## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>4</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>5</td>
</tr>
<tr>
<td>History</td>
<td>6</td>
</tr>
<tr>
<td>Governance</td>
<td>7</td>
</tr>
<tr>
<td>Method</td>
<td>9</td>
</tr>
<tr>
<td>Data Handling</td>
<td>9</td>
</tr>
<tr>
<td>Participating Sites</td>
<td>10</td>
</tr>
<tr>
<td>Data Submission</td>
<td>12</td>
</tr>
<tr>
<td>Patient Characteristics</td>
<td>15</td>
</tr>
<tr>
<td>Faecal Occult Blood Diagnosis (FOBT) and National Bowel Cancer Screening Program (NBCSP)</td>
<td>18</td>
</tr>
<tr>
<td>Surgical Care</td>
<td>20</td>
</tr>
<tr>
<td>Overall Colorectal Cancer</td>
<td>21</td>
</tr>
<tr>
<td>Length Of Hospital Stay</td>
<td>24</td>
</tr>
<tr>
<td>Operative Approach</td>
<td>28</td>
</tr>
<tr>
<td>Colon Cancer</td>
<td>30</td>
</tr>
<tr>
<td>Rectal Cancer</td>
<td>34</td>
</tr>
<tr>
<td>Adjuvant Therapy</td>
<td>39</td>
</tr>
<tr>
<td>Future Directions</td>
<td>40</td>
</tr>
<tr>
<td>BCCA participation</td>
<td>41</td>
</tr>
<tr>
<td>BCCA Personnel</td>
<td>42</td>
</tr>
<tr>
<td>Glossary</td>
<td>43</td>
</tr>
<tr>
<td>References</td>
<td>43</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

BCCA is funded by a combination of sources including in-kind donations from the Colorectal Surgical Society of Australia and New Zealand (CSSANZ), the Royal Australasian College of Surgeons Colon and Rectal Surgery Section and annual subscription fees paid by surgeons. Education and reporting initiatives are supported by Covidien. We also acknowledge funding from Johnson & Johnson who supported BCCA in initial years and the RACS Research, Audit and Academic Surgery Division, in particular support from Wendy Babidge, Katherine Economides and team.

This report would not have been possible without the efforts of surgeons, site managers and other relevant staff who have contributed data to BCCA.

The management committee (Colorectal Cancer Audit Committee) is also gratefully acknowledged and details of personnel can be found on page 41. In particular, Andrew Hunter who chaired this committee until September 2013, Liz Neilson, General Manager of CSSANZ, and the CSSANZ, for their ongoing support.
EXECUTIVE SUMMARY

The Bi-National Colorectal Cancer Audit (BCCA) contains data on over 10,000 patients with colorectal cancer who were diagnosed between 2007 and 2014. The BCCA moved to an online system of data entry at the beginning of 2014 which has increased access for contributing surgeons and allowed surgeons and units to instantaneously benchmark their outcome against the rest of the patients contained within the database. This change in submission process has been accompanied by changes in governance structure to support the potential change in the role of the audit to that of a registry, with a focus on quality. The current data represents around 10% of all the new colorectal cancer cases over this time period.

The majority of patients were over 50 years of age at diagnosis however there were still a significant number of patients developing colorectal cancer under the age of 50, and even under the age of 40. Rectal tumours represent 30% of the total colorectal cancers and approximately 12% of patients have metastatic disease at presentation, which is lower than would be expected. Patients who have been diagnosed through Faecal Occult Blood Testing (FOBT) through the National Bowel Cancer Screening Program (NBCSP) demonstrate a stage shift to diagnosing earlier stage tumours compared to the overall group.

Surgery remains the primary treatment for the majority of patients with colorectal cancer. In-hospital mortality demonstrates a spectrum of rates, with mortality reducing with increased patient submission to the database. This could be considered one of a number of surrogate quality markers but will be risk adjusted in future reports. The mortality rates appear strongly related to the admission category (elective, urgent, or emergency), with the mortality rate of emergency cases over four times that of elective cases.

Overall length of hospital stay (LOS) has not reduced between 2007 and 2014 despite the increasing prevalence of Enhanced Recovery after Surgery (ERAS) programs that have been shown to directly reduce length of stay in other countries. This remains an area of potential financial savings that requires exploration. Site of the primary tumour directly influences LOS, with a progressive increase in LOS as the tumour site moves round the colon, from caecum to rectum. This may represent the scale of surgery which increases moving round from the right colon to the pelvis or the fact that rectal resections often necessitate the requirement of a stoma which itself requires hospital time for patient education. Length of stay increases with patient age and with admission category, from elective to urgent to emergency.

The adoption of laparoscopic surgery for colorectal cancer has evolved significantly since 2007. From a baseline rate of laparoscopic resection of just under 30%, this has now increased to over 60% in 2014. Minimally invasive surgical techniques were used for 62% of colon resections, but fewer than 40% of rectal cases. The length of stay for minimally invasive cases is almost two days less than that for open surgery, supporting the potential impact of minimally invasive surgery on length of stay.

Number of lymph nodes examined can be considered a surrogate marker of quality for care of colon cancer; it demonstrates that an adequate surgical resection and pathological examination of the specimen has been undertaken. In many guidelines 12 lymph nodes is often considered to be the expected lower limit and although the audit demonstrates a spectrum of number of lymph nodes retrieved, even the lower limit of retrieved lymph nodes is over 12 in almost all units.

Approximately half of rectal cancer cases were discussed at a multidisciplinary meeting and the proportion undergoing MRI staging has increased from 40% to almost 70%. Just under half the patients received neoadjuvant therapy prior to surgery. The surgical approach has evolved with only 15% undergoing a minimally invasive approach in 2007 and to almost 40% undergoing a minimally invasive approach for resection in 2014. The permanent stoma rate has a wide spectrum with higher volume centres demonstrating a lower rate of permanent stoma. A few centres do have a very high permanent stoma rate however this may not be representative as the number of cases submitted is small. Circumferential margin involvement rate is stable between 2007 and 2014 at around 10%.

The BCCA will focus on increasing the number of surgeons submitting data to the audit as well as increasing the overall number of patients within the audit. Governance structures for quality assessment and research will be developed.
HISTORY

The Colorectal Cancer Audit Committee (CCAC) was formed in October 2006 as an initiative of the Colorectal Surgical Society of Australia and New Zealand (CSSANZ). The aim was to create a large dataset containing Australian and New Zealand data for research and quality improvement purposes. This data could be used to advance knowledge and understanding of the optimum treatment for colorectal cancer, and help ensure best practice. The CSSANZ Council believed a binational colorectal cancer database was important as part of education and Continuing Professional Development (CPD) and it was introduced as a mandatory requirement for CSSANZ fellowship. The original committee established and developed the Bi-National Colorectal Cancer Audit (BCCA) as an effective means of data collection and surgical audit now appropriate for all surgeons who perform colorectal cancer surgery.

Initial discussions actually began in 2003 when the CSSANZ Council set up a Working Group chaired by Andrew Hunter to investigate establishment of a binational cancer database. Subsequently, a workshop was held in Melbourne in May 2004. Invited speakers included Jeff Stamatakis from the United Kingdom who was involved in developing the ACPGBI (The Association of Coloproctology of Great Britain and Ireland) database, Campbell Miles, Guy Maddern and Chris Reid. Over the next two years efforts were put into defining a minimum data set and construction of a database along the lines of the ACPGBI database. A further meeting was held in October 2005 at ASERNIP-S (Australian Safety and Efficacy Register of New Interventional Procedures Surgical, a program of the Royal Australasian College of Surgeons, RACS) between interested colorectal surgeons, ASERNIP-S staff and Peter Gibbs, a colorectal cancer oncologist at Ludwig Institute for Cancer Research and the Royal Melbourne Hospital to discuss the implementation of a binational colorectal cancer audit.

In early 2007, a Memorandum of Understanding (MOU) was signed establishing collaboration between CSSANZ, RACS (who provided facilities at ASERNIP-S in Adelaide for the project manager, free rental, regular audit meetings, legal and other support, and secure data entry) and Biogrid Australia (who provided initial financial support to employ the project manager). Using a sophisticated technology platform, BioGrid links hospital, medical research and health organisation data in an ethically approved, privacy protected and controlled way. BioGrid was engaged to assist with data management and provided The Australian Comprehensive Cancer Outcomes and Research Database (ACCORD), which was modelled on the ACPGBI dataset. ACCORD collected de-identified data on preoperative information including a risk factor questionnaire, operative details, surgical outcomes, pathology stage, adjuvant therapy, routine follow-up, and local and distant recurrence. Data was entered by two main routes, by paper forms sent to RACS Research, Audit and Academic Surgery Division in Adelaide and entered onto the RACS server (which acted as the default server when BioGrid systems were unavailable), or via hospital servers where ACCORD was already installed. It was envisaged that eventually all hospitals would link data to Biogrid and data officers would be employed to enter data at each hospital. The ACCORD database was to be installed onto each hospital server and de-identified data uploaded onto BioGrid servers.

