INTRODUCTION

Colorectal cancer is a major health problem in the Western world. In the UK, it is the second most common cause of cancer death, accounting for some 16,000 deaths in 2003. In 1999 there were approximately 35,000 new cases, of which about 13,000 were rectal and 22,000 colonic.\(^1\) Although the overall numbers in men and women are similar, the incidence of rectal cancer is higher in men, while the incidence of colonic cancer is higher in women. The 5-year relative survival rate is currently in the region of 45%, and has improved slightly over the last 30 years from around 30% in 1971–75.\(^2\)

Perhaps surprisingly, there is no precise definition of colonic cancer. Although the colon comprises all the large bowel proximal to the rectum, the definition of the rectum is unclear. Anatomical texts describe the top of the rectum as the point where the sigmoid mesocolon ends or that part of the large bowel level with the third sacral vertebra.\(^3\) Surgeons, on the other hand, prefer to think of the rectum as the segment of large bowel lying within the true pelvis.\(^4\) As far as rectal cancer is concerned, in 1989 the United Kingdom Coordinating Committee on Cancer Research (UKCCCR) defined this as a tumour within 15 cm of the anal verge on rigid sigmoidoscopy,\(^4\) whereas authorities in the USA have preferred 11 or 12 cm.\(^5\) Perhaps the simplest definition is the intraoperative identification of the fusion of the two antemesenteric taenia into an amorphous area where the true rectum begins.

These distinctions are important for two practical reasons. First, adjuvant radiotherapy is not appropriate for colonic tumours and, secondly, comparisons between outcomes for colorectal cancer surgery in different series are impossible unless clear and uniform definitions are adopted. This is an important problem that has yet to be addressed by international consensus.

NATURAL HISTORY

Within the colon, about 50% of cancers arise in the left side and 25% in the right (Fig. 3.1); in 4–5% of cases there are synchronous lesions.\(^6,7\) It is now widely accepted that the majority of colonic cancers arise from pre-existing adenomatous polyps, the supporting evidence being as follows.

1. The prevalence of adenomas correlates well with that of carcinomas, the average age of patients with adenomas being around 5 years younger than patients with carcinomas.\(^8,9\)
2. Adenomatous tissue often accompanies cancer, and it is unusual to find small cancers with no contiguous adenomatous tissue.\(^10\)
3. Sporadic adenomas are identical histologically to the adenomas of familial adenomatous
polyposis (FAP), and this condition is unequivocally premalignant.  

4. Large adenomas are more likely to display cellular atypia and genetic abnormalities than small lesions.  

5. The distribution of adenomas throughout the colon is similar to that for carcinomas.  

6. Adenomas are found in up to one-third of all surgical specimens resected for colorectal cancer.  

7. The incidence of colorectal cancer has been shown to fall with a long-term screening programme involving colonoscopy and polypectomy.  

It should be recognised that although the majority of adenomas diagnosed in the West are polyoid or exophytic, the flat adenoma (defined as an adenoma where the depth of the dysplastic tissue is no more than twice that of the mucosa) is now a recognised entity. There is good evidence that these lesions are premalignant, and may indeed have a greater tendency towards malignant transformation than polyoid adenomas. They are difficult to find, but may account for up to 40% of all adenomas. Reliable diagnosis requires a skilful experienced colonoscopist and the use of dye sprayed onto the colonic mucosa to highlight the contours of the abnormal tissue.  

When invasion has taken place, colonic cancer can spread directly and via the lymphatic, blood and transcoelomic routes.  

**Direct spread**  

Direct spread occurs longitudinally, transversely and radially, but as adequate proximal and distal clearance is technically feasible in the majority of colonic cancers, it is radial spread which is of most importance. In a retroperitoneal colonic cancer, radial spread may involve the ureter, duodenum and muscles of the posterior abdominal wall; the intraperitoneal tumour may involve small intestine, stomach, pelvic organs or the anterior abdominal wall.  

**Lymphatic spread**  

In general, the lymphatic spread of colonic cancer progresses from the paracolic nodes along the main colonic vessels to the nodes associated with either cephalad or caudal vessels, eventually reaching the para-aortic glands in advanced disease. This orderly process does not always occur, however, and in about 30% of cases nodal involvement can skip a tier of glands. In contrast to rectal disease, it is rare for a colonic cancer that has not breached the muscle wall to exhibit lymph node metastases (overall, about 15% of cases confined to the bowel wall will be found to have lymph node metastases).  

**Blood-borne spread**  

The most common site for blood-borne spread of colorectal cancer is the liver, presumably arriving by the portal venous system. Up to 37% of patients may have detectable liver metastases at the time of operation, and around 50% of patients may be expected to develop overt disease at some time. The lung is the next most common site, with around 10% of patients developing lung metastases at some stage; other reported sites include ovary, adrenal, bone, brain and kidney.
Transcoelomic spread

Colonic cancer may spread throughout the peritoneum, either via the subperitoneal lymphatics or by virtue of viable cells being shed from the serosal surface of a tumour, giving rise to malignant ascites, which is relatively rare.\(^{20}\)

AETIOLOGY

Knowledge of molecular genetics in sporadic colorectal cancer has increased rapidly in recent years, but the stimuli which lead to these carcinogenic changes are still obscure. In this section, a brief consideration of the genetic basis of colorectal cancer is followed by discussion of aetiological factors.

Genetic factors

The genetic changes associated with colorectal cancer have been widely studied, and the molecular background to inherited colorectal cancer is dealt with in Chapter 2. However, the genetic events that take place in the development of sporadic colorectal cancer are also being elucidated. Mutations of the adenomatous polyposis coli (\(\text{APC}\)) gene, which is probably involved in cell–cell adhesion, are thought to occur early as they are found in 60% of all adenomas and carcinomas.\(^{21}\) \(\text{K-ras}\) mutations, which probably stimulate cell growth by activating growth factor signal transduction, similarly occur in both adenomas and carcinomas. However, as they are more common in large adenomas than small adenomas they are thought to represent a later event.\(^{12,22}\) The deleted in colorectal cancer (\(\text{DCC}\)) gene is a tumour-suppressor gene that may be responsible for cell–cell or cell–matrix interactions,\(^{23}\) and its deletion may be important in further progression towards the malignant state. Mutation of the \(\text{p53}\) gene is common in invasive colonic cancers but rare in adenomas and is therefore deemed to be a late event which accompanies the development of the invasive phenotype.\(^{24}\) This is thought to be important as the \(\text{p53}\) protein has roles in the repair of DNA and the induction of programmed cell death.\(^{25,26}\)

The sequence of events described above is depicted in Fig. 3.2, but it must be stressed that this merely illustrates one possible multistep process; indeed,
there is now good evidence that K-ras and p53 mutations very rarely occur in the same tumour, suggesting alternative pathways to carcinogenesis. Many other genetic events have been observed in sporadic colorectal cancer, and no single event has been seen in all cancers. Thus the range of mutations, inactivations and deletions is wide, and it is likely that no single pattern will be applicable to every tumour. Nevertheless, knowledge of specific genetic events that take place in colorectal carcinogenesis may well have implications for diagnosis, prognosis and ultimately for gene therapy. For example, there is now evidence that K-ras mutations are not only associated with advanced stage at presentation but also with poor prognosis in node-negative disease.

