surgery on or before 30 June 2023, 21.3% were missing performance status, 20.9% were missing TNM T-stage, 20.2% were missing TNM N-stage and 7.7% were missing TNM M-stage. Mode of admission and Charlson co-morbidity score came from HES-APC/PEDW and were only missing in patients who were not linked to HES-APC/PEDW. All people with bowel cancer had complete data on sex, age, and site of cancer.

Data completeness for the 7 key data items peaked prior to the Covid-19 pandemic and since then has been stable at a level similar to that between 2017 and 2019 (Table 3). Data completeness by trust/MDT can be found in Data Table 1

Table 3: Data completeness by audit year (RCRD)

	2018-19		2019-20		2020-21		2021-22		2022-23	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total undergoing major resection*	21,376		22,676		19,516		23,890		21,702	
Complete data on 7 key items	13,247	62.0	15,041	66.3	13,067	67.0	16,117	67.5	13,432	61.9
Data completeness if TNM M-stage recorded	13,247	69.3	15,041	71.9	13,067	72.6	16,117	73.2	13,432	66.9

Case Ascertainment rounded to nearest whole number

***** Total restricted to those eligible for HES/PEDW/ONS linkage, but no restriction on date of surgery

Handling missing data

Multiple imputation using chained equations was used to fill in missing risk factor information for any adjusted outcomes reported at trust/MDT level. This method uses other risk factors recorded for the individual to predict missing information, whilst taking into account the uncertainty due to missing information.

In addition to the variables in the risk-adjustment model and the outcomes, the following variables were included in the imputation model: pre-treatment staging, surgical procedure, number of lymph nodes extracted, number of positive lymph nodes extracted, quintile of deprivation (based on the relevant Index of Multiple Deprivation (national ranking of residential area measuring its relative deprivation across seven domains for England and eight domains for Wales), length of hospital stay, time from diagnosis to surgery, and source of data (England/Wales). The proportions of missing data which required multiple imputation are detailed in the previous section for people with bowel cancer undergoing major surgery.

Results are typically grouped by cancer alliance/Wales and/or trust/MDT. England's 20 cancer alliances were used in the analyses, and compared to Wales as a nation. The results for Wales are reported according to where the multidisciplinary team who discussed the patients' management were located, rather than by trust/hospital.

Adjusted outcomes

Updated risk adjustment model

In previous annual reports, a published peer-reviewed model for risk adjustment of post-operative mortality in people with bowel cancer was used. The variables included in this model were age, sex, ASA grade, Charlson co-morbidity score, mode of admission, pathological TNM stage, and site of tumour. An interaction between age and distant metastases was also included in the model. This is because once people have metastatic disease the effect of age is found to be far less important than in people without metastases.

Due to poor data completeness of ASA grade in the RCRD, it was not possible to use this variable in the risk-adjustment model. WHO performance status[1] was selected as an alternative to ASA grade (Table 4).

Table 4: WHO performance status classification

The WHO performance status classification	
0	Able to carry out all normal activity without restriction
1	Restricted in strenuous activity but ambulatory and able to carry out light work
2	Ambulatory and capable of all self-care but unable to carry out any work activities; up and about more than 50% of waking hours
3	Symptomatic and in a chair or in bed for greater than 50% of the day but not bedridden
4	Completely disabled; cannot carry out any self-care; totally confined to bed or chair

The performance of the updated model (Table 5) was compared to the published peer-reviewed model. The analysis included people with a primary diagnosis of bowel cancer between 1 April 2017 and 31 March 2022 in NBOCA data, and who underwent a major resection. The primary outcome was 90-day mortality.

Calibration of the models were checked using the Hosmer-Lemeshow (HL) test which plots observed versus predicted mortality in deciles of predicted risk. The $\chi 2$ statistic from the Hosmer–Lemeshow (HL) test cannot be combined over imputation sets using Rubin's rules. Instead, an F statistic was constructed, based on the mean $\chi 2$ statistic across imputations The area under the receiver operating characteristic (ROC) curve, the C-index, was used to assess discrimination of the models. The C-index was pooled over imputed datasets using Rubin's rules.

[1] Oken MM, Creech RH, Tormey DC, Horton J, Davis TE, McFadden ET, Carbone PP. Toxicity and response criteria of the Eastern Cooperative Oncology Group. Am J Clin Oncol. 1982 Dec;5(6):649-55. PMID: 7165009.

Table 5: Variables used for risk-adjusted outcomes in the original and updated model

Multivariable Regression Model Variables		
	Original model	Updated model
Individual Characteristics	Age (modelled as age plus age-squared) Sex	Age (modelled as age plus age-squared) Sex
Morbidity and Presentation	**A**SA grade Charlson co-morbidity score (according to HES/PEDW) Mode of admission (according to HES/PEDW)	**Performance status** Charlson co-morbidity score (according to HES/PEDW) Mode of admission (according to HES/PEDW)
Cancer	T-stage (pathological) N-stage (pathological) M-stage (pathological) Site of tumour	T-stage (pathological) N-stage (pathological) M-stage (pathological) Site of tumour

The measures of model performance were similar in both models (Table 6). The F-statistic of the combined HL test gave statistical evidence of lack of fit in both models (P <0.05). Although there was statistical evidence of a lack of fit, the difference between the observed and predicted risk was smaller than 0.5% for all deciles across both models, which is not large enough to be clinically important. Based on these results, and the poor data completeness of ASA grade in English cancer data, it was decided to use the updated model for risk-adjustment of outcomes in the State of the Nation report.

