

## Latest diagnosis and management of diverticulitis

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### Abstract

Diverticular disease is extremely common especially amongst the elderly. It mainly presents as sigmoid diverticulitis but there is potential for serious complications. In the acute setting Computed Tomography is the gold standard investigation and helps classify the stage. Evidence to support outpatient treatment of uncomplicated diverticulitis is appearing however hospital admission and treatment with intravenous antibiotics is often required and is highly effective. The decision to proceed with elective surgery is judged on an individual basis with a long-term conservative approach suitable for most. For elective surgery there is evidence to advocate a laparoscopic approach. In Hinchey stage III or IV disease, laparotomy followed by either a Hartmann's procedure or ideally, a resection followed by primary anastomosis may be required. Radiologically guided drainage of an abscess is an established alternative and laparoscopic lavage is another less invasive option that has emerged. Following successful acute medical management, colonoscopy is usually performed several weeks after resolution to rule out other colonic pathology.

Keywords: Diverticulitis, Diagnosis, Management, Surgery

### Introduction

A colonic diverticulum is defined as a sac-like protrusion of mucosa through the muscular component of the colonic wall<sup>1</sup>. The terms "diverticulosis" and "diverticular disease" are used to express the presence of diverticula without associated inflammation. While the term "diverticulitis" indicates there is inflammation of a diverticulum or diverticula, which is commonly accompanied by either microscopic or macroscopic perforation<sup>2</sup>.

In the developed world, diverticular disease of the colon is widespread and in those aged over 65 years of age it is present in greater than 65%<sup>3</sup>. The incidence increases dramatically with time and while only 5% of the western population are affected in the fifth decade this rises steeply to over 50% by the eighth decade and 60% in the ninth<sup>4</sup>.

Although diverticulosis is extremely common, complications requiring surgery only occur in 1% of patients overall<sup>5</sup> and 10% of those admitted to hospital as an emergency for treatment<sup>6</sup>. Despite this, there is a substantial healthcare burden inflicted by diverticular disease and within the United States alone it accounts for 312,000 hospital admissions, 1.5 million days of inpatient treatment and a total estimated cost of 2.6 billion dollars per annum<sup>7</sup>.

The aetiology of the diverticulosis is poorly understood but it is probably a multi-factorial process involving dietary habits (specifically low fibre intake) as well as changes in colonic pressure, motility and wall structure that are associated with ageing<sup>8</sup>. The pathogenesis of diverticulitis is also uncertain, however stasis or obstruction in a narrow necked diverticulum leading to overgrowth of pathogens and local tissue ischemia is thought likely<sup>2</sup>.

This review will discuss the common presentations, investigations and current treatment strategies utilised in the management of acute diverticulitis and its complications as well as providing an up to date synopsis of existing recommendations for follow up and prevention.

### Symptoms and Signs

In Western nations, diverticula are most commonly situated in the left colon<sup>9</sup> and 99% of patients will have some element of sigmoid involvement<sup>10</sup>. Therefore patients commonly present with sigmoid diverticulitis that typically displays features of left iliac fossa pain and fever with raised inflammatory markers (see below). Physical exam will disclose left lower quadrant peritonism for simple disease, but in complicated cases physical examination findings may reveal a palpable abdominal mass, evidence of fistulas or obstruction, or widespread peritonitis<sup>11</sup>.

In cases of complicated diverticulosis, a stricture may lead to obstructive symptoms with complaints of nausea, vomiting and distension being present. If a fistula has developed, a history of recurrent urinary tract infection, pneumaturia and faecaluria may also be elicited<sup>12</sup>. In a female with a previous history of hysterectomy suspicion will be further raised as colovesical and colovaginal fistulas are rare in females with their uterus in place. If a patient reports passing stools per vagina, insertion of a vaginal speculum and inspection may confirm this latter diagnosis<sup>12</sup>.

### Differential diagnosis

The differential diagnosis for diverticulitis and its complications is extensive and includes irritable bowel syndrome, inflammatory bowel disease, ischaemic or infective colitis, pelvic inflammatory disease and malignancy. It is obviously most

imperative to exclude the latter differential<sup>4</sup>, particularly in the case of a stricture that is impassable on colonoscopy, as many of these specimens following resection (32% in one series<sup>13</sup>) will transpire to be adenocarcinoma<sup>4</sup>. It should also be noted that sigmoid diverticulitis may also masquerade as acute appendicitis if the colon is long and redundant or otherwise situated within the abdomen or pelvis such that the inflamed segment lies in the suprapubic region, right iliac fossa or McBurney's point<sup>2</sup>.

