The use of routine colonoscopy after an episode of acute diverticulitis (AD) remains a point of debate. Most international and clinical practice guidelines advise endoscopy after conservatively treated diverticulitis.1-6 The rationale has always been to exclude an underlying malignancy or advanced colonic neoplasia (ACN). However, this is based merely on expert opinion. A recent article indicated that presently this may be different with increased use of abdominal CT imaging of diverticulitis.7 Furthermore, the yield of colonoscopy in patients after an episode of AD also casts doubt on current international practice.8-20

Routine colonoscopy after an uncomplicated episode of diverticulitis dates from a time where the diagnosis was primarily based on clinical examination and laboratory results with frequent use of barium enema.21 However, in today’s clinical practice, CT is widely used for the diagnosis of diverticulitis, with the possibility to assess potential adverse events such as abscess, fistula, obstruction, or perforation as well. Because of high sensitivity of 94%, a specificity of 99%, and a low interobserver variability, this modality is currently preferred for the diagnosis of diverticulitis, although US also has a good sensitivity.22,23 Nevertheless, it remains uncertain if the prevalence of colorectal carcinoma (CRC) and advanced adenoma (AA) in patients with imaging-proven diverticulitis is higher than in an average-risk population. Apart from diagnosing CRC, the detection of AA is of great importance because it bears the potential to progress to carcinoma.

Colonoscopy is accompanied by such disadvantages as invasiveness and discomfort, potential adverse events such as perforation, and additional costs. It is important to know what the yield of routine colonoscopy is after a confident diagnosis of AD (ie, is there a justified indication?) Therefore, the aim of this systematic review was to determine the pooled prevalence of ACN, thus CRC and/or AA, as detected with colonoscopy in patients after an imaging-proven diagnosis of AD.

METHODS

Review protocol and study eligibility

A review protocol, for which the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist24 served as a guideline, was used by 2 authors (L.D. and C.U.) for the execution of this systematic review.

Eligibility criteria. Definitions. Diverticulitis is complicated diverticular disease with clinical symptoms and evidence of inflammation, confirmed by US or CT imaging. ACN comprises AA and/or CRC. An AA is defined as an adenoma ≥ 10 mm, ≥25% villous features (also classified as tubulovillous or villous histology), or with high-grade dysplasia.25 Right-sided is defined as proximal to the splenic flexure.

Types of studies. There were no predetermined limits of design types or language. Articles were eligible for inclusion when the following criteria were met: studies dealing with follow-up colonoscopy after US- or CT-proven left-sided diverticulitis, human studies, and studies of which the full text and data were available. The following exclusion criteria were used for study selection: studies without follow-up colonoscopy but with CT-colonography or contrast barium enemas instead or with outcome based on surgically obtained pathology specimens.

Types of participants. Patients aged 18 years or older with a recent diagnosis of uncomplicated AD were included. This diagnosis had to be confirmed by US or CT imaging.

Types of outcome measures. Primary outcome measure was the detection of ACN: AA and/or CRC. Secondary outcomes were detection of adenomas and serrated polyps (hyperplastic, sessile serrated adenoma/polyp, and traditional serrated adenoma). Adverse events of colonoscopy were also registered if described.
Assessment of susceptibility to bias

Two reviewers independently assessed the methodologic quality of the studies and susceptibility to bias using the MINORS quality score, an instrument designed to assess the methodologic quality of nonrandomized surgical studies, with a global ideal score of 16 for noncomparative studies.26

Statistical analysis

The primary outcome of this systematic review was the percentage of patients with ACN, and thus CRC and/or AA, as detected with follow-up colonoscopy, after an episode of imaging-proven diverticulitis. Therefore, for each included study, we calculated the 95% confidence intervals (CIs) around the proportions of ACN, CRC, and AA. We calculated the estimated pooled prevalence and 95% CIs based on a random effects model using Meta-Analyst version Beta 3.13 (Tufts Medical Center, Boston, MA, USA). We determined the presence of heterogeneity between the studies by using a forest plot and by performing a χ² heterogeneity test, and the I² index was calculated. To assess publication bias, we performed a funnel plot asymmetry test by using Meta-Analyst version Beta 3.13 as well.