Table 6: Model performance comparing the original and updated models

N= 92,916	Pooled C-statistic (95% CI)	HL test P-value
Original model (ASA grade)	0.822 (0.816-0.829)	<0.001
Updated model (WHO performance status)	0.815 (0.809-0.822)	0.002

Risk-adjusted outcomes

Using the updated model, multivariable logistic regression was carried out to estimate risk-adjusted 90-day post-operative mortality, 30-day emergency readmission, 30-day unplanned return to theatre, and 18-month unclosed diverting ileostomy rates by trust/MDT.

A Poisson model, using the updated model, was fitted to estimate risk-adjusted two-year all-cause mortality after major surgery. Unlike the other outcomes, two-year all-cause mortality rate accounts for the length of time each patient was followed up for. The observed two-year all-cause mortality is the number of people with bowel cancer who died within two years divided by the sum of the amount of time each person is followed for. For example, in two trusts/MDTs with the same proportion of people with bowel cancer dying within two years, the site in which people die earlier will have a higher two-year all-cause mortality rate.

The model for two-year all-cause mortality additionally included interactions between epoch (0-3 months after surgery vs. 3-24 months after surgery) and all of the risk factors, to allow each risk factor to have a different effect dependent on time from surgery. For example, the effect of performance status is much larger peri-operatively than in the longer-term, whilst cancer stage has a bigger influence on mortality long-term. The model for 18-month stoma rate did not include cancer site as it includes only people with rectal cancer.

Records with missing date of surgery were excluded, and multiple imputation was used to fill in any missing information on the risk factors (see Section 6).

Organisations were excluded from the analyses if overall data completeness was less than 20%, or performance status and/or TNM stage was missing in more than 80% of records included in the analyses. A list of these organisations is available here.

Funnel plots

Funnel plots were used to make comparisons between trust/MDT on the following outcomes: 90-day mortality after major resection; 30-day emergency readmission after major resection; two-year all-cause mortality rate after major resection; two-year cancer-specific mortality rate after major resection; adjuvant chemotherapy for stage III colon cancer; severe acute toxicity; unplanned return to theatre; and 18-month unclosed diverting ileostomy rate. The outcome for each trust/MDT is plotted against the total number of people used to estimate the outcome. The 'target' is specified as the average outcome across all trust/MDTs.

The funnel limits depend on the target and the number of people with bowel cancer included in the estimate; estimates have greater uncertainty when estimated from fewer people. Results fall outside the inner limits if they are statistically significantly different from the target at a 0.05 level, and outside the outer limits if they are statistically significantly different from the target at a 0.002 level.

When funnel plots are used for outlier reporting, the inner funnel limit is the threshold for an "alert" and the outer funnel level is the threshold for an "alarm". This implies that 95 per cent of trusts/MDTs are expected to be within the inner funnel limits and 99.8 per cent within the outer funnel limits, if they are all performing according to the target. If outlier reporting is being conducted, trusts/MDTs with results outside the outer (99.8%) funnel limit or above the inner (95.0%) limit on two occasions within the previous three years are considered potential outliers as per the NBOCA Outlier Policy.

Performance Indicators

The NBOCA performance indicators are part of the Quality Improvement Plan. This plan aims to involve all members of the multidisciplinary clinical team managing people with bowel cancer, covering all areas of the treatment pathway, from diagnosis and perioperative care to adjuvant and neo-adjuvant oncological management, stage IV disease and end of life care.

The indicators reported by the National Bowel Cancer Audit (NBOCA) at trust/site/MDT level on the Trust Results pages of the NBOCA website and in the NBOCA Annual/ State of the Nation Reports report on:

1. Data quality
2. Management of all patients
3. Management of patients undergoing major resection
4. Management of rectal cancer patients
5. Patient Outcomes

In the State of the Nation Report, two types of indicator are reported (all at trust/MDT level):

1. Performance Indicators
2. Contextual measures: indicators that provide further context to the results

In order to be published at trust/site/MDT level all indicators require data on a minimum of 10 cases once other exclusions have been applied. Unless otherwise stated the indicator is reported by the organisation performing surgery.

Performance Indicators

* Outlier reported unless otherwise stated in the State of the Nation report/ FAQs

Table 8A

Title	**Clinical nurse specialist review**	
Type of indicator / patient group	Management of all patients	
Indicator	Proportion of people with colorectal cancer seen by a clinical nurse specialist	
Specification	**Numerator**	Number of people with colorectal cancer reported to have been seen by a clinical nurse specialist
	Denominator	Number of people diagnosed with colorectal cancer
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023. Reported by diagnosing organisation.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	Improving the diagnostic pathway
	Risk adjusted	No
	Outlier reporting	No
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Patients with colorectal cancer should meet and have access to a CNS as 'Key Worker' for advice and support from the time of their initial diagnosis."*