### Complications

Although diverticulosis is present in nearly two thirds of the elderly population, the vast majority of patients will remain entirely asymptomatic. Even so, an estimated 20% of those affected will manifest symptomatology, mainly as diverticulitis, but potentially with further complications of perforation, abscesses, fistulas, and obstruction, as well as bleeding per rectum<sup>6</sup>.

The European Association for Endoscopic Surgeons (EAES) developed a classification scheme based upon the severity of diverticulitis, which broadly classifies patients into either simple symptomatic or complicated disease (Table 1)<sup>14</sup>. Where an abscess or perforation develops the Hinchey classification is used as a staging tool and can provide prognostic information on the likely outcome (Table 2)<sup>15</sup>.

**Table 1** - European Association for Endoscopic Surgeons classification system for diverticulitis<sup>14</sup>

Grade of disease	Clinical explanation of grade	Clinical state of the patient
I	Symptomatic uncomplicated disease	Pyrexia, abdominal pain, CT findings consistent with diverticulitis
II	Recurrent symptomatic disease	Recurrence of Grade I
III	Complicated disease	Bleeding, abscess formation, phlegmon, colonic perforation, purulent and faecal peritonitis, stricturing, fistula and obstruction

**Table 2** – Hinchey classification of perforated diverticulitis<sup>15</sup>

Hinchey stage	Features of disease	Risk of death <sup>71</sup>
Stage I*	Diverticulitis with a pericolic abscess	5%
Stage II**	Diverticulitis with a distant abscess (this may be retroperitoneal or pelvic)	5%
Stage III	Purulent peritonitis	13%
Stage IV	Faecal peritonitis	43%

\*Stage I has been divided into Ia Phlegmon and Ib confined pericolic abscess in later modifications<sup>38,72</sup>

\*\* Stage II has been divided into IIa abscesses amenable to percutaneous drainage and IIb complex abscess with or without fistula in later modifications<sup>14,73</sup>

Perforation is probably the most feared complication and the annual prevalence of perforated diverticulitis within a northern European population is currently thought to stand at 3.8 per 100,000 of the population, which is a figure that is increasing<sup>16</sup>. Despite this only 1-2% of patients who attend for urgent assessment and treatment will have a gross perforation<sup>2</sup> but for 80% this will be their first presentation so a high index of suspicion is still required<sup>17</sup>.

### Blood investigations

In clinical practice, inflammatory markers, commonly the White Blood Cell (WBC) count and C-Reactive Protein (CRP) level, are frequently employed to assist in diagnosing diverticulitis and its complications. In a recent retrospective study, a White Blood Cell (WBC) count >10,000/ $\mu$ L was present in 62% of patients with Computed Tomography (CT) confirmed diverticulitis and the presence of leukocytosis was significantly more common in patients with diverticulitis and associated perforation than without (86% v 65%, p=0.01)<sup>18</sup>.

CRP has also been shown to be of considerable benefit in the diagnosis of acute left sided colonic diverticulitis<sup>19</sup>. A recently established diagnostic nomogram with a reported accuracy of 86% that was developed to improve the clinical diagnosis of diverticulitis includes an elevated CRP >50mg/l as well other variables including age, previous episodes, aggravation of pain on movement, absence of vomiting and localization of symptoms and tenderness in the left iliac fossa<sup>19</sup>.

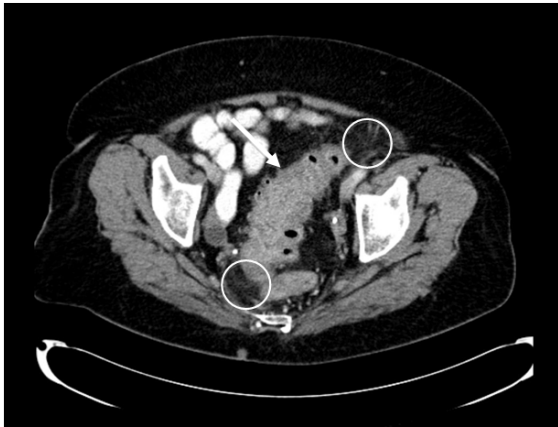
In addition, it has been demonstrated that in acute sigmoid diverticulitis a CRP below 50mg/l is unlikely to correlate with an associated perforation (negative predictive value 79%) while a CRP above 200mg/l is an indicator that the patient may have a perforation (positive predictive value 69%)<sup>20</sup>. In this latter study, CRP also had the highest diagnostic accuracy in diagnosing perforation in acute sigmoid diverticulitis across a range of parameters assessed that included WBC count as well as less commonly used tests like bilirubin and alkaline phosphatase<sup>20</sup>.