RESULTS

Study selection

A total of 959 records was initially identified in the literature search (Fig. 1). Of these, 234 records were excluded because they were duplicate articles. From the 725 remaining records, screened based on title and abstract, another 694 were excluded because of irrelevance. Most studies were irrelevant because they covered other subjects, among others performance and findings of CT-colonography, screening colonoscopy, comparison of standard colonoscopy versus colonoscopy with transparent cap, management of diverticulitis, and sigmoidovesical fistula. Thirty-one full-text articles were retrieved for more detailed examination; 1 additional article was found in reference lists. These were assessed for eligibility. The application of our inclusion and exclusion criteria resulted in 8 relevant studies. Twenty-three articles were excluded because they were abstracts only, case report, contained duplicate data, or failed to meet our inclusion criteria. The 2 reviewers completely agreed on inclusion of studies.

Study characteristics and risk of bias

Eight studies met our inclusion criteria and were reviewed (Table 1).8-15 The studies were executed on 4 different continents within the time frame 2000 to 2010. All studies were retrospective cohort studies, except for the studies of Chabok et al8 and Lahat et al.15 They compared acceptance and diagnostic accuracy of CT-colonography versus colonoscopy and early versus late colonoscopy respectively. Many of these retrospective cohort studies attempted an indirect comparison with published data on high- and average-risk asymptomatic individuals derived from screening studies.22 Lau et al14 compared their CRC rate with that published by the WA Cancer Registry for all Western Australians; however, these data were not based on population colonoscopic screening.20

In all studies, the diagnosis of AD was imaging proven: CT proven in 6 studies, US and/or CT proven in 1,15 and US
The radiologic definition used for diverticulitis was described in 5 studies.\textsuperscript{10,12-15} The histologic definition for ACN was described in only 3 studies.\textsuperscript{10,12,13} The number of patients enrolled per study ranged from 86 to 402. The studies were of moderate to good quality using the MINORS scoring scale, with total scores ranging from 10 to 14 (Table 2).

Patient cohort and results of individual studies

The clinical characteristics and outcome are summarized in Table 3. A total of 1796 patients, aged around 60, had an imaging-proven diagnosis of uncomplicated diverticulitis with endoscopic evaluation in follow-up. Reported colonoscopy completion rates ranged from 85.4\%\textsuperscript{13} to 93.4\%.\textsuperscript{11} More than half of the studies did not mention adverse events; the 3 that did so stated to have experienced none.

One in 5 patients (20.2\%; 363 of 1796) had at least 1 polyp. All but 3 studies\textsuperscript{8,12,14} referred to the most advanced lesion detected. Chabok et al,\textsuperscript{9} Schout et al,\textsuperscript{11} and Lahat et al\textsuperscript{15} did not mention hyperplastic polyps. None of the included studies described the number of (patients with) sessile serrated adenomas/polyps and traditional serrated adenomas. In 236 of 1695 patients (14\%), adenomas were detected. The exact number of patients may have been slightly different because 1 study did not report on adenomas\textsuperscript{7} and therefore was left aside. Another study\textsuperscript{12} mentioned a total number of 36 adenomatous polyps and not patients.

Thirty-three of 915 patients (3.6\%) were found to have AA; 3 studies did not report on patients with AA and consequently were disregarded in this calculation.\textsuperscript{8,9,11} Twenty-nine of 1796 patients (1.6\%) had CRC detected in follow-up with colonoscopy. In 3 studies, no CRC was found.\textsuperscript{9,12,15} When we take into account only studies that

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**Figure 1.** PRISMA flow diagram showing selection of articles for review and analysis.
TABLE 1. General characteristics of included studies