In 2007 BCCA became an approved audit by the RACS for the purpose of CPD, a compulsory component of medical registration. In addition the audit also became a declared Quality Assurance (QA) activity under Part VC of the Health Insurance Act 1973 of the Australian Government, and subsequently in New Zealand Protected Quality Assurance Activity (PQAA) status was approved.

Once data collection processes were established, approval was sought from ethics committees so the activity could be undertaken at major metropolitan hospitals and private hospitals. This process has been a time consuming and frustrating process. It has required intensive investigation, documentation and liaison with every hospital’s ethics committee, ethics specialists, data managers and surgeons. With the progression
of the audit a number of policies have been developed to provide guidance on matters such as data access and authorship, and managing relationships with industry and external groups to facilitate research.

Data collection initially started in South Australia and by 2009 when the first annual report was published, data was being submitted from surgeons and hospitals across South Australia, Tasmania, Victoria, Queensland and New South Wales. By the second report, data collection had also started in New Zealand and soon after, Western Australia. Whilst an initiative of CSSANZ, BCCA is available to be used by all general surgeons.

There were however issues with the system; there were communication and time delays, difficulty obtaining data back from the database, concerns regarding future sustainability and funding, increased costs, lack of progress with installation of BioGrid servers, data storage not centralised, data entry not designed for web based data entry, and increasing demands by RACS, which led to the CCAC exploring other web-based clinical audit options.

Following meetings between CSSANZ, Cabrini Health and Monash University in Cairns during the Tripartite Colorectal Meeting in July 2011, the CCAC and CSSANZ Council decided to move to an online database as developed by Associate Professor Paul McMurrick at Cabrini Health and the Monash University Clinical Informatics and Data Management Unit (CIDMU). This database offers many improvements on the previous system such as secure data entry via encrypted log in, live reporting and incomplete data reminder alerts built into the system and database access via any Internet browser. It was also considered to be a more sustainable system through being totally online and avoiding paper forms, and hence widening the potential access for all surgeons undertaking colorectal cancer surgery. In May 2013 the contract between CSSANZ, Cabrini Health and Monash University was finalised and the new online database was launched in December 2013. The online BCCA database is considered the “Minimum Dataset” and the “Extended Dataset” is led by Associate Professor McMurrick and Cabrini Health and is known as CRC Audit. Relevant data from the extended dataset is linked to the BCCA database. In addition, previous data collected by paper form onto the RACS server has now been imported to the online database, and plans are underway to link data from hospitals entering data through Biogrid, as well as data collected through the Otago Surgical Audit in New Zealand.

As there was a change in the method of data collection to the online model all sites’ Human Research and Ethics Committee (HREC) approvals must be amended before utilising the online system.

There is increasing evidence that the government and the public will demand information on patient outcomes. Surgeons have a professional responsibility to collect this information accurately and thereby control the standard of its reporting and interpretation.

GOVERNANCE

Since 2007 BCCA has been governed by the CCAC, a sub-committee of CSSANZ members who meet monthly along with the BCCA Project Manager and co-opted members from data management support (Monash University, and previously RACS and BioGrid Australia). In 2013 it became apparent the current governance needed to evolve to a more comprehensive structure that included other related groups. In 2015 a new model of governance is being implemented to ensure it conforms to the National Operating Principles for Clinical Quality Registries as set out by the Australian Commission on Safety and Quality in Health Care. It is anticipated the new model will come into effect mid-2015.

The project will be overseen by the BCCA Steering Committee in coordination with the BCCA Operations Committee (which will replace the CCAC). Employment and financial management will remain under the auspices of the CSSANZ Council. Day to day management of the database is achieved by a Project Manager who reports to the Operations Committee monthly.
The Steering Committee will comprise of various stakeholders including clinicians, funders, consumers and others. The membership is as follows:

• Chair; The first chair will be a CSSANZ member nominated by the Auspicing body.
• One member of the CSSANZ Council.
• One member of the Royal Australasian College of Surgeons Colon and Rectal Surgery Section Executive.
• One representative recommended by the General Surgeons Australia Council.
• One representative recommended by the New Zealand Association of General Surgeons.
• A clinician with an interest in colorectal cancer.
• One consumer representative.
• Chair of the BCCA Operations Committee.

The Steering Committee shall be responsible for oversight of BCCA activities including that of the Operations Committee, provide ongoing review of objectives and effectiveness in meeting these and approve any policies to address issues of clinical interest that may arise.

The Operations Committee will replace the current governing committee which is responsible for the day to day management of BCCA, developing quality measures and forming relevant sub-committees to address data access, research and quality issues. The membership is as follows:

• Chair; a CSSANZ member.
• Representatives of the Department of Epidemiology & Preventive Medicine, Monash University (DEPM).
• A representative of CRC Audit (the extended dataset).
• One to eleven surgeons who regularly undertake surgery for colorectal cancer providing a broad geographic binational representation.
• Other co-opted members as required.

Subcommittees will be formed under the Operations Committee to address data access, research and quality. There is an ongoing relationship with other data sources; there will be an automated pipeline from CRC Audit to BCCA, other data sources with equivalent datasets will be assessed for importation at a future date.

FIGURE 1. BCCA GOVERNANCE STRUCTURE AND DATAFLOW OVERVIEW
METHOD

From 2007 to December 2013 data was collected via paper forms with the majority of these sent for entry at the RACS Research, Audit and Academic Surgery Division. Other sites have stored these forms locally on the equivalent database (ACCORD). In December 2013 the new online BCCA database was launched and as sites attain amendments to their ethical approval to this new model they have migrated to utilising this new system.

The online database was developed by and is maintained by CIDMU at Monash University. It is accessible via any Internet browser. Surgeons, site-managers or support staff enter patient data directly into the database after logging in via a secure encrypted page. The online system has in-built processes to ensure data completeness and data integrity. Data can be saved and further details added later, data will only be accepted in approved formats ensuring there are no inconsistencies in reporting, and incomplete cases remain on the home page after login as a reminder to complete them. Surgeons and Sites can only see identifiable data that they have submitted but can run anonymised summary reports comparing themselves to the whole database getting live feedback regarding their performance.

DATA HANDLING

In January 2015 the data collected via RACS from 2007 was imported to the online system. This report is based on that data and any data entered to the online BCCA and CRC Audit databases, covering all BCCA submissions from 2007-2014. There is a variety in data completeness and on review of 31 key items data completion has improved over time. The online system launched in February 2010 for CRC Audit and in December 2013 for BCCA, this suggests the online system is assisting in data completeness.

Throughout the report analyses were undertaken where complete data was submitted, cases with missing information were excluded per question. Where deemed relevant sections include details about how many treatment episodes were included for the analysis.

In the preparation of funnel plots all units of less than 10 patients were included in a single group (60 patients in all, labelled group 0), including this group, there were 57 units analysed. Funnel Plot curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and for most graphs the data has not been risk adjusted. One risk-adjusted graph is included (Figure 10). This risk-adjusted figure takes into account ASA grade, Age, Return to theatre in 30 days, Urgency of surgery, Medical complications and Laparoscopic surgery. Outliers are represented as coloured dots in the plot.

Length of hospital stay (LOS) data was capped at 30 days, this represents 97% of all data submitted. Higher stays were not included in the LOS analyses due to potential data entry errors with the range up to 860 LOS reported.

This approach was also applied in the Lymph Node data, with the highest figure being capped at 30.

Box and whisper plots identify the first quartile, the median and third quartile in the box borders and the mean is highlighted in the centre. The whispers include the range from minimum through to maximum (which was capped at 30 for Length of Stay and Lymph Nodes).

FIGURE 2. PERCENTAGE DATA COMPLETION OVER TIME FOR 31 KEY BCCA ITEMS
PARTICIPATING SITES

Participation in BCCA requires relevant ethics committee approvals. Below is a list of sites who have contributed data to BCCA since its inception although not all of these sites currently submit data. See page 40 for further information about participation and approvals required.

TABLE 1. SITES WHO HAVE SUBMITTED DATA TO BCCA

<table>
<thead>
<tr>
<th>STATE</th>
<th>PARTICIPATING SITES</th>
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<tbody>
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DATA SUBMISSION

This report covers operations complete from 2007 through to 31 December 2014. It includes data that was submitted to RACS and that submitted via the online portals of both the BCCA and CRC Audit. During this period 10,716 individual treatment episodes were submitted for 10,263 patients.