### Imaging investigations

In the acute phase of diverticulitis the extent of the extramural component of inflammation is more important than the degree of the intramural inflammation and as such CT associated with the use of intravenous and oral contrast and, in ideal conditions, rectal contrast is the gold standard means of investigation<sup>21</sup>.

CT can accurately identify extra-luminal complications such as an abscess, phlegmon, adjacent organ involvement, or fistula, as well as recognising other alternative diagnoses such as appendicitis, pelvic inflammatory disease, tubo-ovarian abscess or inflammatory bowel disease<sup>22</sup>.

The two most frequent signs of diverticulitis on CT are bowel wall thickening (96%) and fat stranding (95%) (Figure 1) with less common but highly specific signs including fascial thickening (50%), free fluid (45%), and the presence of inflamed diverticula (43%)<sup>23</sup>. Specifically, abscess formation (Figure 2a and b) and extracolonic air or contrast (Figure 3a and b) are findings that are known to predict severity as summarised in the CT classification system developed by Ambrosetti *et al*<sup>24</sup>.



**Figure 1** - Sigmoid diverticulitis: sigmoid colon with multiple diverticula, significant mural thickening (arrow) and pericolic fat stranding (circles)



**Figure 2a** - Sigmoid diverticulitis with abscess formation: sigmoid colon displaying diverticulosis mural thickening, and pericolic fat stranding (arrow). Adjacent low attenuation, septated collection (circle) representing abscess formation.



**Figure 2b** - Sigmoid diverticulitis with abscess formation: sigmoid colon displaying mural thickening, diverticulosis and pericolic fat stranding (arrow). Adjacent low attenuation, septated collection (circle)

representing abscess formation, with adhesion noted to adjacent small bowel loops.



**Figure 3a** - Perforated sigmoid diverticulitis: sigmoid colon displaying diverticulosis and mural thickening (arrow) with adjacent collection of intra-abdominal free air and adjacent inflammatory fat stranding (circle), representing active diverticulitis with perforation.



**Figure 3b** - Perforated sigmoid diverticulitis: sigmoid colon displaying diverticulosis, mural thickening and pericolic inflammatory fat stranding (arrow) with adjacent collection of intra-abdominal free air and adjacent inflammatory fat stranding (circle), again representative of active diverticulitis with perforation.

However despite CT having a reported sensitivity of 97%, specificity of 98%, and global accuracy of 98%<sup>25</sup>, a misdiagnosis of diverticulitis in cancer patients is relatively common and occurs in 5% of cases<sup>21</sup>. Therefore investigation of the colonic lumen by endoscopic means or barium enema after the acute attack is mandatory<sup>4</sup> but avoided in the initial stages for fear of perforation and exacerbation of the disease<sup>2</sup>.

In expert hands ultrasound is the next best alternative investigation with a reported sensitivity of 94%<sup>26</sup>. It has been supported by a recent systematic review<sup>27</sup> as well as current practice guidance<sup>4</sup> and in critically ill patients it avoids the use of intravenous and intra-luminal contrast<sup>21</sup>. However it is rarely used in practice as it is operator dependent<sup>21</sup> and for it to be accurately utilised it requires a highly skilled/trained individual to be available at all times<sup>28</sup>.

The other practical alternative to CT is a hydro-soluble contrast enema, however this investigation is significantly inferior both in terms of sensitivity (98 v 92%,  $p < 0.01$ ) and evaluation of the severity of inflammation (26 v 9%,  $p < 0.02$ )<sup>29</sup>. While Magnetic resonance imaging (MRI) has a good

sensitivity of 94% and a specificity of 87%<sup>30</sup>, in the acute setting it may be impractical both in terms of examination time and patient co-operation<sup>21</sup>. Finally, laparoscopy can also be helpful for diagnostic purposes but again in practical terms, with the increasing availability of cross-sectional imaging, it is rarely required for this purpose<sup>4</sup>.