This information is now being used in some centres to select patients with apparently early disease for adjuvant chemotherapy.

**Diet**

It is widely held that lack of fibre in the diet is an important factor in the high incidence of colorectal cancer in the West. Burkitt first suggested that, by reducing intestinal transit time and by acting as a diluent, dietary fibre could reduce the exposure of the large intestinal mucosa to potential carcinogens. This hypothesis gained support from epidemiological studies and two recently published major dietary questionnaire studies have indicated strong associations between dietary fibre intake and decreased risk of colorectal cancer or adenoma.

Another dietary influence is animal fat. It has been suggested that a diet rich in animal fats not only causes increased excretion of bile salts in the faeces but also promotes the growth of bacteria that can degrade bile salts to carcinogens. It is also well established that a diet lacking in vegetables is associated with colorectal cancer, and there is good evidence that isothiocyanates in cruciferous vegetables (e.g. broccoli) may be protective by enhancing the expression of carcinogen metabolising enzymes and inducing apoptosis in neoplastic cells.

**Other lifestyle factors**

Other lifestyle factors that have been associated with colon cancer include physical activity, smoking and alcohol intake. There is a consistent inverse relationship between exercise and colon cancer risk in all studies, although the effect seems to be greater in men than in women, avoidance of weight gain also appears to be important. Although earlier studies did not uncover a clear association between smoking and colon cancer, more recent work has shown that long-term smokers are at elevated risk, with relative risks between 1.5 and 3.0. Finally, alcohol consumption may have an association with the disease but the evidence is conflicting, and no definitive statement can be made as yet.

**Bile acids**

There is good evidence that bile acids may act as carcinogens, and this may be related to calcium in the diet. Calcium binds bile acids, and it has been shown that calcium supplementation can bring about a reduction in the risk of recurrent colonic adenomas. It is also of note that secondary bile acid secretion is increased after cholecystectomy, and there is some evidence that this operation may increase the risk of colorectal cancer.

**Bacteria**

Until recently, the role of the colonic flora in the aetiology of cancer has attracted little interest. However, a recent study found that intraepithelial *Escherichia coli* were present in the colonic mucosa of the majority of patients with adenomas or carcinomas but rarely in individuals with normal colons. This interesting finding has opened up a new area of research that has yet to be exploited.

**Predisposing conditions**

Long-standing inflammatory bowel disease, both ulcerative colitis and Crohn’s disease, increases the risk of colorectal cancer, and this is discussed in Chapters 8 and 9. Previous gastric surgery has also been implicated, and although the association is controversial, the risk may be about twofold. Altered bile acid metabolism may play a role in this process, both after gastrectomy and after vagotomy. The risk after uretero-sigmoidostomy is well established, although this operation has now been largely superseded by the use of an isolated ileal conduit for urinary diversion.
PRESENTATION

Colon cancer can present as an emergency or with chronic symptoms that are well recognised. Right-sided cancer typically presents with anaemia, as the liquid nature of the faeces and the wider diameter of the colon make obvious tumour-related symptoms unusual. When the tumour is situated in the descending or sigmoid colon, change of bowel habit, colicky abdominal pain and blood in the stool are the commonest symptoms. Occasionally, the patient may notice the primary tumour as a mass and even more rarely as symptoms of fistulation. A sigmoid cancer may cause pneumaturia and urinary infection by fistulation into the bladder, and a gastrocolic fistula may cause faecal vomiting or severe diarrhoea and weight loss.

Unfortunately, many of the symptoms of colon cancer are common and non-specific, and there has been a good deal of recent work attempting to refine the indications for investigation. Guidelines have been developed to classify those at high risk warranting urgent investigation based on change in bowel habit, rectal bleeding in the absence of anal symptoms, palpable abdominal or rectal masses, and anaemia (Box 3.1). These guidelines are not particularly discriminatory, however, and weighted scoring systems may be more accurate.

INVESTIGATION

When the decision to investigate a patient for colorectal cancer has been made, the choice lies between the combination of barium enema and sigmoidoscopy, colonoscopy or computed tomography (CT) colography.

A barium enema usually demonstrates a colonic cancer as an irregular polypoid lesion or as an ‘apple-core’ stricture with destruction of the mucosal pattern; benign polyps may also be seen as typical filling defects. It must be stressed, however, that false-positive and false-negative results may occur in up to 1% and 7% of cases respectively, and errors usually occur in the sigmoid colon and caecum. These errors can be divided into:

1. perceptive errors, where the original films did indeed show the lesion but the radiologist failed to spot it;
2. technical errors, such as too few films, lack of air contrast and overfilling with barium;
3. limitations of barium radiology itself, particularly in demonstrating small lesions, usually in the caecum, sigmoid colon (especially in the presence of diverticular disease) and rectum, and most particularly when bowel preparation has been poor.

Although rigid sigmoidoscopy can often provide satisfactory views of the rectum, flexible sigmoidoscopy after a cleansing enema is preferred by many. It will provide useful supplementary information, and neoplasia may be detected in the sigmoid colon.

Box 3.1 • UK Department of Health criteria for high and low risk of colorectal cancer

<table>
<thead>
<tr>
<th>Higher risk</th>
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<tbody>
<tr>
<td>• Rectal bleeding with a change in bowel habit to looser stools or increased frequency of defecation persisting for 6 weeks (all ages)</td>
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<tr>
<td>• Change in bowel habit as above without rectal bleeding and persisting for 6 weeks (&gt;60 years)</td>
</tr>
<tr>
<td>• Persistent rectal bleeding without anal symptoms* (&gt;60 years)</td>
</tr>
<tr>
<td>• Palpable right-sided abdominal mass (all ages)</td>
</tr>
<tr>
<td>• Palpable rectal mass (not pelvic) (all ages)</td>
</tr>
<tr>
<td>• Unexplained iron deficiency anaemia (all ages)</td>
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<table>
<thead>
<tr>
<th>Low risk</th>
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</thead>
<tbody>
<tr>
<td>Patients with no iron deficiency anaemia, no palpable rectal or abdominal mass and</td>
</tr>
<tr>
<td>• Rectal bleeding with anal symptoms and no persistent change in bowel habit (all ages)</td>
</tr>
<tr>
<td>• Rectal bleeding with an obvious external cause, e.g. anal fissure (all ages)</td>
</tr>
<tr>
<td>• Change in bowel habit without rectal bleeding (&lt;60 years)</td>
</tr>
<tr>
<td>• Transient changes in bowel habit, particularly to harder or decreased frequency of defecation (all ages)</td>
</tr>
<tr>
<td>• Abdominal pain as a single symptom without signs and symptoms of intestinal obstruction (all ages)</td>
</tr>
</tbody>
</table>

in 25% of cases with ‘normal’ barium enemas, especially if there is coexisting diverticular disease.\textsuperscript{51,52} It may therefore be argued that colonoscopy should be the investigation of choice, but there is little doubt that it carries a risk of perforation (much greater than barium enema), and even in good hands failure to achieve a total colonic examination can be expected in 10% of cases.\textsuperscript{53} In addition, the precise position of a tumour seen at colonoscopy can be very difficult to determine as the only reliable landmarks are the anus and the terminal ileum.\textsuperscript{54}

In the UK, the choice between barium enema and colonoscopy usually depends on local availability and expertise, but if radiology is to be used the rectum must be visualised endoscopically as it is not seen well on radiographs.\textsuperscript{55} If a barium enema is normal in the face of continuing suspicious symptoms, then flexible sigmoidoscopy or colonoscopy as appropriate is mandatory. Likewise, if a primary colonoscopy fails to achieve total colonic visualisation, a completion barium enema should be carried out. Given equal access to either technique, then colonoscopy would be the method of choice when the presenting complaint suggested mucosal pathology (e.g. bleeding or a family history of polyps/cancer) whereas barium radiology would be indicated when there were functional symptoms of altered bowel habit, and especially fistulation or a suspicion of megabowel or sigmoid volvulus.