FIGURE 3. TREATMENT EPISODES SUBMITTED TO BCCA OVER TIME
LIST OF FIGURES

Figure 1. BCCA governance structure and dataflow overview ................................................................. 8
Figure 2. Percentage data completion over time for 31 key BCCA items .................................................. 9
Figure 3. Treatment episodes submitted to BCCA over time ................................................................ 12
Figure 4. Age distribution of patients ..................................................................................................... 16
Figure 5. Diagram of primary tumour site, count and percentage ........................................................... 16
Figure 6. Age distribution of patients diagnosed by FOBT ..................................................................... 18
Figure 7. Site of tumour of patients diagnosed through NBCSP compared to overall BCCA cases .......... 19
Figure 8. Stage of cancer of patients diagnosed via NBCSP vs Overall BCCA dataset ............................. 19
Figure 9. Funnel plot of individual units’ hospital mortality using unadjusted data ................................. 22
Figure 10. Funnel plot of individual units’ hospital mortality using risk-adjusted data ............................... 22
Figure 11. Return to theatre rate for individual units using unadjusted data .......................................... 23
Figure 12. Length of hospital stay and number of patients submitted per unit using unadjusted data ....... 24
Figure 13. LOS and tumour site ............................................................................................................. 25
Figure 15. LOS and age ........................................................................................................................... 26
Figure 16. LOS over time .......................................................................................................................... 27
Figure 17. LOS and category of admission ............................................................................................. 27
Figure 18. Summarised operative approach over time ............................................................................. 28
Figure 19. Detailed operative approach over time .................................................................................. 29
Figure 20. Detailed operative approach and tumour position ................................................................. 29
Figure 21. Summarised operative approach and LOS ........................................................................... 29
Figure 22. Operative approach over time for colon cancer ..................................................................... 31
Figure 23. Relative frequency of surgical complications in colon cancer compared to number of cases recorded per unit using unadjusted data ................................................................. 31
Figure 24. Tumour stage for colon cancers .............................................................................................. 32
Figure 25. Mean number of lymph nodes examined per unit in resected specimen for colon cancers using unadjusted data ........................................................................................................... 33
Figure 26. Lymph nodes examined in resected specimen for colon cancers over time ............................ 33
Figure 27. Proportion of patients with rectal cancer undergoing MRI scan as part of staging over time .. 34
Figure 28. Neoadjuvant therapy use for rectal cancer and type of therapy ............................................. 35
Figure 29. Detailed operative approach over time for rectal cancer ...................................................... 36
Figure 30. Permanent end stoma rate per unit compared to number of cases using unadjusted data ...... 36
Figure 31. Circumferential margin involvement over time in rectal cancer .......................................... 37
Figure 32. Relative frequency of surgical complications in rectal cancer compared to number of cases recorded per unit using unadjusted data ........................................................................... 38
LIST OF TABLES

Table 1. Sites who have submitted data to BCCA ................................................................. 10
Table 2. Patient characteristics ......................................................................................... 15
Table 3. American society of anesthesiologists classification for all treatment episodes .... 15
Table 4. Cancer stage for all treatment episodes ................................................................. 17
Table 5. Number of patients with tumour diagnosed following FOBT over time .............. 18
Table 6. Primary surgical procedure for all treatment episodes ......................................... 20
Table 7. Hospital mortality over time ................................................................................. 21
Table 8. Category of admission over time ......................................................................... 21
Table 9. Category of admission and hospital mortality ....................................................... 23
Table 10. LOS and tumour position .................................................................................. 25
Table 11. LOS and age ....................................................................................................... 26
Table 12. LOS over time ..................................................................................................... 26
Table 13. LOS and category of admission ......................................................................... 27
Table 14. Summarised operative approach and length of stay .......................................... 29
Table 15. Primary procedure for patients with colon cancer ............................................. 30
Table 16. Surgical and medical complications of patients undergoing surgery for colon cancer .... 32
Table 17. Tumour stage for colon cancers ........................................................................ 32
Table 18. Lymph nodes examined in resected specimen for colon cancers over time .......... 33
Table 19. Proportion of rectal cancer cases discussed at multidisciplinary team meeting ... 34
Table 20. Use of neoadjuvant therapy for rectal cancer and type of therapy .................... 35
Table 21. Primary procedure for patients with rectal cancer ............................................ 35
Table 22. Circumferential margin involvement over time in rectal cancer ......................... 37
Table 23. Use of neoadjuvant therapy and margin involvement ........................................ 37
Table 24. Surgical and medical complications of patients undergoing surgery for rectal cancer ........ 38
Table 25. Percentage of stage II and III cancer patients receiving chemotherapy ................ 39
PATIENT CHARACTERISTICS

Information on over 10,000 patients with colorectal cancer across Australia and New Zealand has been collected over the period from 2007 to the end of 2014.

Though this is only a proportion of the total number of patients across the two countries who would have had a new diagnosis of colorectal cancer over this time, it does represent a significant number of patients, and hence the patient demographics and trends in patterns of care are highly likely to be relevant to the patient group as a whole. The patient group however may be skewed to a degree as there are a greater proportion of patients in this dataset having undergone care by colorectal surgeons rather than general surgeons when looking at the breakdown of those contributing data.

The age distribution of the patients is shown in Figure 4 and, as would be expected, the majority were over 50 years of age and the proportion per age group increasing with age, with an expected drop off at extreme age. It is interesting to note that there are still a significant number of patients developing colorectal cancer under the age of 50, and even under the age of 40. These younger patients would not be covered by the National Bowel Cancer Screening Program (NBCSP) which starts screening at age 50.

Rectal tumours represent 30% of the total colorectal cancers which echoes findings demonstrated by other registries1. Approximately 12% of patients have metastatic disease at presentation (as based on The American Joint Committee on Cancer staging system). This is lower than would normally be expected and may represent some skewing of the dataset. It is to be hoped that this proportion will reduce as the bowel cancer screening program begins to identify patients at an earlier asymptomatic stage.

### TABLE 2. PATIENT CHARACTERISTICS

| Age Range | 19-109 |
| Age Mean (±SD) | 69 (±12.8) |
| Age Median | 70 |
| Female: Male | 1:1.2 |

### TABLE 3. AMERICAN SOCIETY OF ANESTHESIOLOGISTS (ASA) CLASSIFICATION FOR ALL TREATMENT EPISODES

<table>
<thead>
<tr>
<th>ASA</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA 1</td>
<td>1551 (16)</td>
</tr>
<tr>
<td>ASA 2</td>
<td>4631 (47)</td>
</tr>
<tr>
<td>ASA 3</td>
<td>3310 (33)</td>
</tr>
<tr>
<td>ASA 4</td>
<td>423 (4)</td>
</tr>
<tr>
<td>ASA 5</td>
<td>13 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>9928 (100)</td>
</tr>
</tbody>
</table>

*ASA is a system for assessing the fitness of cases before surgery where 1 represents a healthy person and 5 represents someone who is not expected to survive without surgery.
FIGURE 4. AGE DISTRIBUTION OF PATIENTS

FIGURE 5. DIAGRAM OF PRIMARY TUMOUR SITE, COUNT AND PERCENTAGE, BASED ON 10,343 PATIENTS

- Splenic Flexure: 332, 3%
- Transverse Colon: 860, 8%
- Hepatic Flexure: 491, 5%
- Ascending Colon: 1257, 12%
- Caecum: 1262, 12%
- *Unknown: 49, 0%
- Rectum Upper Third: 435, 4%
- Rectum Middle Third: 1115, 11%
- Rectum Lower Third: 1568, 15%
- Rectosigmoid: 722, 7%
- Sigmoid Colon: 1918, 19%
- Descending Colon: 334, 3%
- Rectum Middle Third: 1115, 11%
**TABLE 4. CANCER STAGE FOR ALL TREATMENT EPISODES**

<table>
<thead>
<tr>
<th>Stage</th>
<th>COLON (%)</th>
<th>RECTUM (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0</td>
<td>466 (6)</td>
<td>273 (9)</td>
<td>739 (7)</td>
</tr>
<tr>
<td>Stage I</td>
<td>1322 (18)</td>
<td>895 (30)</td>
<td>2217 (22)</td>
</tr>
<tr>
<td>Stage II</td>
<td>2447 (34)</td>
<td>691 (23)</td>
<td>3138 (31)</td>
</tr>
<tr>
<td>Stage III</td>
<td>2022 (28)</td>
<td>814 (27)</td>
<td>2836 (28)</td>
</tr>
<tr>
<td>Stage IV</td>
<td>901 (13)</td>
<td>308 (10)</td>
<td>1209 (12)</td>
</tr>
<tr>
<td>Stage X</td>
<td>25 (0)</td>
<td>37 (1)</td>
<td>62 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>7183 (70)</td>
<td>3018 (30)</td>
<td>10,201 (100)</td>
</tr>
</tbody>
</table>

*The AJCC staging system is a classification system developed by the American Joint Committee on Cancer for describing the extent of disease progression in cancer patients. It utilizes the TNM scoring system to calculate an overall stage value, where T is Tumour size, N is Lymph Nodes affected, and M is Metastases. Stages 0-IV increase in severity from 0 where cancer cells are contained within the inner bowel lining to IV where cancer cells have spread to other parts of the body. Stage X represents that the cancer stage could not be defined.
FAECAL OCCULT BLOOD DIAGNOSIS (FOBT) AND NATIONAL BOWEL CANCER SCREENING PROGRAM (NBCSP)

The National Bowel Cancer Screening Program (NBCSP) was initiated in 2007 across Australia with a progressive roll out to increasing age ranges of people over 50 years of age. The NBCSP currently invites men and women turning 50, 55, 60, and 65 to screen for bowel cancer. Participants are sent a free, easy to use screening kit that can be completed at home. It uses Faecal Occult Blood Testing (FOBT) to identify occult (hidden) lower gastrointestinal bleeding and patients are then recommended to have a colonoscopy to obtain a definitive diagnosis.