### Outpatient treatment

Evidence for successful and economical outpatient treatment of uncomplicated diverticulitis is beginning to emerge. In a prospective study of 70 patients classified on the basis of an ultrasound examination as having mild-to-moderate acute colonic diverticulitis (as defined by either limited inflammation within a diverticulum extending up to an abscess < 2 cm in diameter), 68 patients were successfully treated with oral antibiotics with an initial liquid diet and this led to a cost saving on inpatient treatment of 80%<sup>31</sup>.

In a further retrospective analysis, among a cohort of patients who were referred for outpatient treatment it was found that such treatment was effective for 94% of patients, with women and those with free fluid on CT scan appearing to be at higher risk for treatment failure<sup>32</sup>.

In reality the prospect of outpatient treatment in uncomplicated cases of acute diverticulitis is determined largely by access to the necessary investigative tools for accurate diagnosis and staging of disease, the general fitness of the patient, their ability to maintain adequate oral intake, the possibility of further outpatient review, patient compliance with medications, satisfactory social support and ability to plan for endoscopic follow up<sup>21</sup>.

In broad terms, if symptoms are not severe and the patient has no significant co-morbidities and is compliant with medical treatment, then a course of broad spectrum antibiotics can be administered orally on an outpatient basis and the patient followed up at subsequent outpatient clinics. However if the patient is systemically unwell, elderly, has significant co-morbidities or there are any other concerns it is safer to arrange for a hospital admission and treatment with intravenous antibiotics<sup>12</sup>.

### Conservative inpatient treatment

Simple diverticulitis requiring hospital admission is usually treated by rehydration, symptomatic relief and intravenous antibiotics. Most patients with uncomplicated disease respond well to medical treatment and generally experience significant improvement in their abdominal pain, temperature and inflammatory markers within two days of initiation of antibiotic treatment<sup>33</sup>. If this is not the case or there is clinical concern a repeat CT is advocated and operative intervention or percutaneous drainage considered (see below)<sup>2</sup>.

It should be noted at this stage while the use of broad spectrum antibiotics in acute uncomplicated diverticulitis is supported by guidelines<sup>34</sup> there is no actual evidence mandating the routine use of antibiotics in mild uncomplicated diverticulitis<sup>35</sup> and in some European countries it is not routine<sup>36</sup>.

High-quality evidence regarding the most effective type of antibiotic is also lacking<sup>35</sup>. However anaerobic bacteria (usually bacteroides, clostridium, fusobacterium and peptostreptococcus) are the most commonly cultured organisms with gram-negative aerobes, especially *Escherichia coli*, and facultative gram-positives, such as streptococci, often grown as well<sup>37</sup>. Therefore coverage against both Gram-negative and anaerobic bacteria is widely advocated<sup>2 21 38</sup>.

If combination antibiotics are selected, Metronidazole provides excellent anaerobic cover with less risk of *clostridium difficile* infection than alternatives<sup>4</sup>. However use of single agent may be more cost effective<sup>39</sup>. Local protocols are likely to influence selection but the patient may be safely switched from intravenous to oral therapy when they can tolerate a diet and oral medicines<sup>22</sup> as intravenous antibiotics are not felt to be vastly superior<sup>40</sup>. Seven to ten days of antibiotic therapy is an acceptable treatment period<sup>22</sup> however evidence is emerging to support shorter courses<sup>41</sup>.

### Elective surgery

In a recent position statement from the Association of Coloproctology of Great Britain and Ireland (ASCPGBI) it was concluded that the majority of patients, whether young or old, presenting with acute diverticulitis could be managed with a conservative, medical approach in the longer term. Previous blanket recommendations for elective resection e.g. following two acute episodes of diverticulitis<sup>14</sup> were challenged in this statement and it was proposed that the decision on elective resection should be made on an individual basis<sup>4</sup>. The traditional practice of waiting for a period of 4-6 weeks after a diverticulitis attack before performing an elective operation was not disputed<sup>12</sup>.

Surgery in the elective setting can be by either an open or laparoscopic technique with a recent randomised trial identifying a 27% reduction in major morbidity<sup>42</sup> along with less pain, improved quality of life and shorter hospitalization at the cost of a longer operating time with the laparoscopic approach<sup>43</sup>. In expert centres conversion rates as low as 2.8% and median hospital stays of 4 days can be achieved<sup>44</sup> and individual case reports of resections using single laparoscopic port access have also emerged<sup>45</sup>. However if a laparoscopic resection is considered, it is currently recommended that patients should be treated after full recovery from the acute episode of inflammation as there is evidence to suggest lower complication and conversion rates can be achieved<sup>4</sup>.