Table 8B

Title	**Number of rectal cancer major resections**	
Type of indicator / patient group	Management of rectal cancer patients	
Indicator	The number of people with rectal cancer undergoing a major resection	
Specifications	**Numerator**	Number of people with rectal cancer undergoing major resection
	Denominator	NA
	Further Information	Date of major resection between 01 April 2022 and 31 March 2023.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	Improving perioperative care
	Risk adjusted	No
	Outlier reporting	No
	Guideline	National Institute for Health and Care Excellence. Clinical guideline [NG151] (2020) *"Offer surgery to people with rectal cancer (cT1-T2, cN1-N2, M0, or cT3-T4, any cN, M0) who have a resectable tumour."* *"Hospitals performing major resection for rectal cancer should perform at least 10 of these operations each year."*

Table 8C

Title	**90-day mortality**	
Type of indicator / patient group	Patient Outcomes	
Indicator	Proportion of people with bowel cancer who die within 90-days of major resection	
Specifications	**Numerator**	Number of people with bowel cancer undergoing major resection who die within 90 days of surgery
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023 and underwent major resection by 30 June 2023. Records with invalid date of surgery because the date of surgery is reported to be after date of death, or where the date of surgery/death is missing are excluded. Hospitals/MDTs with <20% data completeness overall, or >80% records missing performance status and/or TNM staging only have their unadjusted result published.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	Improving perioperative care
	Risk adjusted	Yes
	Outlier reporting	Yes*
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Colorectal units should expect to achieve an operative mortality of less than 20% for emergency surgery and less than 5% for elective surgery for colorectal cancer."*

Days to death calculated by counting the number of days between recorded date of surgery and date of death.

Table 8D

Title	**30-day unplanned return to theatre**	
Type of indicator / patient group	Patient Outcomes	
Indicator	Proportion of people with bowel cancer who have an unplanned return to theatre within 30-days of their major resection	
Specifications	**Numerator**	Number of people with bowel cancer with any OPCS code for reoperation in HES-APC/PEDW within 30 days of surgery
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023 and underwent major resection by 30 June 2023. Records that could not be linked to HES-APC/PEDW are excluded. Hospitals/MDTs with <20% data completeness overall, or >80% records missing performance status and/or TNM staging only have their unadjusted result published.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	Improving perioperative care
	Risk adjusted	Yes
	Outlier reporting	Yes*
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Colorectal units should audit their leak rate for colorectal cancer surgery."*

The OPCS codes used to define 30-day unplanned re-operation within HES-APC/PEDW are shown in Supplementary Table 4. The majority of listed OPCS codes are only valid on days 1-30 after surgery to avoid classifying procedures which were part of the original major surgery as an unplanned reoperation. Further details of validation performed using a combined NBOCA-NELA dataset were published in the 2019 methodology supplement.

Table 8E

Title	**30-day unplanned readmission**	
Type of indicator / patient group	Patient Outcomes	
Indicator	Proportion of people with bowel cancer who have an emergency admission for any cause within 30-days of their major resection	
Specifications	**Numerator**	Number of people with bowel cancer who had an emergency admission for any cause, to any trust, within 30 days of their major resection
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023 and underwent major resection by 30 June 2023. Records that could not be linked to HES-APC/PEDW are excluded. Hospitals/MDTs with <20% data completeness overall, or >80% records missing performance status and/or TNM staging only have their unadjusted result published.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	Improving perioperative care
	Risk adjusted	Yes
	Outlier reporting	Yes*
	Guideline	Unplanned readmissions are regarded as a quality metric for surgical care.

30-day unplanned readmission is defined as an emergency admission to any hospital for any cause within 30 days of surgery. Emergency admissions include those via Accident and Emergency, general practitioners, bed bureaus (point of contact for GPs to arrange urgent admission), or consultant outpatient clinics (“admimeth” 21 – 28 including 2A, 2B, 2D).

Feedback received during NBOCA annual report outlier analysis highlighted differences in the coding of discharge method in PEDW compared to HES-APC. Patients with multiple episodes for the same admission in PEDW are often coded as “discharged” at the end of each episode, despite remaining in hospital, leading to subsequent episodes within the same admission being incorrectly captured by NBOCA as readmissions. NBOCA methodology was updated in 2022 to ensure that multiple episodes of the same admission in PEDW are not coded as multiple hospital admissions.

Table 8F

Title	**18-month unclosed ileostomy**	
Type of indicator / patient group	Patient Outcomes	
Indicator	Proportion of people with rectal cancer who have an unclosed ileostomy 18-months after their anterior resection	
Specifications	**Numerator**	People with rectal cancer without a procedure code for stoma reversal within 18-months of surgery, according to HES-APC/PEDW
	Denominator	People with rectal cancer undergoing an anterior resection according to NBOCA receiving an ileostomy within 30 days of their procedure, according to HES-APC/PEDW
	Further Information	Diagnosis between 01 January 2017 and 31 December 2021 with anterior resection performed between 01 April 2017 and 31 March 2022. Records that could not be linked to HES-APC/PEDW are excluded. Hospitals/MDTs with <20% data completeness overall, or >80% records missing performance status and/or TNM staging only have their unadjusted result published.
	Data Sources	England: NCRD received 2023 Wales: Data received 2023
	QI aim	Improving perioperative care
	Risk adjusted	Yes
	Outlier reporting	Yes*
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"After low anterior resection, a temporary defunctioning stoma should be considered."* *"The permanent stoma rate following rectal cancer resection of colorectal units should be audited."*

HES-APC/PEDW data is used to capture whether those recorded as undergoing an anterior resection received a stoma within 30 days of their procedure; if this stoma was recorded as an ileostomy the individual was eligible for inclusion (the denominator).