<table>
<thead>
<tr>
<th>Study, year and country</th>
<th>Study design</th>
<th>Inclusion period</th>
<th>Type of patients</th>
<th>Radiologic diagnosis AD</th>
<th>Definition: AD ACN/AA</th>
<th>Interval of AD to colonoscopy</th>
<th>Endpoint(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elmi et al, 2013, United States</td>
<td>Retrospective</td>
<td>Jan 2000 to Dec 2004</td>
<td>Acute (un)complicated diverticulitis in patients older than 49 years, without a history of CRC</td>
<td>CT</td>
<td>No No</td>
<td>5.3 years (1 month to 11 years, 34.8% &lt; 6 months)*</td>
<td>Sensitivity, specificity, and predictive values of CT parameters for prediction of CRC</td>
</tr>
<tr>
<td>Chabok et al, 2013, Sweden</td>
<td>Prospective comparative</td>
<td>Oct 2005 to Jan 2007</td>
<td>Acute left-sided colonic diverticulitis (without a colorectal examination during the last 2 years)</td>
<td>CT</td>
<td>No No</td>
<td>6-8 weeks</td>
<td>Patient acceptance and diagnostic accuracy of CTC vs colonoscopy for DD, adenomas, and CRC</td>
</tr>
<tr>
<td>Van de Wall et al, 2012, NL</td>
<td>Retrospective cross-sectional</td>
<td>Jan 2007 to Jan 2010</td>
<td>Primary episode diverticulitis (98.5% Hinchey I)</td>
<td>CT (61%) and/or US</td>
<td>Yes Yes</td>
<td>8.9 weeks ± 10.6*</td>
<td>Detection rate of hyperplastic polyps, adenomas, and ACN</td>
</tr>
<tr>
<td>Schout et al, 2012, NL</td>
<td>Retrospective</td>
<td>2000 to 2010</td>
<td>Diverticulitis with or without intra-abdominal abscess</td>
<td>CT or US</td>
<td>No No</td>
<td>NR</td>
<td>Number of malignant and benign colon tumors detected by FU program</td>
</tr>
<tr>
<td>Schmilovitz-Weiss et al, 2012, Israel</td>
<td>Retrospective</td>
<td>Jun 2002 to Sep 2009</td>
<td>AD (exclusion if questionable CT findings and/or hematochezia)</td>
<td>CT</td>
<td>Yes Yes</td>
<td>4-6 weeks</td>
<td>Yield of early colonoscopy and correlation between imaging results and colonoscopy outcomes</td>
</tr>
<tr>
<td>Westwood et al, 2011, New Zealand</td>
<td>Retrospective longitudinal</td>
<td>Jan 2004 to Dec 2008</td>
<td>Acute uncomplicated diverticulitis (exclusion if complicated or mass lesions)</td>
<td>CT</td>
<td>Yes Yes</td>
<td>“After” AD or &lt;2 years before AD</td>
<td>Yield of AON with colonoscopy/CTC</td>
</tr>
<tr>
<td>Lau et al, 2011, Australia</td>
<td>Retrospective</td>
<td>Jan 2003 to Jun 2009</td>
<td>(Un)complicated left-sided diverticulitis</td>
<td>CT</td>
<td>Yes No</td>
<td>70 days</td>
<td>No. of patients in whom CRC were diagnosed and other incidental findings</td>
</tr>
<tr>
<td>Lahat et al, 2007, Israel</td>
<td>Prospective (RCT early vs late colonoscopy)</td>
<td>Jan 2004 to Jun 2006</td>
<td>AD (exclusion if adjacent pericolic air or fluid or free perforation)</td>
<td>CT</td>
<td>Yes No</td>
<td>5.2 days (3-11) vs 7.8 weeks (6-19)*</td>
<td>Feasibility (endoscopic findings and compliance rates) and risk (adverse events)</td>
</tr>
</tbody>
</table>

NR, Not reported; AD, acute diverticulitis; ACN, advanced colonic neoplasia; AA, advanced adenoma; CRC, colorectal carcinoma; CTC, CT-colonography; DD, diverticular disease; NL, The Netherlands; FU, follow-up; RCT, randomized controlled trial.

*Values are means ± standard deviations.

| Values are medians (range). |
reported on both AA and CRC, a total of 45 of 915 patients were diagnosed with ACN (4.9%), comprising either AA or CRC, with a range of 3.4% to 6% between studies. Localization of ACN, specified in 4 studies, was found in all cases except for 1 left-sided or, more specifically, the sigmoid colon. Lau et al14 presented a 5.6% rate of ACN and was the only study to conclude that routine colonoscopy is mandatory in uncomplicated diverticulitis.