Preoperative histological confirmation of colonic cancer is ideal, but this can be achieved only by performing endoscopy in every case. If a barium enema demonstrates an unequivocal carcinoma, then biopsy may be deemed unnecessary, but where there is any doubt regarding the nature of a stricture or other lesion, then endoscopic visualisation and biopsy are mandatory.

Occasionally, both barium enema and colonoscopy will be unsatisfactory, either because of poor bowel preparation or through inability to retain contrast or air, especially in elderly patients. In such instances, careful spiral CT of the abdomen may be useful.\textsuperscript{56} CT is also attracting interest as, with appropriate software, it is now possible to carry out CT colography or ‘virtual colonoscopy’, which is effective in detecting polypoid lesions down to 6 mm in diameter.\textsuperscript{57} Although not yet widely available in the UK, this technology is fast becoming a standard investigation and will almost certainly replace barium enema as the radiological investigation of choice.

Many surgeons think it sensible to screen for liver and lung metastases. A fit patient with liver metastases may be suitable for active treatment, whereas an elderly patient with a relatively asymptomatic primary and evidence of widespread dissemination may escape resection. For pulmonary lesions, a chest radiograph is adequate; for hepatic involvement, preoperative ultrasonography, although widely used, does not always achieve an 85% accuracy.\textsuperscript{58,59} For this reason the use of intraoperative ultrasonography has gained ground in recent years, and several studies now indicate its superiority over preoperative examination and intraoperative clinical assessment.\textsuperscript{60}

CT is generally regarded as superior to preoperative ultrasonography\textsuperscript{59} and is accurate in the detection of liver metastases over 1.5 cm in diameter.\textsuperscript{61} It may also provide information on local extension and possible ureteric involvement. Until recently, magnetic resonance imaging (MRI) was considered to be less useful because the long image acquisition time resulted in movement artefact. With ultrafast scanning, however, MRI may yet prove the investigation of choice for both distant and local disease.\textsuperscript{62}

A routine preoperative intravenous urogram, particularly for tumours of the left colon, was once regarded as important,\textsuperscript{63} but opinion has changed and few now perform it as a routine.\textsuperscript{64,65} Under certain circumstances, however, particularly where there is evidence of ureteric obstruction on CT or ultrasound, an intravenous urogram may still be needed.

**SCREENING**

Colon cancer would seem to be a very suitable candidate for screening. Prognosis after treatment is much better in early-stage disease and the polyp–carcinoma sequence (see above) offers an opportunity to prevent cancer by treating premalignant disease. The ideal screening test should detect the majority of tumours without a large number of false positives, i.e. it should have high sensitivity and specificity. In addition, it must be safe and acceptable to the population offered screening.
In colorectal cancer, the most widely studied test is Haemoccult, a guaiac-based test that detects the peroxidase-like activity of haematin in faeces. Because this activity is diminished as haemoglobin travels through the gastrointestinal tract, upper gastrointestinal bleeding is less likely to be detected than colonic bleeding. On the other hand, false-positive results may be produced by ingestion of animal haemoglobin or vegetables containing peroxidase, and dietary restriction is necessary to confirm marginally positive results. In addition, because of the intermittent nature of bleeding from tumours, the sensitivity of Haemoccult is only about 50–70%.

Screen-detected tumours are much more likely to be at an early stage than symptomatic disease, but this does not prove that screening is beneficial. Even improved survival in patients whose tumours are detected by screening is not conclusive because of the biases inherent in screening. These biases are threefold, and comprise selection bias, length bias and lead-time bias.

Selection bias arises from the tendency of people who accept screening to be particularly health conscious and therefore atypical of the population as a whole. Length bias indicates the tendency for screening to detect a disproportionate number of cancers that are slow-growing, and which thereby have a good prognosis. Lead-time bias results from the time between the date of detection of a cancer by screening and the date when it would have been diagnosed had the subject not been screened. As survival is measured from the time of diagnosis, screening advances the date at which diagnosis is made, thus lengthening the survival time without necessarily altering the date of death.

Because of these biases, effectiveness can be assessed only by comparing disease-specific mortality in a population offered screening with that in an identical population not offered screening. This has to be done in the context of a well-designed randomised controlled trial, and for colorectal cancer three trials using faecal occult blood (FOB) have reported mortality data.

The first of these was carried out in Minnesota and showed a significant 33% reduction in colorectal cancer-specific mortality with annual FOB testing and a significant 21% reduction in a group offered biennial screening. However, this study was carried out on volunteers so that it was not a true population study. In addition, the test used rehydrated Haemoccult, which was not very specific and resulted in a large proportion of subjects undergoing negative colonoscopies.

In Nottingham, a strictly population-based randomised study of 150,251 subjects aged 45–74 years has been carried out, with recruitment between 1981 and 1991. At the first round, tests were sent to 75,253 individuals, of whom 53.4% accepted. The test was positive in 906 (2.1%) and, of these, 104 (11%) were found to have carcinoma (46% stage A). Those who completed the tests were offered further screening at 2-year intervals, and an extra 132 cancers (37% stage A) were found. In total, 893 cancers were diagnosed in the study group, of which 26% were detected by screening, 28% presented as interval cancers and 46% arose in patients who had refused the test. At a median follow-up of 7.8 years, 360 individuals had died of colorectal cancer in the study group compared with 420 in the control group. This represents a significant 15% reduction in cumulative mortality (odds ratio 0.85, 95% confidence interval 0.74–0.98). An almost identical study carried out in Funen, Denmark, has obtained very similar results, showing an 18% reduction in mortality.

There seems little doubt that FOB screening can reduce mortality from colorectal cancer, albeit modestly when applied to unselected populations, and the challenges for the future are to increase compliance and to improve the sensitivity and specificity of the screening test.

As 70% of cancers and large adenomas are found in the distal 60 cm of the large bowel, flexible sigmoidoscopy has been proposed as a screening test and there is good evidence that it is more sensitive than FOB testing. The Imperial Cancer Research Fund (now Cancer Research UK) has investigated the role of once-only flexible sigmoidoscopy as a screening modality in a multicentre randomised study, but the effect on mortality is not yet known. Another approach for improving the test is to examine stool for DNA mutations that are known to occur in colorectal cancer. This would be highly specific, but for it to be sensitive such a test would have to be capable of detecting mutations in a
number of genes, as there is no uniform pattern of genetic mutation common to all cancers. However, researchers have been successful in picking up mutations in the APC, K-ras and p53 genes in stool samples from patients with colorectal cancer, and the prospect of a stool test that would scan for a panel of appropriate genetic mutations is not far away.