Reviewing the current data, a greater proportion of sigmoid tumours are diagnosed through the NBCSP than compared to the dataset as a whole. Variability in data completeness may impact on the proportion of patients diagnosed by FOBT. Unfortunately, this field has been left blank in many cases (which probably means the patient was NOT diagnosed by FOBT) but this makes interpretation of this data less accurate. Patients diagnosed through the NBCSP do appear to be diagnosed at a significantly earlier stage than compared to the patients diagnosed through other means. This will be an important area to watch in future years as data completeness improves with the online system and may give a reflection of the impact of the NBCSP. In New Zealand a screening program is being piloted in the Waitemata District Health Board area from October 2011 to December 2015 to assess whether a national program should be introduced.

| TABLE 5. NUMBER OF PATIENTS WITH TUMOUR DIAGNOSED FOLLOWING FOBT OVER TIME (BASED ON 7044 TREATMENT EPISODES) |
|-----------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                                  | 2007(%) | 2008(%) | 2009(%) | 2010(%) | 2011(%) | 2012(%) | 2013(%) | 2014(%) | TOTAL(%)       |
| FOBT YES                         | 47 (9)  | 142 (14)| 147 (11)| 147 (11)| 150 (11)| 99 (12) | 112 (33) | 149 (52) | 993 (14)       |
| FOBT NO                          | 464 (91)| 903 (86)| 1182 (89)| 1199 (89)| 1207 (89)| 729 (88)| 228 (67) | 139 (48) | 6051 (86)      |
| Total                            | 511     | 1045    | 1329    | 1346    | 1357    | 828     | 340     | 288     | 7044           |

FIGURE 6. AGE DISTRIBUTION OF PATIENTS DIAGNOSED BY FOBT (BASED ON 7056 TREATMENT EPISODES)

![Age Distribution of Patients Diagnosed by FOBT](image-url)
**Figure 7. Site of Tumour of Patients Diagnosed Through NBCSP Compared to Overall BCCA Cases**
(Based on 1009 and 10,688 Patients)

<table>
<thead>
<tr>
<th>Site of Tumor</th>
<th>NBCSP</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caecum</td>
<td>10%</td>
<td>12%</td>
</tr>
<tr>
<td>Ascending Colon</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>Hepatic flexure</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>Transverse Colon</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Splenic flexure</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Descending Colon</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Sigmoid Colon</td>
<td>29%</td>
<td>19%</td>
</tr>
<tr>
<td>Rectum upper third (&gt;12cm)</td>
<td>25%</td>
<td>12%</td>
</tr>
<tr>
<td>Rectum mid third (8-12cm)</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Rectum lower third (&lt;8cm)</td>
<td>11%</td>
<td>8%</td>
</tr>
</tbody>
</table>

**Figure 8. Stage of Cancer of Patients Diagnosed via NBCSP vs Overall BCCA Dataset**
(Based on 303 and 10,209 Patients)

<table>
<thead>
<tr>
<th>Cancer Stage</th>
<th>Overall BCCA Dataset</th>
<th>Diagnosed via NBCSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Stage I</td>
<td>22%</td>
<td>41%</td>
</tr>
<tr>
<td>Stage II</td>
<td>41%</td>
<td>31%</td>
</tr>
<tr>
<td>Stage III</td>
<td>31%</td>
<td>17%</td>
</tr>
<tr>
<td>Stage IV</td>
<td>28%</td>
<td>24%</td>
</tr>
<tr>
<td>Stage V</td>
<td>28%</td>
<td>24%</td>
</tr>
<tr>
<td>Stage X</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>Stage &gt;X</td>
<td>1%</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Using Chi-Square test, there is a significant difference in Stage I disease between the two groups (p<0.0001)
Surgical Care

Surgery remains the primary treatment for the majority of patients with colorectal cancer. The data demonstrates a broad range of operations consistent with site of the primary tumour within the bowel. It is interesting to note that 50% of operations are for tumours in the rectum or rectosigmoid parts of the bowel. This may represent a higher proportion of data submitted by colorectal surgeons who are more likely to operate on rectal tumours.

Table 6. Primary Surgical Procedure for All Treatment Episodes.

<table>
<thead>
<tr>
<th>Primary Procedure</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hemicolectomy</td>
<td>2528</td>
<td>27%</td>
</tr>
<tr>
<td>Extended right hemicolectomy</td>
<td>493</td>
<td>5%</td>
</tr>
<tr>
<td>Left hemicolectomy</td>
<td>315</td>
<td>3%</td>
</tr>
<tr>
<td>Sigmoid colectomy</td>
<td>81</td>
<td>1%</td>
</tr>
<tr>
<td>Total colectomy</td>
<td>114</td>
<td>1%</td>
</tr>
<tr>
<td>Subtotal colectomy</td>
<td>263</td>
<td>3%</td>
</tr>
<tr>
<td>Proctocolectomy</td>
<td>74</td>
<td>1%</td>
</tr>
<tr>
<td>High anterior resection (10.1-15)</td>
<td>1614</td>
<td>17%</td>
</tr>
<tr>
<td>Low anterior resection (6.1-10)</td>
<td>838</td>
<td>9%</td>
</tr>
<tr>
<td>Ultra low anterior resection (0-6)</td>
<td>1258</td>
<td>14%</td>
</tr>
<tr>
<td>APR</td>
<td>586</td>
<td>6%</td>
</tr>
<tr>
<td>Hartmanns</td>
<td>364</td>
<td>4%</td>
</tr>
<tr>
<td>Miscellaneous operation (eg. for complication)</td>
<td>28</td>
<td>0%</td>
</tr>
<tr>
<td>Colo-anal anastomosis</td>
<td>28</td>
<td>0%</td>
</tr>
<tr>
<td>Transverse colectomy</td>
<td>64</td>
<td>1%</td>
</tr>
<tr>
<td>Local excision</td>
<td>61</td>
<td>1%</td>
</tr>
<tr>
<td>TEMS/TAMIS</td>
<td>65</td>
<td>1%</td>
</tr>
<tr>
<td>Laparotomy only</td>
<td>19</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>165</td>
<td>2%</td>
</tr>
<tr>
<td>Non-operative</td>
<td>318</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>9276</td>
<td>100%</td>
</tr>
</tbody>
</table>
OVERALL COLORECTAL CANCER

The funnel plots of mortality demonstrate a spectrum of mortality rates, which reduces as the number of cases submitted increases. This is predictable as one would expect less anecdotal variation as the number of patients’ submitted per surgeon increases. There are no outliers represented on the plot. Hospital mortality can be considered as one of a number of surrogate markers for overall quality of care but it is essential that data is appropriately risk adjusted and analysed before any conclusions with respect to outliers are made. Risk adjustment takes into account characteristics or variables of the patients that the surgeon is seeing, for example some hospitals may specialise in treating more advanced cancers and therefore it would be expected that they would have worse outcomes without risk adjusting the data. Some examples of items data could be adjusted for include stage of cancer, age, comorbid diagnoses, and if it is a first or a repeat cancer diagnosis. Risk adjustment is planned as a major component of the quality initiative of this registry and will be an important future activity within the BCCA. The mortality data presented below shows both unadjusted data (Figure 9) and risk-adjusted data (Figure 10).

Figure 10 takes into account ASA grade, Age, Return to theatre in 30 days, Urgency of surgery, Medical complications, and Laparoscopic surgery. The data is not perfect, as we are missing some important predictors of mortality for example weight, but it does show there are no outliers when it comes to mortality - all units are within the defined limits. Overall mortality data has limited value initially with variations in completeness of data submission; however this has improved over time with increasing submission and data completeness.

Category of admission (elective, urgent, or emergency) has frequently been demonstrated to be an important factor for outcome in patients with colorectal cancer. The distribution across these categories has remained fairly consistent over the years of the audit which is not unexpected. The mortality rates appear strongly related to the admission category; this category is another item that will be important to take into account during risk adjustment and when analysis of individual unit outcome data is undertaken and outlier units identified.

Return to theatre is considered a potential surrogate quality marker and the distribution is similar to that of mortality with reduced variation as the number of patients submitted increases.