HES-APC/PEDW was then used to capture whether any stoma was formed within 18 months of anterior resection (G74, H151, H152, H331) and whether this was reversed. Those without a procedure code for any stoma reversal (G753, H154) within 18-months of surgery were assumed to have a stoma at 18 months (numerator).

Table 8G

Title	**Adjuvant chemotherapy**	
Type of indicator / patient group	Management of patients having major resection	
Indicator	Proportion of people with stage III colon cancer undergoing major resection who have adjuvant chemotherapy	
Specifications	**Numerator**	Number of people with stage III colon cancer receiving adjuvant chemotherapy according to either SACT or HES-APC in England / according to PEDW in Wales
	Denominator	People with stage III colon cancer undergoing major resection
	Further Information	Major resection performed between 01 April 2020 and 30 November 2022. Reported by organisation performing surgery
	Data Sources	England: RCRD received May 2024 Wales: Data received 2023 and 2024
	QI aim	Improving oncological care
	Risk adjusted	No
	Outlier reporting	No
	Guideline	National Institute for Health and Care Excellence. Clinical guideline [NG151] (2020) *"For people with stage III colon cancer (pT1-4, pN1-2, M0) offer adjuvant chemotherapy."* ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Adjuvant chemotherapy should be considered in older patients with stage III colorectal cancer, with appropriate tailoring of treatment."*

People were considered to have received adjuvant chemotherapy if they had a linked SACT record demonstrating receipt of a standard adjuvant colorectal chemotherapy regimen within 4 months after their date of surgery. Alternatively, they could have a chemotherapy code (OPCS-4 procedural code) recorded within the same 4 month period within HES-APC or PEDW. Regimens considered to be standard adjuvant therapy included: 5-fluorouracil alone, 5-fluorouracil and oxaliplatin (FOLFOX), capecitabine alone or capecitabine and oxaliplatin (CAPOX). OPCS codes in Supplementary Table 2

Full details have been published here.

Table 8H

Title	**Severe acute toxicity after adjuvant chemotherapy for stage III colon cancer**	
Type of indicator / patient group	Management of patients having major resection	
Indicator	Proportion of people receiving adjuvant chemotherapy for stage III colon cancer with severe acute toxicity	
Specifications	**Numerator**	Number of peoples with severe acute toxicity in overnight admissions in HES-APC/ PEDW from the first cycle of chemotherapy to 8 weeks after the last cycle of chemotherapy
	Denominator	Number of people receiving adjuvant chemotherapy according to either SACT or HES-APC in England / according to PEDW in Wales (adjuvant chemotherapy numerator)
	Further Information	Major resection performed between 01 April 2020 and 30 November 2022. Reported by organisation delivering chemotherapy
	Data Sources	England: RCRD received May 2024 Wales: Data received 2023 and 2024
	QI aim	Improving oncological care
	Risk adjusted	Yes
	Outlier reporting	No
	Guideline	Boyle JM, et al. Measuring variation in the quality of systemic anti-cancer therapy delivery across hospitals: A national population-based evaluation. Eur J Cancer. 2023 Jan;178:191-204. The delivery of adjuvant chemotherapy is a complex process which includes appropriate patient selection and optimisation, tailoring treatment doses, and the monitoring and management of toxicities. NBOCA have developed and evaluated the use of a national performance indicator to assess hospital variation in severe acute toxicity rates in order to stimulate and support quality improvement.

This measures the proportion of people who received adjuvant chemotherapy for stage 3 colorectal cancer that required an overnight hospital admission for severe acute toxicity. Severe acute toxicity was determined from International Classification of Diseases, 10th revision (ICD-10) diagnosis codes in HES-APC/PEDW. The methodology for developing and validating the coding framework for identifying severe acute toxicity is described in detail here.

Any planned or unplanned admissions requiring an overnight stay, from administration of the first cycle of chemotherapy up until 8 weeks after the last cycle of chemotherapy, were examined to identify ICD-10 diagnosis codes from the severe acute toxicity coding framework. Toxicities corresponded to at least Grade 3 according to the Common Terminology Criteria for Adverse Events (CTCAE) (CTCAE) dictionary.

For the small proportion of people undergoing a surgical procedure during this timeframe, the date of this surgery was used as the cut-off for identifying toxicities to ensure that post-operative complications were not captured.

Risk-adjustment for this performance indicator includes age, sex, number of comorbidities, performance status, tumour site, and staging.

This outcome is reported by the organisation coded as delivering chemotherapy rather than the diagnosing or surgical trust. In some areas of England and Wales, specific organisations are responsible for chemotherapy delivery for patients who underwent their surgery elsewhere.

Table 8I

Title	**Neo-adjuvant therapy**	
Type of indicator / patient group	Management of rectal cancer patients	
Indicator	The proportion of people with rectal cancer undergoing a major resection who receive pre-operative radiotherapy	
Specifications	**Numerator**	The number of people with rectal cancer undergoing major resection who receive pre-operative radiotherapy according to either RTDS (England) or submitted data (Wales)
	Denominator	Number of people with rectal cancer undergoing major resection
	Further Information	Date of diagnosis between 01 January 2022 and 31 December 2022.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2023 and 2024
	QI aim	Improving oncological care
	Risk adjusted	No
	Outlier reporting	No
	Guideline	National Institute for Health and Care Excellence. Clinical guideline [NG151] (2020) *"Offer preoperative radiotherapy or chemoradiotherapy to people with rectal cancer that is cT1-T2, cN1-N2, M0, or cT3-T4, any cN, M0."*

At the time of analysis, RTDS data was only available for patients who received their radiotherapy in England. The equivalent data source for Wales will be available to NBOCA in the future, but for this report, directly submitted data has been used to determine use of radiotherapy in Wales (type of radiotherapy and start date).