The principles for both approaches are the same. A colorectal anastomosis is a predictor of lower recurrence rates after elective

sigmoid resection for uncomplicated diverticulitis<sup>46</sup>. Therefore it is recommended that the distal resection margin is taken onto the rectum as opposed to the distal sigmoid and the splenic flexure is fully mobilised to facilitate this<sup>4</sup>, however in the case of a long redundant left colon this may not be necessary<sup>12</sup>. The proximal resection margin is less clear but should be made onto soft compliant bowel<sup>4 34</sup>. Often it is possible to identify the ureters intra-operatively however, there may be cases of complicated diverticulitis in which the extent and degree of inflammatory changes warrant the use of pre-operatively placed ureteric stents to help aid their identification and avoid injury<sup>12</sup>.

### Emergency surgery for complicated diverticulitis

The indications for emergency operative intervention in acute diverticulitis include the presence of generalised peritonitis, uncontained visceral perforation, gross uncontrollable sepsis, a large undrainable or inaccessible abscess, bowel obstruction and lack of improvement or clinical deterioration with initial medical management<sup>2</sup>.

Historically, perforated diverticulitis was treated with a three-stage procedure consisting of faecal diversion with a stoma, resection of the diseased segment of bowel, followed by takedown of the stoma and restoration of intestinal continuity. This then shifted to performing a Hartmann's procedure which includes a primary resection of the diseased segment and end colostomy followed by subsequent colostomy reversal at a second operation<sup>11</sup>. In this case reconstruction generally involves a second laparotomy because although laparoscopic reconstruction is effective, it is infrequently performed<sup>47-48</sup>. As a result reversal is often permanently deferred.

In selected cases the ideal therapeutic option in colonic perforation is a one-stage procedure with resection followed by primary anastomosis, which adds the benefits of being a definitive treatment with the avoidance of the morbidity and mortality associated with a stoma and its reversal<sup>49</sup>. A protective ileostomy after resection and primary anastomosis is viewed as a valid additional step in patients at high risk of an anastomotic leak (immunosuppression, American Society of Anaesthesiologists (ASA) grade IV, faecal peritonitis)<sup>21</sup> but a Hartmann's procedure may also be selected.

Particularly in cases where there is a stricture causing obstruction and significant faecal loading, a resection in conjunction with on-table colonic lavage and primary anastomosis may be used. This technique has also been described as facilitating a primary anastomosis in the case of a perforation<sup>50</sup>. However in certain patients with obstruction depending on the viability of the proximal colon a subtotal colectomy with ileorectal anastomosis may be required<sup>12</sup> and because small-bowel obstruction may also occur, especially in the presence of a large diverticular abscess, this may also warrant further treatment<sup>2</sup>.

The use of endoscopic colonic stenting as a treatment of acute obstruction of the large bowel secondary to colonic cancer has been well documented in the literature either as a definitive procedure or as a bridge to surgery and can effectively decompress the obstructed colon in 90% of cases<sup>51</sup>. However the use of stents in benign disease is less well documented, with it used mainly as a bridge to surgery<sup>52</sup> and because it is associated with a higher incidence of complications in acute diverticular disease<sup>53</sup> it cannot as yet be recommended.

### Laparoscopic surgery in the emergency setting

There have been a number of recent reports of laparoscopic lavage with or without the placement of an intra-abdominal drain for patients with acute diverticulitis and perforation, with the reported advantages including the avoidance of an acute resection and the possibility of a stoma<sup>4</sup>. The evidence that has been produced thus far to support its case is highly promising.

A recent systematic review of laparoscopic lavage for perforated colonic diverticulitis identified two prospective cohort studies, nine retrospective case series and two case reports with 231 patients and the vast majority of patients (77%) had Hinchey grade III purulent peritonitis. Laparoscopic peritoneal lavage successfully controlled abdominal and systemic sepsis in 95.7% of patients, mortality was 1.7%, morbidity 10.4% and only four (1.7%) patients received a colostomy<sup>54</sup>.

In the largest series in the literature to date, Myers *et al* reported 100 patients with perforated diverticulitis and generalised peritonitis. Eight patients with Hinchey IV disease required conversion to an open procedure, with the overall mortality being 4% and recurrence rates only 2% over a median time period of 36 months<sup>55</sup>.