### TABLE 7. HOSPITAL MORTALITY OVER TIME (BASED ON 10,336 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Deaths/Number of Treatment Episodes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>12/516</td>
<td>2%</td>
</tr>
<tr>
<td>2008</td>
<td>17/1046</td>
<td>2%</td>
</tr>
<tr>
<td>2009</td>
<td>22/1345</td>
<td>2%</td>
</tr>
<tr>
<td>2010</td>
<td>15/1668</td>
<td>1%</td>
</tr>
<tr>
<td>2011</td>
<td>30/1715</td>
<td>2%</td>
</tr>
<tr>
<td>2012</td>
<td>22/1280</td>
<td>2%</td>
</tr>
<tr>
<td>2013</td>
<td>13/1174</td>
<td>1%</td>
</tr>
<tr>
<td>2014</td>
<td>29/1561</td>
<td>2%</td>
</tr>
</tbody>
</table>

### TABLE 8. CATEGORY OF ADMISSION OVER TIME (BASED ON 10,359 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Deaths/Number of Treatment Episodes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Emergency admission</td>
<td>7%</td>
</tr>
<tr>
<td>2008</td>
<td>Urgent admission</td>
<td>5%</td>
</tr>
<tr>
<td>2009</td>
<td>Elective admission</td>
<td>8%</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td>6%</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td>7%</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td>8%</td>
</tr>
</tbody>
</table>

*Category of admission was defined as follows; Emergency: patients requiring surgery within 4 hours of presentation, Urgent: patients requiring surgery within 24 hours of presentation, Elective: patients requiring surgery at a planned time.*
FIGURE 9. FUNNEL PLOT OF INDIVIDUAL UNITS’ HOSPITAL MORTALITY USING UNADJUSTED DATA (BASED ON 57 UNITS)

Inpatient Death (overall 1.6%).

*Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) and the data has not been risk-adjusted.

FIGURE 10. FUNNEL PLOT OF INDIVIDUAL UNITS’ HOSPITAL MORTALITY USING RISK-ADJUSTED DATA (BASED ON 57 UNITS)

Risk Adjusted Inpatient Mortality.

*Sign. 5%
*Sign. .2%

*All units are within two standard deviations of the mean. This risk-adjusted figure takes into account ASA grade, Age, Return to theatre in 30 days, Urgency of surgery, Medical complications and Laparoscopic surgery.
FIGURE 11. RETURN TO THEATRE RATE FOR INDIVIDUAL UNITS USING UNADJUSTED DATA (BASED ON 57 UNITS)

Return to Theatre in 30 days (overall 4.9%).

*Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and the data has not been risk-adjusted.

TABLE 9. CATEGORY OF ADMISSION AND HOSPITAL MORTALITY (BASED ON 10,290 PATIENTS)

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Deaths/Number of Treatment Episodes</td>
<td>%</td>
<td>Number of Deaths/Number of Treatment Episodes</td>
<td>%</td>
<td>Number of Deaths/Number of Treatment Episodes</td>
<td>%</td>
<td>Number of Deaths/Number of Treatment Episodes</td>
<td>%</td>
</tr>
<tr>
<td>Urgent admission</td>
<td>1/26 4</td>
<td>1/51 2</td>
<td>1/100 1</td>
<td>2/112 2</td>
<td>5/123 4</td>
<td>5/95 5</td>
<td>1/178 1</td>
<td>2/144 1</td>
</tr>
<tr>
<td>Elective admission</td>
<td>9/448 2</td>
<td>12/919 1</td>
<td>15/1160 1</td>
<td>10/1455 1</td>
<td>8/1474 1</td>
<td>13/1117 1</td>
<td>9/1021 1</td>
<td>22/1368 2</td>
</tr>
<tr>
<td>OVERALL</td>
<td>12/497 2</td>
<td>17/1042 2</td>
<td>22/1315 2</td>
<td>5/1662 1</td>
<td>30/1706 2</td>
<td>2/1276 2</td>
<td>3/1170 1</td>
<td>29/1588 2</td>
</tr>
</tbody>
</table>
LENGTH OF HOSPITAL STAY

Length of hospital stay generates significant focus and may be considered as a surrogate marker of quality of care. The time a patient spends in hospital is a major component of total cost of care for patients with colorectal cancer and globally there has been significant interest in exploring factors that impact on length of stay (LOS) and application of methods that reduce length of stay\(^1\). This has included the application of Enhanced Recovery Programs after Surgery (ERAS) that have been shown to directly reduce length of stay\(^3\).

In the current dataset the spectrum of LOS reduces as the number of patients submitted increases, which is as would be expected with reduced variance over greater patient numbers. Site of the primary tumour directly influences LOS, with a progressive increase in LOS as the tumour site moves round the colon, from caecum to rectum. This may represent the scale of surgery which increases moving round from the right colon to the pelvis or the fact that rectal resections often necessitate the requirement of a stoma which itself requires hospital time for patient education.

Length of hospital stay increases with age for patients 60 years and over. This may have the potential to facilitate modelling for resourcing for patient care with consideration of the population and patient spread. The increase in LOS with acuteness of admission category, from elective to urgent to emergency is as would be expected. It is interesting to note that there appears to have been comparatively limited change in length of stay from 2007 to 2014. This is in spite of application of programs such as ERAS across a number of centres. This may be due to the selective nature of data submission or patchy applications of programs such as ERAS. ERAS has demonstrated the potential for significant financial savings on a national basis, as demonstrated by its application in the National Health Service in the UK\(^4\); however this requires broad application and needs to be assessed by comprehensive data evaluation such as could be facilitated through registries like the BCCA.

The following summaries of LOS are based on 97% submitted patient data. The maximum was set to 30 days, and higher stays were not included in this section due to potential data entry errors with the range up to 860 LOS reported.

**FIGURE 12. LENGTH OF HOSPITAL STAY (LOS) AND NUMBER OF PATIENTS SUBMITTED PER UNIT USING UNADJUSTED DATA (BASED ON 57 UNITS)**

*Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and the data has not been risk-adjusted.*

Mean Length of Stay (overall 11.2 days).
**TABLE 10. LOS AND TUMOUR POSITION**

<table>
<thead>
<tr>
<th></th>
<th>RIGHT</th>
<th>LEFT</th>
<th>RECTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>3621</td>
<td>3095</td>
<td>2944</td>
</tr>
<tr>
<td>Mean (±SD)</td>
<td>8 (±4)</td>
<td>8 (±5)</td>
<td>10 (±5)</td>
</tr>
<tr>
<td>Median</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>IQR</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

*IQR = Interquartile range, the difference between the third and first quartiles*

**Figure 14 shows LOS compared across tumour position, aggregated into right colon (caecum to splenic flexure), left colon (splenic flexure to rectosigmoid), and rectum. All of the following Box and Whisper plots identify the first quartile, the median and third quartile in the box border and the mean is highlighted in the centre.**
### TABLE 11. LOS AND AGE

<table>
<thead>
<tr>
<th>Age Group</th>
<th>&lt;30</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60-69</th>
<th>70-79</th>
<th>80-89</th>
<th>90+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>55</td>
<td>171</td>
<td>509</td>
<td>1370</td>
<td>2559</td>
<td>2830</td>
<td>2020</td>
<td>205</td>
</tr>
<tr>
<td>Mean (±SD)</td>
<td>8 (±4)</td>
<td>8 (±4)</td>
<td>8 (±5)</td>
<td>8 (±5)</td>
<td>9 (±5)</td>
<td>9 (±5)</td>
<td>10 (±5)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>IQR</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

### FIGURE 15. LOS AND AGE

![Box plot showing the distribution of length of stay by age group](image)

### TABLE 12. LOS OVER TIME

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>454</td>
<td>952</td>
<td>1269</td>
<td>1576</td>
<td>1619</td>
<td>1216</td>
<td>1124</td>
<td>1501</td>
</tr>
<tr>
<td>Mean (±SD)</td>
<td>9 (±5)</td>
<td>9 (±5)</td>
<td>9 (±5)</td>
<td>9 (±5)</td>
<td>9 (±5)</td>
<td>9 (±5)</td>
<td>8 (±5)</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>IQR</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Figure 16. LOS Over Time

![Box plots showing LOS over time from 2007 to 2014.](image)

Figure 17. LOS and Category of Admission

![Box plots showing LOS for different categories of admission.](image)

Table 13. LOS and Category of Admission

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Mean (±SD)</th>
<th>Median</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency</td>
<td>528</td>
<td>10 (±5)</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Urgent</td>
<td>688</td>
<td>10 (±5)</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Elective</td>
<td>8456</td>
<td>8 (±5)</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>
The adoption of laparoscopic surgery for colorectal cancer has evolved significantly since 2007. From a baseline rate of laparoscopic resection of just under 30%, this has now increased to almost 60% in 2014. The data is probably not fully representative of the approach across Australia and New Zealand as a whole because a high proportion of the surgeons submitting to the BCCA are specialist colorectal surgeons who are perhaps more likely to undertake laparoscopic resections at the current time. It is however very encouraging as patients undergoing laparoscopic resection spend less time in hospital and are likely to return to the workforce earlier than those undergoing an open resection. It is interesting to note that this progression has occurred with significant industry support over this time period.