In general, treatment episodes for rectal cancer were grouped into long-course, short-course and other, based on the number of attendances. The audit date of surgery was used to distinguish between radiotherapy only, pre-operative radiotherapy, and post-operative radiotherapy for rectal cancer. RTDS data and SACT data was used as the basis of the first definitive non-surgical treatment for rectal cancer patients.

Previously RTDS data was only available in calendar years therefore, for consistency, analyses that use RTDS data are presented for those diagnosed between 01 January and 31 December 2022.

Table 8J

Title	**2-year survival rate**	
Type of indicator / patient group	Patient Outcomes	
Indicator	2-year survival rate after major resection	
Specifications	**Numerator**	Number of people with bowel cancer undergoing major resection who are alive 2 years after surgery
	Denominator	The sum of the time each person was followed up for in the two years following their major resection
	Further Information	Major resection performed between 01 April 2020 and 31 March 2021. Records with invalid date of surgery because the date of surgery is reported to be after date of death, or where the date of surgery/death is missing are excluded. Hospitals/MDTs with <20% data completeness overall, or >80% records missing performance status and/or TNM staging only have their unadjusted result published.
	Data Sources	England: NCRD received 2023 Wales: Data received 2023
	QI aim	Improving oncological care
	Risk adjusted	Yes
	Outlier reporting	Yes*
	Guideline	Shulman LN, et al. Survival As a Quality Metric of Cancer Care: Use of the National Cancer Data Base to Assess Hospital Performance. J Oncol Pract. 2018 Jan;14(1):e59-e72. "2-year all-cause mortality rate after major resection is an important quality metric of cancer care."

The observed two-year all-cause mortality rate is the number of people who died within two years of surgery divided by the sum of the amount of time each person undergoing surgery is followed for. The inverse of this (1 – “two-year all-cause mortality”) is the two-year all-cause survival rate.

Taking into account the amount of follow-up time means that the estimate compares not just the proportion of people who died within 2 years but also how soon after surgery they died eg if two trusts/ MDTs have the same proportion dying within two years, the site in which they die earlier will have a lower two-year all-cause survival rate.

Contextual Measures

Table 8K

Title	**Data completeness of seven items for risk-adjustment in those undergoing major surgery**	
Type of indicator / patient group	Data quality	
Indicator	The proportion of people with bowel cancer with complete data for the variables required for risk-adjustment: age, sex, performance status, pathological TNM stage (tumour, node, metastasis staging) and site of cancer	
Specification	**Numerator**	Number of people with bowel cancer with completion of 7 data items for risk-adjustment
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Audit and Outcome Reporting *"Surgeons and trusts must make provisions for the prospective collection of accurate clinical data for submission to the NBOCA."*

Table 8L

Title	**Minimally invasive surgery**	
Type of indicator / patient group	Data quality	
Indicator	The proportion of people with bowel cancer undergoing major resection who are reported to have undergone minimally invasive surgery	
Specifications	**Numerator**	Number of people with bowel cancer who underwent minimally invasive surgery according to HES-APC (England) or PEDW/submitted data (Wales)
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023. Records that could not be linked to HES-APC/PEDW or that were missing surgical access data for major resection are included in the denominator.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	Laparoscopic surgery for colorectal cancer (NICE technology appraisal guidance TA105) (2006) *"Laparoscopic (including laparoscopically assisted) resection is recommended as an alternative to open resection for individuals with colorectal cancer in whom both laparoscopic and open surgery are considered suitable."* ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Laparoscopic resection should be considered in all patients with colon cancer. This should be performed by suitably trained, experienced surgeons who should audit outcomes and submit results to the NBOCA database."*

The COSD variable SURGICAL ACCESS TYPE was poorly completed, therefore HES-APC was used to obtain information about surgical access for those undergoing surgery in England.

The following OPCS codes were considered to represent minimally invasive surgery: Y75.1, Y75.2, Y75.3, Y75.4, Y75.8, Y75.9, and Y76.5, when present on the date of major resection in HES-APC/ PEDW.

Compared to the proportion of people reported to have undergone minimally invasive surgery within the data submitted by Wales, there was undercapture within PEDW, especially of laparoscopic procedures converted to open. Therefore, records in the Welsh data that did not have an OPCS code record of minimally invasive surgery were updated to minimally invasive if this was reported in the submitted data.

Table 8M

Title	**Length of stay**	
Type of indicator / patient group	Management of all patients	
Indicator	Proportion of people with bowel cancer with length of hospital stay after major resection greater than five days	
Specifications	**Numerator**	Number of people with bowel cancer undergoing major resection with length of stay in HES-APC/PEDW greater than five days after major resection
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023 and underwent major resection by 30 June 2023. Records where length of stay could not be determined from HES-APC/PEDW, either because they could not be linked to HES-APC/PEDW or because the date of discharge was recorded as before the date of surgery in HES-APC/PEDW are excluded.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Peri-operative care in elective surgery should be based on ERAS principles."*

Length of stay is calculated by counting the number of days between recorded date of surgery and date of discharge in HES-APC/PEDW.