### Percutaneous therapy

The appropriate management of diverticular abscesses is a matter of some debate. However according to the American Society of Colon and Rectal Surgeons (ASCRS) radiologically guided percutaneous drainage is usually the most appropriate treatment for patients with a large diverticular abscess as it avoids the need for emergency surgery and possibility of a colostomy<sup>34</sup>.

When the abscess diameter is over 5 cm, percutaneous CT guided drainage, in combination with antibiotics, is the standard treatment and offers rapid improvement in symptoms in over 90% of cases, albeit with a high recurrence rate in more severe cases<sup>38</sup> and higher likelihood of surgery being needed in those involving the pelvis<sup>56</sup>.

In practical terms diverticular abscesses less than 3 cm in diameter usually cannot be successfully drained, as the diameter of the pigtail of most drainage catheters will be a similar dimension<sup>28</sup>. Also for smaller abscesses<sup>21</sup>, especially those less than 2cm resolution usually occurs with the use intravenous

antibiotics alone<sup>34</sup>. However if a drain is sited it is advisable that before it is removed, resolution of the abscess should be confirmed and a potential bowel fistula excluded by a further contrast study<sup>28</sup>.

Finally, diverticular disease of the colon is also a relatively common cause of acute lower gastrointestinal bleeding and is in fact the diagnosis in 23% of cases<sup>37</sup>. This usually settles with conservative management but if the bleeding is profuse angiography and endovascular intervention may be helpful, with surgery very rarely required for this indication<sup>4</sup>.

### Follow up

Following successful medical management of an acute episode of diverticulitis, colonoscopy, flexible sigmoidoscopy or barium enema should be performed several weeks after the resolution of symptoms to confirm the diagnosis and rule out other colonic pathology such as malignancy, inflammatory bowel disease, or ischemia<sup>22</sup>.

Following surgery there is reported to be a high incidence of the order of 25% for recurrent symptoms, which is put down to the diagnostic overlap that exists with irritable bowel syndrome<sup>58</sup>. However any suspicion of recurrent diverticulitis following surgical resection should be confirmed by CT scan after which antibiotic treatment should be initiated, as for a case of primary uncomplicated disease<sup>12</sup>. If this is excluded the high incidence (17.6%) of symptomatic anastomotic stenosis after elective laparoscopic sigmoidectomy should be borne in mind with the possibility of endoscopic dilatation considered if applicable<sup>59</sup>.

### Summary points

- CT scan is the gold standard means of investigation for acute diverticulitis and helps classify the stage of disease.
- Evidence to support outpatient treatment of uncomplicated diverticulitis is beginning to appear, however hospital admission and treatment with broad spectrum intravenous antibiotics is often required and is highly effective.
- The decision to proceed with elective surgery is judged on an individual basis and there is evidence gathering to advocate a laparoscopic approach.
- In Hinchey stage III or IV disease, emergency laparotomy followed by either a Hartmann's procedure or ideally in selected patients a resection followed by primary anastomosis may be required.
- In certain cases percutaneous radiologically guided drainage of abscesses is an established alternative to open surgery with laparoscopic lavage another less invasive and highly promising option.

### Lifestyle modifications and prevention

Following treatment weight loss, rationalisation of certain medications and exercise are recommended as obesity is significantly associated with an increased incidence of both diverticular bleeding and diverticulitis<sup>60</sup>, as are non-steroidal

anti-inflammatory drugs and paracetamol<sup>61</sup>, with physical activity significantly associated with a reduction in the risk of complications<sup>62</sup>.

Whilst dietary fibre, particularly cellulose<sup>63</sup>, is recommended<sup>22</sup> the evidence that supports these recommendations is not particularly strong<sup>64</sup>. However foodstuffs such as nuts, seeds, popcorn and corn that are usually discouraged have no evidence to support the theory that they may lead to increased complications<sup>65</sup>.

Small studies without control groups suggest that probiotics may have a positive effect on the recurrence of symptomatic diverticular disease<sup>66-67</sup>. Long term administration of the non-absorbable antibiotic Rifaximin has also been used with reported success<sup>68</sup> as has the anti-inflammatory mesalazine<sup>69</sup>. However none of these medications have a strong evidence base and as a result are not in routine use<sup>70</sup>.

### Competing Interests

None declared

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