SURVEILLANCE OF HIGH-RISK GROUPS

Individuals at high risk of colon cancer are not suitable for the population screening strategies described above, as the tests employed are not sufficiently sensitive. Surveillance of patients with inflammatory bowel disease is dealt with in Chapters 8 and 9, and of individuals with a family history of colon cancer in Chapter 2. However, another important group comprises those with adenomatous polyps and, particularly where screening is available, these individuals pose a significant challenge in terms of the use of colonoscopy resources. For this reason, guidelines have been developed that classify patients as being at low, intermediate or high risk of adenoma recurrence.

In the low-risk category (those with one or two adenomas <1 cm in diameter), either no follow-up or a repeat colonoscopy at 5 years is recommended. In the intermediate-risk category (those with three to four adenomas or at least one adenoma >1 cm in diameter), colonoscopy at 3 years is recommended. In the high-risk category (those with five or more small adenomas or three or more where at least one is >1 cm in diameter), patients should have another colonoscopy at 1 year. While the evidence upon which these guidelines is based is not very strong, they represent a very sensible approach, and one that has been adopted widely in the UK.

ELECTIVE SURGERY

Given that a patient is fit for surgery and does not have advanced disseminated disease, resection of colonic cancer is the only advisable primary treatment. It is important to stress that surgery offers a realistic hope of cure in this disease, as two-thirds of patients will survive 5 years after potentially curative resection and recurrence is very rare after 4 years of disease-free survival. In colon cancer, there is now evidence that adjuvant chemotherapy may also be of value; this is dealt with in Chapter 5.

Preparation for surgery

The first priority is to obtain informed consent, and the surgeon must be prepared to discuss the risks of death, complications such as anastomotic dehiscence, venous thromboembolism and wound infection, and disease recurrence. The patient must also be assessed for fitness for operation. This implies obtaining a full history and examination, full blood count, urea and electrolytes, and ECG where indicated. In addition, investigations for disseminated disease should be performed as outlined above.

Blood transfusion

The patient must have blood taken for crossmatch, but the amount of blood requested will depend on the individual procedure. Group and save alone will be suitable for most right hemicolectomies, whereas for other types of colectomy and depending on the operating technique it is prudent to have at least two units of blood available.

There is still some debate as to the effects of blood transfusion on prognosis in colorectal cancer. Since the report by Burrows and Tartter that blood transfusion may be associated with an increased likelihood of recurrence, there have been many reports, some making allowance for case mix, that have reached conflicting conclusions.

Recently, however, a randomised trial comparing the use of predeposited autologous and allogeneic blood in patients undergoing resection for colorectal cancer showed no difference in prognosis. For this reason, the observed effects of blood transfusion on recurrence must be treated with caution.

Bowel preparation

Immediately before surgery, most surgeons require the patient to undergo some form of mechanical bowel preparation. A wide variety of washouts, enemas and purgatives have been used, and one of the most popular regimens uses Picolax. This combines a senna compound (10 mg sodium
picosulphate), which is activated by colonic bacteria and causes vigorous mass contraction, with magnesium citrate, which reduces water and sodium reabsorption so that a large hyperosmolar fluid load reaches the caecum. This is usually given in the morning and the afternoon of the day before operation; however, although it is easy to take, it often causes abdominal discomfort and may cause dehydration unless extra fluids are taken either by mouth or intravenously. A popular alternative is polyethylene glycol salt solution, which can achieve preparation within 3 hours, and this appears to be preferred by patients to more conventional approaches. However, it does necessitate 4–5 L of oral intake, and some elderly patients find this difficult. Nasogastric whole-gut irrigation with an electrolyte solution obtains excellent results, but patients find it very unpleasant.

Whatever approach is taken, care must be taken not to attempt preoperative preparation in the presence of obstruction. If a patient experiences excessive pain or abdominal distension during preparation, it should be stopped. In such cases, the use of intraoperative preparation should be considered (see below).

Finally, it is by no means certain that bowel preparation is essential to prevent anastomotic leakage or its consequences. Most anastomotic leaks are caused by technical error (such as poor knotting/suturing or too much tension) or biological failure (usually from ischaemia), neither of which will be influenced by bowel preparation. The effects of an early leak (usually due to poor technique) would probably be obviated by bowel preparation, but most leaks occur late after the patient has recommenced oral feeding so that any value of preoperative bowel preparation will have been lost.

Thromboembolism prophylaxis

Although there have been no studies confined to patients with colorectal cancer, a meta-analysis of appropriate randomised trials has shown that rates of deep vein thrombosis, pulmonary embolism and death from pulmonary embolism can all be significantly reduced by the use of subcutaneous heparin in general surgical patients.

Offset against the advantages are the problems of increased bleeding, particularly when performing pelvic surgery, so that there still remains room for surgeons to choose. Low-molecular-weight heparin has received attention recently, and a large randomised trial of patients undergoing abdominal surgery has shown that it is less likely to cause bleeding-related complications than standard heparin.

Other measures include graduated compression stockings, intravenous dextran and intermittent pneumatic calf compression. Stockings alone are less effective than other methods and dextran is not as effective as heparin, but there is at least one trial indicating that intermittent compression is equivalent to heparin in reducing the incidence of deep vein thrombosis.

Antibiotic prophylaxis

All patients should receive antibiotic prophylaxis, as there is good evidence from several randomised trials that systemic antibiotics reduce the risk of sepsis after colorectal surgery.

The choice of antibiotic and the route of administration are still open to debate, but in the UK the intravenous use of metronidazole for Bacteroides fragilis combined with broad-spectrum cover against gut anaerobes is favoured. A single dose of cephalosporin plus metronidazole is just as effective as a three-dose regimen in preventing wound infection.

If there is significant contamination at the time of surgery, then prolonging antibiotic therapy for 3–5 days may be appropriate. Whatever regimen is used, it is important that the antibiotics are given immediately before the inoculation of bacteria into the wound, and the ideal timing is immediately after induction of anaesthesia.

Bladder catheterisation

This is usually done after the patient has been anaesthetised in order to monitor urine output perioperatively and postoperatively. The urethral route is most commonly used, although there is evidence that suprapubic catheterisation may be preferable.
Resection

Radical excision of a colonic tumour along with the appropriate vascular pedicle and accompanying lymphatic drainage is the most appropriate operation to obtain local control. Occasionally, a very limited resection may be appropriate in an unfit patient or one with widespread disease.

Classical resection removes the lymphatic drainage that lies along the arterial blood supply, thereby rendering the associated colon ischaemic; thus right hemicolecotomy removes the ileocolic and right colic arteries, transverse colectomy removes the middle colic artery and left hemicolecotomy removes the left colic artery. However, transverse colectomy has fallen out of favour owing to a perception that anastomotic leakage is unacceptably high, and the distinction between left hemicolecotomy and sigmoid colectomy is irrelevant if the principle of radical excision of the vascular pedicle is accepted. Thus, many surgeons would now hold that the decision as to type of operation lies between right hemicolecotomy and left hemicolecotomy, with the extent of bowel resection dependent on site of tumour.