Table 8N

Title	**Data completeness of performance status**	
Type of indicator / patient group	Data quality	
Indicator	The proportion of people with bowel cancer with recorded performance status	
Specification	**Numerator**	Number of people with bowel cancer with recorded performance status
	Denominator	Number of people diagnosed with bowel cancer
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023. Reported by diagnosing organisation.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Audit and Outcome Reporting *"Surgeons and trusts must make provisions for the prospective collection of accurate clinical data for submission to the NBOCA."*

Table 8O

Title	**Data completeness of staging data**	
Type of indicator / patient group	Data quality	
Indicator	The proportion of people with bowel cancer with stage recorded (stage 1-4)	
Specification	**Numerator**	Number of people with bowel cancer with stage 1-4 recorded
	Denominator	Number of people diagnosed with bowel cancer
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023. Reported by diagnosing organisation.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Audit and Outcome Reporting *"Surgeons and trusts must make provisions for the prospective collection of accurate clinical data for submission to the NBOCA."*

Table 8P

Title	**Distant metastases at time of surgery**	
Type of indicator / patient group	Management of patients having major resection	
Indicator	Proportion of people with bowel cancer undergoing major resection who have distant metastases at the time of surgery	
Specifications	**Numerator**	Number of people with bowel cancer undergoing major resection recorded as M1 on pathological staging, or with missing pathological M-stage and M1 on pre-treatment staging
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Date of diagnosis between 01 April 2022 and 31 March 2023. M-stage recorded as Mx or M9 are recorded as missing. Those missing pre- and post- treatment staging are included in the denominator.
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	National Institute for Health and Care Excellence. Clinical guideline [NG151] (2020) *"Consider resection, either simultaneous or sequential, after discussion by a multidisciplinary team with expertise in resection of disease in all involved sites."* ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Surgical Management *"Synchronous and metachronous liver or lung metastases should be considered for potentially curative treatments."*

Table 8Q

Title	**Lymph node yield**	
Type of indicator / patient group	Management of patients having major resection	
Indicator	Proportion of people with bowel cancer undergoing major resection where ≥12 lymph nodes are pathologically examined	
Specifications	**Numerator**	Number of people with bowel cancer undergoing major resection where ≥12 lymph nodes are pathologically examined
	Denominator	Number of people with bowel cancer undergoing major resection
	Further Information	Records with no lymph yield recorded are included in the denominator
	Data Sources	England: RCRD received May 2024 Wales: Data received 2024
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	ACPGBI: Guidelines for the Management of Cancer of the Colon, Rectum and Anus (2017) – Multidisciplinary Management *"Known high-risk features in stage II cancers include pT4 stage, obstructed tumours, poor or mucinous differentiation, EMVI and fewer than 12 lymph nodes assessed histologically."*

Table 8R

Title	**Abdominoperineal resection (APER)/ Hartmann's**	
Type of indicator / patient group	Management of rectal cancer patients	
Indicator	Proportion of people with rectal cancer undergoing major resection who undergo APER/pelvic exenteration/Hartmann's	
Specifications	**Numerator**	Number of people with rectal cancer undergoing major resection who have an APER/ pelvic exenteration/ Hartmann's
	Denominator	Number of people with rectal cancer undergoing major resection
	Further Information	Diagnosis between 01 January 2017 and 31 December 2021 with major resection performed between 01 April 2017 and 31 March 2022.
	Data Sources	England: NCRD received 2023 Wales: Data received 2023
	QI aim	N/A
	Risk adjusted	No
	Outlier reporting	No
	Guideline	Not applicable

2-year cancer specific survival rate

Cancer-specific mortality rate was defined as death from any cause within 90 days of surgery, or death with bowel cancer or cancer of an unspecified site as the underlying cause in the 91 days to two years after surgery. ONS defines the underlying cause of death as “the disease or injury which initiated the train of morbid events leading directly to death”. The observed two-year cancer-specific mortality rate for a trust/MDT is calculated by dividing the number of people with a cancer-specific death within two years of surgery divided by the sum of the amount of time each person undergoing surgery is followed up for. The inverse of this (1 – “two-year cancer-specific mortality”) is the two-year cancer-specific survival rate.

Risk-adjustment was carried out using indirect standardisation (Section 9). A competing risks flexible parametric survival model, with death from other causes as the competing event, was used to estimate the expected number of cancer-specific deaths for a trust/MDT. The flexible parametric survival model uses regression splines to model the baseline cause-specific hazards. Four knots were used for the splines, placed at evenly distributed centiles of the distribution of the uncensored log event times.

The risk factors in the updated risk model (Table 6) were used . The effect of the following risk factors was allowed to vary with time with three knots: TNM stage T4, TNM N stage, distant metastases, performance status 3/4.

Mismatch repair immunohistochemistry (MMR IHC) testing

This analysis uses data from the NDRS Somatic Molecular Data Set which is linked to the NCRD dataset. Data is currently available for people diagnosed up to the end of 2021. The NDRS Somatic Molecular Data Set collects data on immunohistochemistry protein tests carried out on the four mismatch repair proteins.