**Pooled prevalence**

As shown in Figures 2, 3, and 4, the estimated pooled prevalence was 5.0% (95% CI, 3.8%-6.7%) for ACN, 1.5% (95% CI, 1.0%-2.3%) for CRC, and 3.8% (95% CI, 2.7%-5.3%) for AA as detected at follow-up after an episode of imaging-confirmed AD. There was limited evidence of heterogeneity among included studies for the detection of CRC ($I^2 = 32\%$) and none for ACN ($I^2 < .01\%$) and AA ($I^2 < .01\%$). Results of the funnel plot asymmetry tests are presented in Figure 5 and show some asymmetry that could be indicative of publication bias.

**Excluded studies**

Of the 23 excluded studies, most failed to meet our inclusion criteria and/or were abstracts only. Three studies were excluded because they concerned bowel thickening on CT scan and only a fraction of the included patients (2.8%-29.3%) were diagnosed with diverticulitis or diverticular disease.29-31 Three studies dealt with complicated20,32 or persistent33 diverticulitis. It was concluded that early colonoscopy is mandatory and safe. One study that compared colonoscopy with CT-colonography was excluded because not all included patients had imaging-proven diverticulitis.34 Four studies appeared to meet the eligibility criteria but were excluded because they were abstracts only and not published to date.16-19 Despite inclusion of patients with CT patterns of tumor-like lesions of the sigmoid (5.5%) and sigmoid stenosis (8.3%), Alatawi et al18 found low diagnostic rates for adenomas, AAs, and CRC. The excluded studies, which were considered a relevant addition to obtain a complete overview on current literature, are summarized in Table 4.

**DISCUSSION**

The purpose of this review was to determine the prevalence of ACN as detected with colonoscopy in patients after a diagnosis of AD confirmed by imaging. In our systematic review, the estimated pooled prevalence was 5.0% (95% CI, 3.8%-6.7%) for ACN, 1.5% (95% CI, 1.0%-2.3%) for CRC, and 3.8% (95% CI, 2.7%-5.3%) for AA. The overall adenoma detection rate (ADR) was 14%.

**TABLE 2. Assessment for risk of bias**

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<tbody>
<tr>
<td>1. A clearly stated aim</td>
<td>2 2 2 2 2 2 2 2</td>
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<tr>
<td>2. Inclusion of consecutive patients</td>
<td>2 2 2 1 1 2 1 2</td>
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<td>3. Prospective collection of data</td>
<td>0 2 0 0 0 0 0 2</td>
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<tr>
<td>4. Endpoints appropriate to the aim of the study</td>
<td>2 2 2 2 2 2 2 2</td>
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<tr>
<td>5. Unbiased assessment of the study endpoint</td>
<td>2 2 2 1 2 2 2 2</td>
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<tr>
<td>6. FU period appropriate to the aim of the study</td>
<td>1 2 2 2 2 2 2 2</td>
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<tr>
<td>7. Loss to FU &lt; 5%</td>
<td>2 2 2 2 2 2 2 2</td>
<td></td>
<td></td>
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<tr>
<td>8. Prospective calculation of the study size</td>
<td>0 0 0 0 0 0 0 0</td>
<td></td>
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<tr>
<td>Total score</td>
<td>11 14 12 10 11 11 11 14</td>
<td></td>
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<td></td>
<td></td>
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</tbody>
</table>

FU, Follow-up.
*The items are scored 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate); items 9-12 were left out because they only apply to comparative cohort studies.

Maximal total score of 16 for noncomparative studies.