A standard right hemicolecotomy involves division of the ileocolic and right colic arteries at their origins from the superior mesenteric artery (Fig. 3.3). The marginal artery or the right branch of the middle colic artery will also need division to complete vascular isolation. For tumours of the descending colon and sigmoid colon, a formal left hemicolecotomy involves division of the inferior mesenteric artery at its origin from the aorta (Fig. 3.4).

Splenic flexure carcinoma

The main controversy arises with tumours in the region of the splenic flexure, and here there are two options. One is to regard the tumour as left sided and to carry out a left hemicolecotomy, dividing the inferior mesenteric artery at its origin and dividing the left branch of the middle colic artery. A more conservative approach to this operation is to preserve the inferior mesenteric trunk, but this is essentially a segmental resection. The other approach is to carry out an extended right hemicolecotomy, dividing the middle colic artery and the ascending branch of the left colic artery.

Expert opinion is divided as to which approach to take, but left hemicolecotomy will necessitate anastomosis between right colon and rectum, which may be difficult to achieve without tension in some patients. Furthermore, the blood supply of the colon is inconstant. In 6% of cases there is no left colic artery and the blood supply of the splenic flexure is from the middle colic artery. In 22% of cases the middle colic artery is absent and the blood supply of the splenic flexure comes from both the left and right colic arteries. A cancer operation involves removing the tumour with its associated lymphatic drainage, and as the lymphatic drainage follows the arterial blood supply, it would seem sensible to ligate the right colic, middle colic and left colic arteries, making extended right hemicolecotomy necessary.

For these reasons, I prefer extended right hemicolecotomy, with an anastomosis between sigmoid colon and mobile well-vascularised ileum. It must be stressed, however, that the ideal operation will be dictated by individual anatomy, the most important criteria being lack of tension and good blood supply as evidenced by brisk bleeding and good colour at the cut bowel ends.
The Large Bowel Cancer Project found a high local recurrence rate and poor survival for patients with splenic flexure carcinoma, regardless of stage and presentation, which may reflect surgical inadequacy of primary treatment.98

Advanced tumours

When a tumour is locally advanced, it may still be possible to achieve a curative resection if the surgeon is prepared to resect adjacent involved organs, such as ureter, duodenum, stomach, spleen, small bowel, bladder and uterus (Rupert Turnbull at the Cleveland Clinic classified tumours that involved other organs as Dukes’ D, for which he achieved a number of cures). In addition, about 5% of women will have macroscopic ovarian metastases99 and a further 2% will have microscopic disease.100 For this reason, a few surgeons carry out routine oophorectomy in all women with colorectal cancer.

In a patient with a truly inoperable tumour of the colon an ileocolonic bypass may be appropriate for lesions of the right side, whereas for tumours of the distal colon a defunctioning colostomy may be preferable. With multiple colonic tumours, a subtotal or total colectomy should be considered.

Operative technique

RIGHT HEMICOLECTOMY

I prefer midline incisions for all colonic resections, as there is no muscle damage and access is gained to all parts of the abdomen and pelvis. For a right hemicolectomy it is useful to have two-thirds of the incision above the umbilicus to facilitate mobilisation of the hepatic flexure.

With the surgeon standing on the patient’s left, the right colon is retracted towards the midline, and the peritoneum in the right paracolic gutter is divided. This extends from the caecal pole to the hepatic flexure, and distal to this point the lesser sac is entered and the greater omentum divided below the gastroepiploic arcade up to the point of intended division of the transverse colon. The right colon is then retracted firmly towards the midline, and the plane between the colonic mesentery and the posterior abdominal wall is carefully developed with diathermy or scissors, taking care not to damage the duodenum. If this is done, the ureter and gonadal vessels will fall away safely.

It then remains to divide the appropriate colonic vessels as described above, which can be facilitated by transillumination of the mesentery. Once done, the bowel wall is cleared at the sites of transection and single crushing clamps are applied. Soft clamps may be applied on proximal small bowel and distal large bowel, and the bowel is divided on the crushing clamps, leaving them on the specimen.

LEFT HEMICOLECTOMY

For all left-sided colonic resections, it is advisable to place the patient in the Lloyd-Davies position, as standing between the legs is an advantageous position for an assistant, and it also allows the operator excellent access to the splenic flexure. (Editor’s note: at St Mark’s Hospital even patients for right colon operations are placed in the lithotomy–Trendelenburg position, not only for distribution of surgeon, assistants and scrub nurse around the operating table but also because at times right-sided tumours or Crohn’s disease will be found
to involve the rectum.) A long midline incision is employed, extending from above the umbilicus to the pubis. The operator stands on the patient’s left side, and one assistant retracts the sigmoid colon medially while the other retracts the lower left abdominal wall.

The peritoneum lateral to the sigmoid and descending colon is divided close to the ‘white line’ of fusion using diathermy or a knife. It should then be possible to see the plane between the mesentery and the retroperitoneal structures, which can be further developed using a combination of firm medial traction of the bowel by the assistant and countertraction applied by the operator on the retroperitoneum using a swab or forceps. This manoeuvre will ensure that ureter and gonadal vessels are swept away. Care must be taken to identify the hypogastric nerves, and these should be separated from the mesentery or they may be damaged as the upper rectum is prepared for anastomosis. The splenic flexure should then be mobilised, and this is best done by dissecting the greater omentum off the transverse colon and continuing laterally towards the flexure. However, if the tumour is in the region of the splenic flexure, it is advisable to divide the gastrocolic ligament and take the omentum with the specimen. In either event, the spleen is at risk from tears caused by traction on its peritoneal attachments, and despite extreme care splenectomy is sometimes necessary. For minor tears, however, application of a haemostatic agent such as oxycellosis is sufficient.

Once the left colon has been mobilised, the origin of the inferior mesenteric artery is identified by dividing the peritoneum over the aorta close to the fourth part of the duodenum, ligated and divided. To obtain full mobility it is then necessary to divide the inferior mesenteric vein just below the inferior border of the pancreas. The colon is then divided as described for right hemicolectomy at a convenient point in the transverse colon and at the rectosigmoid junction.

‘NO-TOUCH’ TECHNIQUE

It has been argued that early vascular ligation before mobilisation of the tumour, sometimes even supported by the use of proximal and distal occluding tapes around the bowel, prevents embolisation of tumour cells and improves survival.

ANASTOMOSIS

For anastomosis after resection of a colonic cancer, I prefer to use hand suturing, although it is appreciated that stapling may produce excellent results.

Appositional serosubmucosal anastomosis

This method, initially described by Matheson et al., utilises a single layer of interrupted 3/0 braided polyamide. For mobile anastomoses (usually ileocolic) the first step is to ensure that the ends to be anastomosed are roughly equal in circumference. This is usually achieved by making an incision on the antimesenteric aspect of the small bowel, although some surgeons prefer to use an end-to-side technique. One side of the anastomosis is performed on the serosal aspect of the bowel between the mesenteric and antimesenteric borders, placing the sutures 4 mm apart and 4 mm deep, ensuring that the muscle layer and the submucosa but not the mucosa have been included (Fig. 3.5). The sutures are left untied until they have all been inserted (Fig. 3.6), and each knot is then tied by hand to ensure a snug but non-constrictive result. The half-completed anastomosis is then turned over and the process repeated. Mesenteric defects are not closed.