Minimally invasive techniques were used in over 60% of colon resections whilst less than 40% of rectal cases were completed using this approach. There has been a binational NHMRC trial of laparoscopic vs open resection of rectal cancer, the A La CaRT trial, which has been recruiting patients between 2011 and 2014, this may have contributed to the rectal case numbers undertaken laparoscopically over this time period.

The length of stay for minimally invasive cases is almost 2 days less than for open surgery, supporting the potential impact of minimally invasive surgery on length of stay.

*Minimally Invasive was defined as laparoscopic, hybrid, conversion of laparoscopic and robotic procedures.
FIGURE 19. DETAILED OPERATIVE APPROACH OVER TIME (BASED ON 10,224 TREATMENT EPISODES)

YEAR

FIGURE 20. DETAILED OPERATIVE APPROACH AND TUMOUR POSITION (BASED ON 10,126 TREATMENT EPISODES)

TUMOR POSITION

TABLE 14. SUMMARISED OPERATIVE APPROACH AND LENGTH OF STAY (BASED ON 9498 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>OPERATIVE APPROACH</th>
<th>OPEN</th>
<th>MINIMALLY INVASIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>5219</td>
<td>4279</td>
</tr>
<tr>
<td>Mean (±SD)</td>
<td>10 (5)</td>
<td>7 (4)</td>
</tr>
<tr>
<td>Median</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>IQR</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

* LOS capped at 30, which includes 97% of data, and Minimally Invasive was defined as laparoscopic, hybrid, conversion of laparoscopic and robotic procedures.

FIGURE 21. SUMMARISED OPERATIVE APPROACH AND LOS

LENGTH OF STAY (DAYS)
COLON CANCER

The distribution of operations shows as would be expected, the highest proportion of resections for colon cancer being through a right hemicolectomy. It is interesting to note that the minimally invasive operation rate has almost doubled from 32% in 2007 to 62% in 2014.

There is a spectrum of rates of post-operative complications, which reduce as the submitted number of patients increase. There are a few units lying outside the 95% confidence intervals but the data has not been risk stratified and the overall data represents only a proportion of the colonic cancers resected over this time period. The proportion of Stage IV colon cancers at 12% is lower than would usually be expected within a population colorectal cancer registry, which would be around 20 to 25%. This may be a result of a skewed patient sample within the database and may change with increasing patient submission overall to the registry over time.

Number of lymph nodes examined can be considered a surrogate marker of quality of care of colon cancer; it demonstrates that an adequate surgical resection and pathological examination of the specimen has been undertaken. Twelve lymph nodes is often considered to be the expected lower limit however this may vary with operation type and age of patient, amongst other factors. In this data there is a spectrum of lymph nodes numbers but even the lower limit of retrieved lymph nodes is over twelve in almost all units which is very encouraging.

### TABLE 15. PRIMARY PROCEDURE FOR PATIENTS WITH COLON CANCER (BASED ON 6557 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>PRIMARY PROCEDURE</th>
<th>COUNT</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hemicolectomy</td>
<td>2974</td>
<td>45%</td>
</tr>
<tr>
<td>Extended right hemicolectomy</td>
<td>582</td>
<td>9%</td>
</tr>
<tr>
<td>Left hemicolectomy</td>
<td>388</td>
<td>6%</td>
</tr>
<tr>
<td>Sigmoid colectomy</td>
<td>93</td>
<td>1%</td>
</tr>
<tr>
<td>Total colectomy</td>
<td>121</td>
<td>2%</td>
</tr>
<tr>
<td>Subtotal colectomy</td>
<td>302</td>
<td>5%</td>
</tr>
<tr>
<td>Proctocolectomy</td>
<td>51</td>
<td>1%</td>
</tr>
<tr>
<td>High anterior resection (10.1-15)</td>
<td>1844</td>
<td>28%</td>
</tr>
<tr>
<td>Transverse colectomy</td>
<td>83</td>
<td>1%</td>
</tr>
<tr>
<td>Laparotomy only</td>
<td>11</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>108</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>6557</td>
<td>100%</td>
</tr>
</tbody>
</table>
FIGURE 22. OPERATIVE APPROACH OVER TIME FOR COLON CANCER (BASED ON 7089 TREATMENT EPISODES)

FIGURE 23. RELATIVE FREQUENCY OF SURGICAL COMPLICATIONS IN COLON CANCER COMPARED TO NUMBER OF CASES RECORDED PER UNIT USING UNADJUSTED DATA (BASED ON 57 UNITS)

*Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and the data has not been risk-adjusted.
TABLE 16. SURGICAL AND MEDICAL COMPLICATIONS OF PATIENTS UNDERGOING SURGERY FOR COLON CANCER (BASED ON 7505 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>SURGICAL COMPLICATIONS</th>
<th>1434</th>
<th>19%</th>
<th>MEDICAL COMPLICATIONS</th>
<th>1091</th>
<th>15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal pelvic collection</td>
<td>116</td>
<td>2%</td>
<td>DVT PE</td>
<td>56</td>
<td>1%</td>
</tr>
<tr>
<td>Anastomotic leak</td>
<td>171</td>
<td>2%</td>
<td>Chest infection</td>
<td>348</td>
<td>5%</td>
</tr>
<tr>
<td>Enterocutaneous fistula</td>
<td>22</td>
<td>0%</td>
<td>Cardiac</td>
<td>415</td>
<td>6%</td>
</tr>
<tr>
<td>Superficial wound dehiscence</td>
<td>109</td>
<td>1%</td>
<td>Other medical complications</td>
<td>454</td>
<td>6%</td>
</tr>
<tr>
<td>Deep wound dehiscence</td>
<td>42</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>272</td>
<td>4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td>167</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged ileus</td>
<td>575</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small bowel obstruction</td>
<td>63</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary retention</td>
<td>107</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary injury</td>
<td>8</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Splenectomy</td>
<td>8</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative haemorrhage</td>
<td>76</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other surgical complications</td>
<td>239</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1975</td>
<td>Total</td>
<td>1273</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* From 7505 Treatment episodes there were 1434 TEs with 1975 surgical complications; 19% with complications
From 7505 Treatment episodes there were 1091 TEs with 1273 medical complications; 15% with complications

TABLE 17. TUMOUR STAGE FOR COLON CANCERS (BASED ON 7144 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>OVERALL STAGE</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0</td>
<td>457</td>
</tr>
<tr>
<td>Stage I</td>
<td>1318</td>
</tr>
<tr>
<td>Stage II</td>
<td>2447</td>
</tr>
<tr>
<td>Stage III</td>
<td>2009</td>
</tr>
<tr>
<td>Stage IV</td>
<td>888</td>
</tr>
<tr>
<td>Stage X</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>7144</td>
</tr>
</tbody>
</table>

FIGURE 24. TUMOUR STAGE FOR COLON CANCERS (BASED ON 7144 TREATMENT EPISODES)
**FIGURE 25. MEAN NUMBER OF LYMPH NODES EXAMINED PER UNIT IN RESECTED SPECIMEN FOR COLON CANCERS USING UNADJUSTED DATA (BASED ON 57 UNITS)**

![Graph showing the mean number of lymph nodes examined per unit in resected specimen for colon cancers using unadjusted data.](image)

*Mean Lymph Nodes per Colon Cancer Resection (overall 17.3).*

*Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and the data has not been risk-adjusted.*

**TABLE 18. LYMPH NODES (LN) EXAMINED IN RESECTED SPECIMEN FOR COLON CANCERS OVER TIME (BASED ON 6270 CASES)**

LN figures over 30 were excluded leaving 92% of data submitted

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>320</td>
<td>657</td>
<td>853</td>
<td>992</td>
<td>1080</td>
<td>758</td>
<td>723</td>
<td>887</td>
<td>6270</td>
</tr>
<tr>
<td>Mean (±SD)</td>
<td>14(±7)</td>
<td>14(±7)</td>
<td>14(±6)</td>
<td>15(±6)</td>
<td>15(±6)</td>
<td>16(±6)</td>
<td>17(±6)</td>
<td>18(±6)</td>
<td>15(±7)</td>
</tr>
<tr>
<td>Median</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>IQR</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

**FIGURE 26. LYMPH NODES (LN) EXAMINED IN RESECTED SPECIMEN FOR COLON CANCERS OVER TIME**

![Box plot showing the number of lymph nodes examined in resected specimen for colon cancers over time.](image)
RECTAL CANCER

Rectal cancer poses a different set of challenges to those of colon cancer. Multidisciplinary management with the selective application of neoadjuvant therapy, usually chemoradiotherapy, with cases selected by appropriate local imaging, usually MRI (Magnetic resonance imaging), is integral to management. Surgery for rectal cancer is often challenging, and resection margin involvement by tumour results in a significantly higher risk of local recurrence. Margin involvement is hence a surrogate marker of quality of surgery. Margin involvement may be unavoidable in some cases due to the local stage of the tumour at presentation, and it is important that these patients receive preoperative neoadjuvant therapy if possible. An additional indicator of quality is permanent stoma rate, which should usually be as low as possible. Approximately half the cases were discussed at a multidisciplinary meeting and the proportion undergoing MRI staging has increased from 40% to almost 70%. Just under half the patients received neoadjuvant therapy prior to surgery. The surgical approach has evolved with only 15% undergoing a minimally invasive approach in 2007 and almost 50% undergoing a minimally invasive approach for resection in 2014.