MMR IHC testing is only possible for people with a histological confirmation of bowel cancer. MMR testing is calculated by dividing the number of people with a record of MMR IHC testing by the total number of people with a histological diagnosis of bowel cancer. A person is considered to have been tested if they had a record of IHC testing for all four MMR proteins. Data on microsatellite instability (MSI) testing is not available at present.

Appendix

Supplementary Tables 1: Surgical OPCS codes

Procedures classified as Major Resections

Procedure group	OPCS code	Description
Right Hemi-colectomy	H06	Extended excision of right hemicolon
	H07	Other excision of right hemicolon
	H112	Colectomy and side to side anastomosis of ileum to colon NEC
	H116	Colectomy and end to side anastomosis NEC
	H118	Other specified other excision of colon
	H119	Unspecified other excision of colon
Transverse colectomy	H08	Excision of transverse colon
Left Hemi-colectomy	H09	Excision of left hemicolon
	H111	Colectomy and end to end anastomosis of colon to colon NEC
Sigmoid colectomy	H10	Excision of sigmoid colon
Total/Subtotal colectony	H04	Total excision of colon and rectum
	H05	Total excision of colon
	H29	Subtotal excision of colon
	H113	Colectomy and anastomosis NEC
	H114	Colectomy and ileostomy NEC
	H414	Peranal mucosal proctectomy and endoanal anastomosis
Anterior Resection	H115	Colectomy and exteriorisation of bowel NEC
	H332	Proctectomy and anastomosis of colon to anus
	H333	Anterior resection of rectum and anastomosis of colon to rectum using staples
	H334	Anterior resection of rectum and anastomosis NEC
	H336	Anterior resection of rectum and exteriorisation of bowel
	H338	Other specified excision of rectum
	H339	Unspecified excision of rectum
	H404	Trans-sphincteric anastomosis of colon to anus
	H411	Rectosigmoidectomy and peranal anastomosis
Hartmanns	H335	Rectosigmoidectomy and closure of rectal stump and exteriorisation of bowel
APER*	H331	Abdominoperineal excision of rectum and end colostomy
	H337	Perineal resection of rectum HFQ
Pelvic Exenteration	X14	Clearance of pelvis

*APER: Abdomino Perineal Excision of Rectum

Procedures classified as Stoma Only

OPCS code	Description
G74	Creation of artificial opening into ileum
H151	Loop colostomy
H152	End colostomy

Procedures classified as Local Excision

OPCS code	Description
H201	Fibreoptic endoscopic snare resection of lesion of colon
H205	Fibreoptic endoscopic submucosal resection of lesion of colon
H206	Fibreoptic endoscopic resection of lesion of colon NEC
H207	Fibreoptic endoscopic mucosal resection of lesion of colon
H208	Other specified endoscopic extirpation of lesion of colon
H209	Unspecified endoscopic extirpation of lesion of colon
H231	Endoscopic snare resection of lesion of lower bowel using fibreoptic sigmoidoscope
H235	Endoscopic submucosal resection of lesion of lower bowel using fibreoptic sigmoidoscope
H236	Endoscopic resection of lesion of lower bowel using fibreoptic sigmoidoscope NEC
H237	Endoscopic mucosal resection of lesion of lower bowel using fibreoptic sigmoidoscope
H238	Other specified endoscopic extirpation of lesion of lower bowel using fibreoptic sigmoidoscope
H239	Unspecified endoscopic extirpation of lesion of lower bowel using fibreoptic sigmoidoscope
H261	Endoscopic snare resection of lesion of sigmoid colon using rigid sigmoidoscope
H266	Endoscopic submucosal resection of lesion of sigmoid colon using rigid sigmoidoscope
H267	Endoscopic resection of lesion of sigmoid colon using rigid sigmoidoscope NEC
H268	Other specified endoscopic extirpation of lesion of sigmoid colon using rigid sigmoidoscope
H269	Unspecified endoscopic extirpation of lesion of sigmoid colon using rigid sigmoidoscope
H371	Endoscopic mucosal resection of lesion of sigmoid colon using rigid sigmoidoscope
H378	Other specified other endoscopic extirpation of lesion of sigmoid colon using rigid sigmoidoscope
H379	Unspecified other endoscopic extirpation of lesion of sigmoid colon using rigid sigmoidoscope
H401	Trans-sphincteric excision of mucosa of rectum
H402	Trans-sphincteric excision of lesion of rectum
H408	Other specified operations on rectum through anal sphincter
H409	Unspecified operations on rectum through anal sphincter
H412	Peranal excision of lesion of rectum
H418	Other specified other operations on rectum through anus
H419	Unspecified other operations on rectum through anus

Procedures classified as Stent insertion

OPCS code	Description
H214	Fibreoptic endoscopic insertion of expanding metal stent into colon
H243	Endoscopic insertion of tubal prosthesis into lower bowel using fibreoptic sigmoidoscope
H244	Endoscopic insertion of expanding metal stent into lower bowel using fibreoptic sigmoidoscope
H273	Endoscopic insertion of tubal prosthesis into sigmoid colon using rigid sigmoidoscope
H274	Endoscopic insertion of expanding metal stent into sigmoid colon using rigid sigmoidoscope
H314	Image guided insertion of colorectal stent

Supplementary Table 2: OPCS-4 and ICD-10 codes to identify chemotherapy in HES-APC/PEDW