For colorectal or ileorectal anastomoses, the posterior row of sutures is inserted first, holding each suture with a specially designed suture clamp or individual artery forceps. If artery forceps are used, they should be threaded on to a forceps holder to avoid tangling. Again, the sutures are tied by hand after insertion of the whole row, the knots being tied on the luminal side of the anastomosis.
after the proximal bowel has been ‘parachuted’ down the sutures to the upper rectum (Fig. 3.7). The knot tails are then cut so that they are covered by the cut edges of the undisturbed mucosal layers. On completion of the posterior aspect of the anastomosis, the anterior part is performed in a similar fashion but with the knots tied on the extraluminal side. This type of anastomosis is greatly facilitated by the use of curved ‘Heaney’ needle holders, with the needle mounted facing out from the convex side of the tip.

Stapled anastomoses
After right hemicolecotomy the most widely employed stapled anastomosis is the ‘functional end-to-end’.

Here, the ends of the colon and ileum are stapled closed at the time of specimen excision, and two small enterotomies are made to permit insertion of the limbs of a linear cutting stapler. The anastomosis is then performed by firing the stapler, taking care not to include mesentery (Fig. 3.8), and after checking the staple line for bleeding the remaining defect is closed with a linear stapler. After left hemicolecotomy, a true end-to-end anastomosis can be performed using a circular anastomosing stapler introduced per anum (Fig. 3.9), although in some male patients the intact rectum can be difficult to negotiate.

Results of anastomotic techniques
The interrupted serosubmucosal technique is recommended for its adaptability to any anastomosis involving the colon, but it is also associated with the best results in the literature, being associated with leak rates of 0.5–3% in sizeable series.\textsuperscript{104,105}

Stapling has been compared with hand suturing in several randomised trials.\textsuperscript{106–110} Although the results vary, there seems to be no consistent difference in colonic anastomotic dehiscence between the two approaches.

In one trial there was evidence that tumour recurrence was less in the stapled group, but no
distinction between rectal and colonic resections was made.\textsuperscript{111}

**DRAINS**

After the anastomosis is complete, many surgeons will leave a drain in the peritoneal cavity either to minimise the consequences of an anastomotic leak or to prevent the accumulation of fluid that might be infected.

However, there is no evidence to support this practice and three randomised trials have shown there to be no advantage associated with drainage of colonic or colorectal anastomoses.\textsuperscript{112–114}

**Postoperative care/complications**

After colectomy, postoperative care is similar to that of any patient undergoing major abdominal surgery. Opiate analgesia is best administered by a patient-driven system, and is usually required for the first two or three postoperative days. Early mobilisation is encouraged, and the urethral catheter should be removed as soon as the patient can cope without it unless there are fluid balance problems.

The patient’s fluid intake is maintained intravenously in the first few postoperative days, but oral fluids can be given from the first postoperative day without mishap and it is my policy to allow patients to regulate their own oral intake. Many surgeons, however, still require active bowel sounds and the passage of flatus before starting fluids in a stepwise fashion.

Lilkewise, nasogastric intubation is often maintained until there is evidence of intestinal activity, although there is good evidence from a randomised trial that it confers no benefit in elective colorectal surgery.\textsuperscript{115}

It is my policy to avoid routine nasogastric intubation after colectomy.

**Anastomotic dehiscence**

Although patients undergoing colectomy may suffer any of the complications associated with major abdominal surgery, it is anastomotic breakdown that is the major source of morbidity specific to this type of operation. Subclinical leaks occur more frequently than clinically obvious leaks,\textsuperscript{116} but after resection of a colonic tumour the overall significant leak rate is currently in the region of 4%.\textsuperscript{6}

A leak may present in a variety of ways and the onset of symptoms may be quite insidious. Warning signs are pyrexia, increasing pulse rate and abdominal distension due to paralytic ileus. The patient may then develop localised or generalised peritonitis, or a faecal fistula, usually through the wound. Occasionally a patient will develop sudden generalised peritonitis and septicemic shock as a result of rapid faecal contamination of the peritoneal cavity.

Because of the heterogeneous nature of the symptoms, a leak should be suspected in any patient with an anastomosis who is not progressing as well as expected, including those with apparent cardiac events. Investigations that may prove useful in a doubtful case include a full blood count, abdominal and chest radiography, water-soluble contrast enema and CT. The white cell count is usually raised, but not inevitably. Plain radiographs will
frequently demonstrate distended loops of bowel and gas may be seen under the diaphragm, although both may be seen after any laparotomy in the absence of a leak. Surgeons often consider the most useful investigation to be a water-soluble contrast enema but many radiologists now favour CT.

The treatment of an anastomotic dehiscence depends on the specific mode of presentation. The patient with general peritonitis requires laparotomy after appropriate resuscitation. The anastomosis should be taken down and the two ends exteriorised if possible; primary repair of the anastomotic dehiscence is doomed to failure and should not be attempted. After dealing with the anastomosis, careful peritoneal toilet must be performed using copious quantities of warm saline with or without antibiotic, and the patient will require at least 5 days of intravenous antibiotic therapy.

In the patient with localised peritonitis who remains otherwise well a conservative approach with systemic antibiotics may be appropriate, although laparotomy should not be delayed if there is any deterioration. A faecal fistula can also be treated in this way but care must be taken with the surrounding skin, and nutritional support may be required if drainage is prolonged.

**Laparoscopic surgery**

Laparoscopic surgery for colonic cancer has excited a great deal of interest in recent years, but there are serious concerns regarding this type of surgery. First, it is technically difficult. As in open surgery, the important principles of traction and precise dissection in the correct plane must be observed for colonic mobilisation, and it can be difficult to obtain adequate vision and the correct angles for this to be done. Intracorporeal anastomosis is likewise awkward, and most surgeons will use an extracorporeal technique where possible. To facilitate complex laparoscopic surgery the concept of hand assistance has arisen; this utilises a special sealing device that allows the introduction of the surgeon’s hand into the peritoneal cavity via a small incision. Although this overcomes some of the problems outlined above, it sacrifices some of the advantages of minimal access in colonic surgery.

The second problem is that of specimen retrieval, and for colonic cancers a relatively large incision has to be made. This negates a lot of the benefit in terms of postoperative pain, and the duration of hospital stay after laparoscopic colorectal surgery is currently little different from that achieved by open surgery.

Port-site tumour recurrence has also been a major concern; although its incidence varies from 1.5 to 21% depending on the series, it is unlikely to be much more than the 1% abdominal wall recurrence rate reported after conventional surgery. Crucial to the future of laparoscopic surgery are long-term data indicating the survival and rates of distant or local recurrence that can be expected after laparoscopic colonic cancer resection. For this reason, randomised trials are being carried out, and in the UK the results of a trial sponsored by the Medical Research Council are awaited. Recently, a Spanish group has reported follow-up of 3–9 years in a randomised trial that has shown a significant benefit for laparoscopic surgery in terms of cancer-related survival. If these findings are replicated by other studies, laparoscopic surgery for colorectal cancer will have come of age, and the onus will be on coloproctologists to embrace this technique.