The permanent stoma rate has a wide spectrum with higher volume centres demonstrating a lower rate of permanent stoma. A few centres do have a high permanent stoma rate however this may not be representative as the number of cases submitted is small. Circumferential margin involvement rate is stable between 2007 and 2014 at around 10%.

<table>
<thead>
<tr>
<th>NUMBER OF RECTAL CASES</th>
<th>PERCENTAGE OF RECTAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not discussed at MDT</td>
<td>588</td>
</tr>
<tr>
<td>Discussed at MDT</td>
<td>606</td>
</tr>
<tr>
<td>Total</td>
<td>1194</td>
</tr>
</tbody>
</table>

**TABLE 19. PROPORTION OF RECTAL CANCER CASES DISCUSSED AT MULTIDISCIPLINARY TEAM MEETING (MDT) (BASED ON 1194 TREATMENT EPISODES)**

**FIGURE 27. PROPORTION OF PATIENTS WITH RECTAL CANCER UNDERGOING MRI SCAN AS PART OF STAGING OVER TIME (BASED ON 2010 TREATMENT EPISODES)**
### TABLE 20. USE OF NEOADJUVANT THERAPY FOR RECTAL CANCER AND TYPE OF THERAPY (BASED ON 3043 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>Neoadjuvant therapy</th>
<th>Number of Rectal Cases</th>
<th>Percentage of Rectal Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1407</td>
<td>46%</td>
</tr>
<tr>
<td>No</td>
<td>1636</td>
<td>54%</td>
</tr>
<tr>
<td>Total</td>
<td>3043</td>
<td>100%</td>
</tr>
</tbody>
</table>

### FIGURE 28. NEOADJUVANT THERAPY USE FOR RECTAL CANCER AND TYPE OF THERAPY (BASED ON 1407 TREATMENT EPISODES)

- Short Course radiotherapy: 40
- Long Course Chemoradiotherapy: 300
- Other: 1067

### TABLE 21. PRIMARY PROCEDURE FOR PATIENTS WITH RECTAL CANCER (BASED ON 3163 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>Primary Procedure</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proctocolectomy</td>
<td>54</td>
<td>2%</td>
</tr>
<tr>
<td>High anterior resection (10.1-15)</td>
<td>97</td>
<td>3%</td>
</tr>
<tr>
<td>Low anterior resection (6.1-10)</td>
<td>594</td>
<td>19%</td>
</tr>
<tr>
<td>Ultra low anterior resection (0-6)</td>
<td>1351</td>
<td>43%</td>
</tr>
<tr>
<td>APR</td>
<td>627</td>
<td>20%</td>
</tr>
<tr>
<td>Hartmanns</td>
<td>140</td>
<td>4%</td>
</tr>
<tr>
<td>Miscellaneous operation (eg. for complication)</td>
<td>16</td>
<td>1%</td>
</tr>
<tr>
<td>Colo-anal anastomosis</td>
<td>29</td>
<td>1%</td>
</tr>
<tr>
<td>Local excision</td>
<td>72</td>
<td>2%</td>
</tr>
<tr>
<td>TEMS/TAMIS</td>
<td>68</td>
<td>2%</td>
</tr>
<tr>
<td>Laparotomy only</td>
<td>12</td>
<td>0%</td>
</tr>
<tr>
<td>Other</td>
<td>103</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>3163</td>
<td>100%</td>
</tr>
</tbody>
</table>
FIGURE 29. DETAILED OPERATIVE APPROACH OVER TIME FOR RECTAL CANCER (BASED ON 3073 TREATMENT EPISODES)

- Transanal
- Robotic
- Conversion of Laparoscopic
- Hybrid
- Laparoscopic
- Open

FIGURE 30. PERMANENT END STOMA RATE PER UNIT COMPARED TO NUMBER OF CASES USING UNADJUSTED DATA (BASED ON 57 UNITS)

*Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and the data has not been risk-adjusted.*
TABLE 22. CIRCUMFERENTIAL MARGIN INVOLVEMENT OVER TIME IN RECTAL CANCER (BASED ON 2562 CASES)

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative (&gt;1mm)</td>
<td>86</td>
<td>202</td>
<td>224</td>
<td>322</td>
<td>297</td>
<td>239</td>
<td>211</td>
<td>424</td>
<td>2005</td>
</tr>
<tr>
<td>Positive (&lt;=1mm) (%)</td>
<td>15 (13)</td>
<td>17 (7)</td>
<td>22 (7)</td>
<td>41 (10)</td>
<td>30 (7)</td>
<td>35 (11)</td>
<td>14 (5)</td>
<td>28 (6)</td>
<td>202 (8)</td>
</tr>
<tr>
<td>Not reported</td>
<td>19</td>
<td>33</td>
<td>49</td>
<td>49</td>
<td>85</td>
<td>56</td>
<td>38</td>
<td>26</td>
<td>355</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>252</td>
<td>295</td>
<td>412</td>
<td>412</td>
<td>330</td>
<td>263</td>
<td>478</td>
<td>2562</td>
</tr>
</tbody>
</table>

FIGURE 31. CIRCUMFERENTIAL MARGIN INVOLVEMENT OVER TIME IN RECTAL CANCER (BASED ON 2562 CASES)

TABLE 23. USE OF NEOADJUVANT THERAPY AND MARGIN INVOLVEMENT (BASED ON 2525 TREATMENT EPISODES)

Margin involvement increases the risk of local recurrence of rectal cancer after surgery. This risk is reduced if neoadjuvant therapy, consisting of radiotherapy with or without chemotherapy, is used prior to surgery. This therapy is optimal if applied prior to surgery, and hence prior to knowledge of margin involvement. The difficulty is identification of patients preoperatively who are at an increased risk of margin involvement and hence would benefit from neoadjuvant therapy. The proportion of patients not receiving neoadjuvant therapy and who have involved margins should be as small as possible.

<table>
<thead>
<tr>
<th>YES NEOADJUVANT THERAPY (%)</th>
<th>NO NEOADJUVANT THERAPY (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative (&gt;1mm) 951 (79)</td>
<td>1031 (78)</td>
<td>1982 (78)</td>
</tr>
<tr>
<td>Positive (&lt;=1mm) 113 (9)</td>
<td>88 (7)</td>
<td>201 (8)</td>
</tr>
<tr>
<td>Not reported 140 (12)</td>
<td>202 (15)</td>
<td>342 (14)</td>
</tr>
<tr>
<td>Total 1204 1321 2525</td>
<td></td>
<td>2525</td>
</tr>
</tbody>
</table>
### TABLE 24. SURGICAL AND MEDICAL COMPLICATIONS OF PATIENTS UNDERGOING SURGERY FOR RECTAL CANCER (BASED ON 3138 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th>SURGICAL COMPLICATIONS</th>
<th>975</th>
<th>31%</th>
<th>MEDICAL COMPLICATIONS</th>
<th>442</th>
<th>14%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal pelvic collection</td>
<td>127</td>
<td>4%</td>
<td>DVT PE</td>
<td>27</td>
<td>1%</td>
</tr>
<tr>
<td>Anastomotic leak</td>
<td>92</td>
<td>3%</td>
<td>Chest infection</td>
<td>124</td>
<td>4%</td>
</tr>
<tr>
<td>Enterocutaneous fistula</td>
<td>2</td>
<td>0%</td>
<td>Cardiac</td>
<td>151</td>
<td>5%</td>
</tr>
<tr>
<td>Superficial wound dehiscence</td>
<td>77</td>
<td>2%</td>
<td>Other medical complications</td>
<td>222</td>
<td>7%</td>
</tr>
<tr>
<td>Deep wound dehiscence</td>
<td>37</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>145</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td>93</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged ileus</td>
<td>351</td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small bowel obstruction</td>
<td>58</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary retention</td>
<td>155</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ureteric injury</td>
<td>10</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Splenectomy</td>
<td>6</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative haemorrhage</td>
<td>40</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other surgical complications</td>
<td>190</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1383</td>
<td></td>
<td>Total</td>
<td>524</td>
<td></td>
</tr>
</tbody>
</table>

* From 3138 Treatment episodes there were 975 TEs with 1383 surgical complications: 31% with complications.