OPCS-4 code	Classification
X701	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 1
X702	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 2
X703	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 3
X704	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 4
X705	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 5
X708	Other specified procurement of drugs for chemotherapy for neoplasm in Bands 1-5
X709	Unspecified procurement of drugs for chemotherapy for neoplasm in Bands 1-5
X711	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 6
X712	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 7
X713	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 8
X714	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 9
X715	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 10
X718	Other specified procurement of drugs for chemotherapy for neoplasm in Bands 6-10
X719	Unspecified procurement of drugs for chemotherapy for neoplasm in Bands 6-10
X721	Delivery of complex chemotherapy for neoplasm including prolonged infusional treatment at first attendance
X722	Delivery of complex parenteral chemotherapy for neoplasm at first attendance
X723	Delivery of simple parenteral chemotherapy for neoplasm at first attendance
X724	Delivery of subsequent element of cycle of chemotherapy for neoplasm
X728	Other specified delivery of chemotherapy for neoplasm
X729	Unspecified delivery of chemotherapy for neoplasm
X731	Delivery of exclusively oral chemotherapy for neoplasm
X738	Other specified delivery of oral chemotherapy for neoplasm
X739	Unspecified delivery of oral chemotherapy for neoplasm
X748	Other specified other chemotherapy drugs
X749	Unspecified other chemotherapy drugs
X352	Intravenous chemotherapy
X373	Intramuscular chemotherapy
X384	Subcutaneous chemotherapy
ICD-10 code	**Classification**
Z082	Follow-up exam after chemotherapy for malignant neoplasm
Z292	Other prophylactic chemotherapy
Z511	Chemotherapy session for neoplasm
Z512	Other chemotherapy
Z542	Convalescence following chemotherapy

Supplementary Table 3: Morphology codes

Supplementary Table 3 lists the morphology codes that have been excluded from both NCRD and RCRD. For the majority of these, the first three characters were extracted from the full variable and this was used to identify records for exclusion. Some of these are not related to bowel cancer, but were present in the data. The following variables were used for exclusion: TUMOUR_MORPHOLOGY (RCRD) and HISTOLOGY_CODED (NCRD).

Histology code	3 character histology code	Histology description
	872	NEVI & MELANOMAS
	873	AMELANOTIC MELANOMA
	874	MAL. MEL. IN JUNCT. NEVUS
	877	EPITHELIOID CELL MELANOMA
	824	CARCINOID TUMOR, MALIGNANT
	815	ENDOCRINOMAS
	880	SARCOMA, NOS
	881	FIBROMATOUS NEOPLASMS
	882	SARCOMA, NOS
	893	STROMAL SARCOMA
	885	LIPOSARCOMA NEOPLASMS
	889	MYOMATOUS NEOPLASMS
	898	CARCINOSARCOMA, NOS
	804	SMALL CELL CARCINOMA, NOS
	808	LYMPHOEPITHELIAL CARCINOMA
	812	TRANSITIONAL CELL CARCINOMA, NOS
	831	CLEAR CELL ADENOCARCINOMA, NOS
	832	GRANULAR CELL CARCINOMA
	838	ENDOMETRIOID ADENOCARCINOMA
	895	MULLERIAN MIXED TUMOR
	896	CLEAR CELL SARC/NEPHROBLASTOMA
80133		Large cell neuroendocrine carcinoma
80333		Pseudosarcomatous carcinoma
85743		Adenocarcinoma with neuroendocrine differentiation
>=90000		

Supplementary Table 4: OPCS codes considered to represent an unplanned return to theatre

	OPCS code											
Codes valid on day 0	G731	S572	S571	S608	T301	G731						
	S068	S424	S573	T283	T302	S068						
					T303							
Codes valid on days 1-30	G35	G711	G76	H17	H531	J72	M258	N249	S472	T282	T343	T419
	G36	G712	G78	H19	H541	L703	M264	P111	S474	T283	T348	T423
	G52	G713	G822	H29	H558	M021	M274	P131	S476	T288	T349	T428
	G53	G714	G824	H303	H568	M025	M292	P134	S478	T289	T361	T431
	G584	G715	G828	H304	H581	M062	M359	P138	S571	T301	T362	T432
	G588	G718	H04	H305	H582	M136	M37	P253	S572	T302	T365	T463
	G589	G72	H05	H308	H583	M151	M624	P258	S573	T303	T368	T468
	G591	G731	H06	H311	H588	M162	M651	Q552	S577	T304	T369	T469
	G601	G733	H07	H312	H589	M168	M733	S068	S608	T308	T374	T488
	G602	G734	H08	H33	H62	M191	M734	S242	S628	T309	T384	T554
	G608	G738	H09	H412	H662	M193	M735	S352	T252	T312	T388	T571
	G61	G74	H10	H418	J021	M202	M736	S358	T253	T313	T398	T77
	G63	G751	H11	H444	J04	M212	M737	S359	T259	T315	T411	T963
	G674	G752	H122	H448	J18	M218	M738	S422	T262	T316	T412	
	G69	G753	H13	H464	J212	M221	M763	S423	T272	T318	T413	
	G702	G754	H14	H468	J241	M223	M764	S424	T273	T331	T414	
		G755	H15	H469	J69	M228	N242	S428	T278	T341	T415	
		G758	H16	H47	J701	M229	N248	S438	T279	T342	T418	