**EMERGENCY MANAGEMENT**

In the UK, about 20% of patients with colonic cancer will present as an emergency while 16% will present with obstruction. Bleeding and perforation are less common modes of emergency presentation; when perforation occurs, it is often in the caecum as a result of distal obstruction in the face of a competent ileocaecal valve. Obstruction is thus the most likely reason for emergency or urgent operation.

**Investigation**

The patient with obstruction will usually present with colicky abdominal pain and abdominal distension, with a variable degree of vomiting and change in bowel habit. Paradoxically, the obstructed patient may complain of diarrhoea rather than constipation owing to overflow. The first specific investigation in this case will be a plain abdominal radiograph, which will demonstrate the typical features of large or, in the case of an obstructing caecal cancer, small bowel obstruction.
Particular attention should be paid to the size of the caecum on the radiograph, and whether gas is present in small bowel loops. If the caecum is 12 cm or more in diameter and there is no evidence of decompression into the small bowel, then there is significant risk of caecal perforation and urgent intervention is required, particularly if there is local tenderness.

However, before committing the patient to laparotomy, it is important to identify the site of obstruction, as colonic pseudo-obstruction can mimic the clinical and radiological signs of mechanical obstruction. Thus, every patient should have rigid sigmoidoscopy at least to exclude rectal pathology, followed by a water-soluble contrast enema.123 Barium should not be used as it can become inspissated in the segment of colon distal to the obstruction, and if there is a perforation barium can enter the peritoneal cavity with disastrous consequences.

**Management of obstruction**

Once mechanical obstruction is diagnosed and the patient resuscitated, laparotomy should proceed with experienced surgical and anaesthetic staff in attendance, preferably during daylight hours. The first task at laparotomy is usually to decompress the gaseous distension of the large bowel, and this can be achieved by inserting a 19G (white) needle attached to suction into the lumen through a convenient taenia. If a larger tube is required to evacuate large amounts of liquid faeces, this should be inserted into the caecum via an enterotomy in the terminal ileum.

When the bowel can be safely handled, a decision must be made as to the type of operation required. If the obstruction is due to a right-sided lesion, it is usually easy and safe to carry out a standard right hemicolectomy. If, however, the cancer is on the left side, several options are available. Traditionally, obstructing left-sided cancers were treated by a three-stage approach, starting with a defunctioning loop colostomy followed by resection and anastomosis, and then by closure of the defunctioning stoma. This gradually gave way to a two-stage procedure, with primary resection of the tumour in the form of a Hartmann’s operation where the proximal colon is brought out as an end colostomy and the distal segment either closed off or brought out as a mucous fistula.124

Recently, however, there has been a move towards one-stage procedures, and here the choice lies between subtotal colectomy with ileocolic or ileorectal anastomosis and left hemicolectomy after on-table colonic irrigation.125 For tumours in the region of the splenic flexure, the former approach is often sensible, especially if there is doubt about the viability of the caecum.

If a decision is made to perform a left hemicolectomy, then the colon proximal to the site of obstruction should be irrigated using the technique originally described by Dudley et al.127 to produce ideal conditions for the anastomosis. A colostomy is made just proximal to the lesion, taking care not to spill bowel contents, and anaesthetic scavenging tubing is inserted and secured with heavy silk around the bowel wall. The end of this tubing is tied into a large plastic bag which is placed into a bucket on the floor. A large Foley catheter is then inserted into the caecum by means of an enterotomy in the appendix or the terminal ileum, and the balloon inflated (Fig. 3.10). About 3–4 L of warm saline are then infused into the caecum and massaged around the colon to the anaesthetic tubing, pieces of solid faeces being broken up within the lumen by gentle manipulation. This should continue until the effluent is clear. A standard resection and anastomosis can then be safely performed.

Clearly, the choice of operation will depend on individual circumstances, and few surgeons would attempt an anastomosis in the presence of severe intra-abdominal sepsis or in a severely ill patient. In these cases, a Hartmann’s resection is perfectly acceptable, and in some situations a defunctioning stoma may be the best option. Increasingly, expanding metal (wall) stents are being used in obstructing left-sided colonic tumours. Although most experience has been palliative in intent, more lesions are now being treated in this way to allow
decompression followed by bowel preparation and elective resection of the tumour.  

Management of perforation

In the patient who is found to have a perforated caecum as a result of an obstructing distal cancer, an extended right hemicolectomy or subtotal colectomy is the treatment of choice. Whether an anastomosis is fashioned will depend on the degree of peritoneal contamination. For the cancer which has perforated primarily, it is important to resect the lesion itself to eliminate not only the malignancy but also the source of sepsis. This can be technically demanding, and for left-sided lesions will almost always necessitate a Hartmann’s procedure.

Management of advanced disease

The surgical management of the advanced primary tumour is covered in the section on elective surgery. In colonic cancer, local recurrence usually occurs at the suture line and, in the absence of disseminated disease, re-resection should be attempted, although palliative bypass may be all that can be achieved. The patient with distant metastases poses different challenges.

Operable metastases

Hepatic resection for colorectal cancer metastases is now widely practised, but there is still debate as to its value. It has never been tested in a randomised trial, and all comparative studies have used retrospective data from historical controls.  

Nevertheless, with careful patient selection, hepatectomy for colorectal metastases can be associated with a 5-year survival of around 30%. Although the most widely accepted criterion for resection is one to three resectable metastases in one lobe of the liver, many surgeons are now extending their indications. Perhaps the most persuasive argument in favour of hepatectomy comes from the Registry of Hepatic
Metastases in the USA. In a multicentre long-term follow-up study, this group found that after resection of colorectal hepatic metastases, recurrence was very rare after 3 years of disease-free survival, suggesting that about 30% of treated patients were effectively cured. Recently, however, this observation has been challenged by the prospective Gastrointestinal Tumour Study Group trial, which shows a continuing attrition rate up to 5 years after surgery.

The timing of liver resection is also debatable. Although some surgeons advocate immediate operation, especially when the metastases are found synchronously with the primary tumour, leading authorities suggest that a delay of 3–4 months with intensive restaging investigations at the end of this time is appropriate. In this way patients with rapidly progressive disease that is unlikely to benefit from resection will be spared fruitless major surgery. In a proportion of patients with liver disease that is not amenable to resection, in situ ablation using cryotherapy or radiofrequency energy may be employed. This may prolong survival, but as yet must be regarded as palliative.

Pulmonary metastases may also be amenable to resection, but as only 10% of patients develop such metastases and only 10% of these have disease confined to the lung, very few patients will be suitable. Nonetheless, segmental resection of the lung may be associated with 5-year survival rates of 20–40%.

Inoperable disseminated disease

In the patient with widespread disease, chemotherapy containing 5-fluorouracil (5-FU) is the only established therapeutic option, but this can only be regarded as palliative. Few studies have compared chemotherapy with supportive treatment only, and the survival benefits, though significant, are not great.

Pathological staging

Accurate, detailed and consistent pathology reporting for colorectal cancer is important for estimating prognosis and planning further treatment in terms of adjuvant therapy (see Chapter 5). Both macroscopic and histological appearances must be described in some detail, and the following information should be available.