From 3138 Treatment episodes there were 442 TEs with 524 medical complications: 14% with complications.

### FIGURE 32. RELATIVE FREQUENCY OF SURGICAL COMPLICATIONS IN RECTAL CANCER COMPARED TO NUMBER OF CASES RECORDED PER UNIT USING UNADJUSTED DATA (BASED ON 57 UNITS)

* Dotted curves represent two standard deviations (95% confidence intervals) and three standard deviations (99.8% confidence intervals) from the mean and the data has not been risk-adjusted.
ADJUVANT THERAPY

Chemotherapy is an important component of multidisciplinary care of patients with colorectal cancer. It is not indicated in all cases but has demonstrated improvement in survival in select groups of patients. It may be given postoperatively in the adjuvant setting in order to reduce the risk of recurrence of cancer and should be considered in patients where there has been spread of the tumour to lymph nodes, node positive or Stage III cases, or in high risk node negative tumours. As patients get older or develop more co-morbidities, the risk-benefit curve shifts such that it may not be appropriate to administer adjuvant chemotherapy to those patients.

The data demonstrates a fairly high rate of chemotherapy use in Stage III patients in the adjuvant setting. The rate remains fairly stable over time but does diminish with increasing patient age, particularly with patients over 80 years. The use of chemotherapy in Stage II cases is more selective and it is interesting to see the drop-off in application at age 50.

### TABLE 25. PERCENTAGE OF STAGE II AND III CANCER PATIENTS RECEIVING CHEMOTHERAPY (BASED ON 3910 TREATMENT EPISODES)

<table>
<thead>
<tr>
<th></th>
<th>&lt;30</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60-69</th>
<th>70-79</th>
<th>80-89</th>
<th>90+</th>
<th>OVERALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received Chemo</td>
<td>90%</td>
<td>68%</td>
<td>80%</td>
<td>59%</td>
<td>46%</td>
<td>29%</td>
<td>7%</td>
<td>5%</td>
<td>35%</td>
</tr>
<tr>
<td>Stage III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received Chemo</td>
<td>95%</td>
<td>93%</td>
<td>96%</td>
<td>93%</td>
<td>94%</td>
<td>87%</td>
<td>51%</td>
<td>6%</td>
<td>85%</td>
</tr>
</tbody>
</table>
FUTURE DIRECTIONS

SURGEON RECRUITMENT

The shift of the Bi-National Colorectal Cancer Audit (BCCA) to an online system has demonstrated improved completeness of data entry and provides instant data feedback to participants and the ability for individual surgeons to benchmark their data. At present, only approximately 10% of colorectal cancer cases are submitted to the BCCA, and hence the data is likely to demonstrate a skewed view of colorectal cancer care across Australia and New Zealand. Increasing the proportion of surgeons undertaking colorectal cancer surgery that submit data to the BCCA is a key goal for the future and will provide greater validity to the registry as a reflection of colorectal cancer care across Australia and New Zealand.

QUALITY IMPROVEMENT

The potential of the registry to facilitate quality improvement is substantial. It provides an overview of colorectal cancer care rather than the more limited snapshot that is provided in the literature through individual unit reporting. With progressive increase in the number of surgeons and units submitting data, the intention is to risk adjust the data with respect to the individual cases. It is essential that this is undertaken in a transparent manner and that interpretation of the data is not inappropriately dramatised. Until all colorectal cancer patients are submitted, data interpretation may be skewed, however risk adjustment will allow individual units to assess their outcomes more clearly and provide the opportunity to highlight areas where patient care can be improved. Submission to the BCCA remains voluntary and hence it is essential that appropriate Quality Improvement structures and processes are developed to encourage surgeons to participate and submit their data.

RESEARCH

There are currently almost 12,000 cases on the BCCA and this represents a valuable resource from which to undertake research. There has been significant focus recently on health service research and on the potential of registries to generate important research, and the BCCA would definitely fit these requirements. It is essential that everyone who submits patients to the BCCA is enabled to undertake research projects from this resource if they wish and that this is not limited to larger units or academic centres only. Research governance will be developed to support and facilitate this approach.
BCCA PARTICIPATION

Participation in BCCA requires approval from the relevant hospital or health service Human Research Ethics Committee (HREC). The requirements vary from country to country, state to state and public vs. private. Support with ethics applications can be offered by the BCCA Project Manager and for further details about your site please contact the Project Manager directly. Approvals must be up to date for the online model, in the circumstance of the old model being approved and an amendment is yet to be reviewed this data can still be submitted to BCCA Project Manager. Paper forms are no longer accepted from sites who have approval for the online model.

AUSTRALIA

PUBLIC

ACT  Ethics approval via ACT Health HREC
NSW  Ethics approval via Sydney Local Health District HREC and Site Specific Governance approval via the applying hospital’s Research Governance Officer.
NT  Ethics approval via Menzies School of Health Research
QLD   Ethics approval via Metro South Health HREC, Public Health ACT approval via QLD Department of Health and Site Specific Governance approval via the applying hospital’s Research Governance Officer.
SA   Ethics approval via Royal Adelaide Hospital HREC and Site Specific Governance approval via the applying hospital’s Research Governance Officer.
TAS  Ethics approval via the University of Tasmania’s Health and Medical HREC
VIC  Ethics approval via Melbourne Health HREC and Site Specific Governance approval via the applying hospital’s Research Governance Officer.
WA   Ethics approval via Sir Charles Gardiner Hospital HREC and Site Specific Governance approval via the applying hospital’s Research Governance Officer.

PRIVATE

Each hospital is different; some offer national or state approval, others approved via Medical Advisory Committee (MAC) and hospital Executive, and others require and external ethics committee’s approval.

NEW ZEALAND

PUBLIC

All public hospitals approvals are in place via Ministry of Health, Health and Disability Ethics Committees (HDEC)

PRIVATE

Each hospital is different; some offer national approval, others approved via Medical Advisory Committee (MAC) and hospital Executive.

ACCOUNTS

Once relevant ethical approvals are in place the BCCA Project Manager can create individual surgeons their Consultant accounts. These are linked to their email address where the surgeon can control their password. A surgeon can have several different hospitals linked to their account and when logged in can view all of their submitted data.

Several other accounts are available: Site Manager and Data Entry. The Site Manager profile can view and edit data for all surgeons registered at that site and can run all reports available. The Data Entry profile can view and edit data for all surgeons at their site but cannot run all reports. Site Manager and Data Entry accounts can only be linked to one site. Like the Consultant account the password is managed via the linked email address.
BCCA PERSONNEL

COLORECTAL CANCER AUDIT COMMITTEE:
Professor Alexander Heriot (Chair)
Associate Professor Chris Byrne
Clinical Professor Pierre Chapuis
Mr Mark Doudle
Mr Andrew Hunter
Associate Professor Paul McMurrick
Mr James Moore (President, CSSANZ)
Professor Cameron Platell
Mr Mark Thompson-Fawcett

CO-OPTED MEMBERS:
Professor Chris Reid, (Department of Epidemiology & Preventive Medicine, Monash University)
Mr David Morrison, (Clinical Informatics & Data Management Unit, Monash University)

PROJECT MANAGER:
Ms Michaela O’Regan
BCCA Project Manager
Suite 6
9 Church Street
Hawthorn
VIC 3122
Phone: +61 3 9853 8013
Email: bcca@cssanz.org
Website: https://bcca.registry.org.au/
GLOSSARY

BCCA  Bi-National Colorectal Cancer Audit
CSSANZ  Colorectal Surgical Society of Australia and New Zealand
DEPM  Department of Epidemiology and Preventative Medicine, Monash University
CIDMU  The Clinical Informatics and Data Management Unit, Monash University
CCAC  Colorectal Cancer Audit Committee
RACS  Royal Australasian College of Surgeons
CRC Audit  Colorectal Cancer Audit (Extended dataset managed by Associate Professor Paul McMurrick)
ACCORD  The Australian Comprehensive Cancer Outcomes and Research Database
HREC  Human Research and Ethics Committee
HDEC  Health and Disability Ethics Committee
CPD  Continuing Professional Development
MAC  Medical Advisory Committee
FOBT  Faecal Occult Blood Test
NBCSP  National Bowel Cancer Screening Program
ACPGBI  The Association of Coloproctology of Great Britain and Ireland
A La CaRT  Australasian Laparoscopic Cancer of the Rectum Trial: A phase III prospective randomised trial comparing laparoscopic-assisted resection versus open resection for rectal cancer
MRI  Magnetic resonance imaging
ASA  American Society of Anesthesiologists Classification
IQR  Interquartile range
SD  Standard Deviation
DVT PE  Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)
TE  Treatment Episode

REFERENCES