Macroscopic description
1. Size of the tumour (greatest dimension).
2. Site of the tumour in relation to the resection margins.
3. Any abnormalities of the background bowel.

Microscopic description
1. Histological type.
2. Differentiation of the tumour, based on the predominant grade within the tumour.
3. Maximum extent of invasion into/through the bowel wall (submucosa, muscularis propria, extramural).
4. Serosal involvement by tumour, if present.
5. A statement on the completeness of excision at the cut ends (including the ‘doughnuts’ from stapling devices).
6. Number of lymph nodes examined, the number containing metastases, and whether the apical node is involved.
7. Extramural vascular invasion if present.\textsuperscript{143}
8. Pathological staging of the tumour according to Dukes’ classification.\textsuperscript{144}

Dukes’ staging is simple, reproducible and widely recognised, and it should always be used. TNM staging may also be used and the two systems are described in Box 3.2. Some pathologists use the Jass classification,\textsuperscript{145} although its usefulness may be limited by observer variation in the degree of lymphocytic infiltration at the advancing margin of the tumour (one of the four parameters that contribute to the classification) and the fact that its prognostic value appears to be confined to rectal tumours.

After curative resection, cancer registry data indicate that age-adjusted 5-year survival for Dukes’ stage A colonic cancer is 85%, for stage B 67% and for stage C 37%. These results can be improved as evidenced by individual series,\textsuperscript{146} and the ‘Will Rogers’ effect (stage migration owing to variable quality of pathology reporting) may play a role in this respect.

**RECOMMENDATIONS FOR BEST PRACTICE**

The recommendations given here represent a summary of the evidence-based guidelines from the Association of Coloproctology and the Scottish Intercollegiate Guidelines Network for the management of colorectal cancer as they apply to colonic tumours.\textsuperscript{147,148}

**Investigation**

1. Patients with suspicious symptoms or a proven colorectal cancer should be investigated with either endoscopic visualisation of the whole rectum plus a high-quality double-contrast barium enema or a total colonoscopy. Supplementary flexible endoscopy should be carried out where it is impossible, with any certainty, to exclude neoplasia on barium enema.

2. All patients should have preoperative full blood count and urea and electrolyte estimations, and, unless it cannot alter management, screening for lung and liver metastases should be carried out by means of chest radiography and CT or ultrasound.

**Preparation for surgery**

1. All patients undergoing surgery for colorectal cancer should give informed consent. This

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<tr>
<th>Box 3.2 • Clinicopathological staging of colorectal cancer</th>
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<tr>
<td><strong>Dukes’ staging (based on histological examination of the resection specimen)</strong></td>
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<td><strong>Note</strong>: Dukes’ stage D has come to mean the presence of distant metastases.</td>
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<td><strong>TNM staging</strong></td>
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<td><strong>Note</strong>: direct invasion in T4 includes invasion of other segments of the colorectum by way of the serosa, e.g. invasion of the sigmoid colon by a carcinoma of the caecum</td>
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implies being given information about the likely benefits and risks of the proposed treatment and details of any alternatives.

2. Blood should not be withheld if there is a clinical indication to give it, and preparations for blood transfusion should be made in all patients undergoing surgery for colorectal cancer except where an individual patient refuses.

3. Mechanical bowel preparation prior to surgery is recommended.

4. Subcutaneous heparin or intermittent compression should be employed as thromboembolism prophylaxis in surgery for colorectal cancer unless there is a specific contraindication.

5. All patients undergoing surgery for colorectal cancer should have antibiotic prophylaxis. It is impossible to be dogmatic as regards the precise regimen, but a single dose of appropriate intravenous antibiotics appears to be effective.

Elective surgical treatment
1. Any tumour with a distal margin at 15 cm or less from the anal verge using a rigid sigmoidoscope should be classified as rectal.

2. Although no definite recommendations can be made regarding anastomotic technique, the interrupted serosubmucosal method is adaptable to all colonic anastomoses and has the lowest reported leak rate in the literature.

3. Laparoscopic surgery for colorectal cancer should be performed only by experienced laparoscopic surgeons who have been properly trained in colorectal surgery, and who are prepared to audit their results very carefully.

Emergency treatment
1. Emergency surgery should be carried out during daytime hours as far as possible, by experienced surgeons and anaesthetists.

2. In patients presenting with obstruction, steps should be taken to exclude pseudo-obstruction before operation.

3. Stoma formation should be carried out in the patient's interests only and not as a result of lack of experienced surgical staff.

4. The overall mortality for emergency/urgent surgery should be 20% or less.

Adjuvant therapy
Patients with stage C colonic cancer who are medically and psychosocially fit should be offered fluorouracil-containing adjuvant chemotherapy.

Treatment of advanced disease
1. It is recommended that effective palliation with optimal quality of remaining life should be the main aim of therapy in advanced disease.

2. Consideration should be given to palliative chemotherapy in patients with local advanced and metastatic disease. Thus, patients with advanced disease who remain in good general condition should have the opportunity to discuss the possible benefits of palliative therapy with an oncologist.

3. Consideration should also be given to surgical treatment in selected patients with locally advanced and metastatic disease. In particular, the patient with limited hepatic involvement should be considered for partial hepatectomy by an experienced liver surgeon.

Outcomes
Surgeons should carefully audit the outcome of their colorectal cancer surgery.

1. They should expect to achieve an operative mortality of less than 20% for emergency surgery and 5% for elective surgery for colorectal cancer.

2. Wound infection rates after surgery for colorectal cancer should be less than 10%.

3. Surgeons should expect to achieve an overall leak rate below 4% for colonic resection.

4. Surgeons should carefully examine their practice with a view to meeting or improving targets set by national long-term mortality statistics.

Pathology
All resected colorectal tumours should be submitted for histological examination. For this to be useful, the report should reach an acceptable standard, providing information that will be useful in assessing prognosis, planning treatment and carrying out audit.
**Key points**

- It is now accepted that most if not all colon cancers arise from pre-existing adenomatous polyps. However, it has to be recognised that the flat adenoma which can be difficult to detect endoscopically may be a significant precursor lesion.
- While genetic background is clearly important in the aetiology of colorectal cancer, it is now recognised that lifestyle factors are also important. Diet contributes to colorectal cancer in that red meat appears to be a risk factor and both green vegetables and fibre are protective. There is also evidence that exercise and avoidance of weight gain are important protective factors.
- Colonoscopy is the gold standard investigative procedure but there is increasing evidence that CT colography will have an important role to play in the future.
- It is now established that faecal occult blood test screening can reduce colon cancer mortality. The evidence to support flexible sigmoidoscopy screening is awaited.
- Surgery is the only definitive curative treatment for the majority of colon cancers and technique is important to ensure a good outcome. The evidence for laparoscopic surgery for colon cancer is accumulating rapidly and this may be an important therapeutic modality in the future.
- The majority of colon cancers that present as an emergency do so because of intestinal obstruction. It is important that these patients are dealt with by specialist teams and the role of radiological stenting is rapidly expanding.

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This trial provides evidence for the effectiveness of a new chemotherapeutic agent in colorectal cancer.