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<table>
<thead>
<tr>
<th>Study, year</th>
<th>No. of patients</th>
<th>Age (years)</th>
<th>Complete colonoscopy</th>
<th>No. of patients with neoplastic lesions (inclusive of polyps)</th>
<th>No. of patients with adenoma</th>
<th>No. of patients with ACN CRC AA</th>
<th>Age at diagnosis of ACN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elmi et al, 2013</td>
<td>402</td>
<td>63.3 (range, 50-94)*</td>
<td>NR</td>
<td>78 (19.4%) 21 (5.2%) hyperplastic 2 (5.2%) polypoid granulations</td>
<td>55 (13.7%)</td>
<td>NR</td>
<td>68.1*</td>
</tr>
<tr>
<td>Chabok et al, 2013</td>
<td>101</td>
<td>56 (range, 27-84)</td>
<td>100 (of 110; 90.9%)</td>
<td>20 (20%)</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Van de Wall et al, 2012</td>
<td>205</td>
<td>57.3 ± 13.2a</td>
<td>146 (90.6%)</td>
<td>40 (19.5%) 15 (6.8%) hyperplastic</td>
<td>7 (3.4%)</td>
<td>2 (1.0%)</td>
<td>62.7 (37-83)</td>
</tr>
<tr>
<td>Schout et al, 2012</td>
<td>378</td>
<td>NR</td>
<td>NR</td>
<td>47 (12.4%)</td>
<td>39 (10.3%)</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Schmilovitz-Weiss et al, 2012</td>
<td>100</td>
<td>61.8 ± 13.3a</td>
<td>NR</td>
<td>32 (32%) (42 lesions) 5 hyperplastic</td>
<td>NR (36 adenomas); 6 tubulovillous adenomas, 1 &gt; 1 cm 30 tubular adenomas</td>
<td>6 (6%)</td>
<td>NR</td>
</tr>
<tr>
<td>Westwood et al, 2011</td>
<td>205</td>
<td>60 (23-95)†</td>
<td>175 (85.4%)</td>
<td>50 (24.4%) 20 (9.8%) hyperplastic</td>
<td>11 (5.4%)</td>
<td>1 (0.5%)</td>
<td>63 (46-82)</td>
</tr>
<tr>
<td>Lau et al, 2011</td>
<td>319</td>
<td>59.8 ± 15.2a</td>
<td>298 (93.4%)</td>
<td>91 (28.5%) 40% of 82 polyps hyperplastic</td>
<td>18 (5.6%)</td>
<td>9 (2.8%)</td>
<td>NR</td>
</tr>
<tr>
<td>Lahat et al, 2007</td>
<td>86</td>
<td>60.5 ±11.4a vs 60.3 ±14.7a</td>
<td>75 (87.2%)</td>
<td>5 (5.8%)</td>
<td>5 (5.8%) 5 tubular adenomas 2 villous adenomas &gt; 1 cm 1 tubulovillous adenoma</td>
<td>3 (3.5%)</td>
<td>NR</td>
</tr>
</tbody>
</table>

ACN, Advanced colonic neoplasia; CRC, colorectal carcinoma; AA, advanced adenoma; NR, not reported.
*Values are means ± standard deviations.
†Values are medians (range).
‡Total number of adenomas instead of number of patients with adenoma was reported.
In 2012 a systematic review was published concerning colonoscopy after CT diagnosis of AD to exclude colon cancer.\textsuperscript{7} Sai et al included 10 studies of which only 2 met our inclusion criteria. By including patients with radiologic features suspicious for neoplasia, namely atypical findings such as colonic wall thickening and mass lesions, it can be expected to have resulted in a higher yield of CRC at subsequent colonoscopy. Their included studies had follow-up by surgery in most cases; colonoscopy exclusively, on the other hand, was the method of follow-up in only 4 studies. As a result of surgical follow-up, another selection bias might have been introduced because a minority of patients need surgery after AD. Barium enema, a follow-up method used in 2 studies, is less reliable. Full bowel preparation is needed and test performance is low: sensitivity for lesions $\geq 10$ mm and $\geq 6$ mm was only 48% and 35%, respectively, in a high-risk cohort.\textsuperscript{35} Sai et al\textsuperscript{7} presented an estimated pooled CRC prevalence of 2.1\% (95\% CI, 1.2\%-3.2\%), which is somewhat higher than the 1.5\% in the current review. Based on a comparison with a prevalence of .68\% as calculated in a general population in the United States, their conclusion was that there are limited data to support the recommendation to perform colonoscopy after a diagnosis of AD. Since acceptance of Sai et al’s review in December 2011, several articles and abstracts have been published on this topic. Therefore, our systematic review can provide a more up-to-date and reliable answer.

Most studies included in our review were of moderate methodologic quality and pooled data with limited evidence of heterogeneity. Statistical power calculations were not done in the included studies. As a consequence, the relatively small number of patients included in the studies might cause a beta error in the conclusion that the yield of colonoscopy is equal or lower in patients after imaging-proven diverticulitis as compared with the yield in a general population, because a huge number of patients are needed to detect a significant difference.

A drawback of the available studies was the study design. Because there was a lack of an adequate control group in all included studies, namely a cohort of average-risk healthy individuals of similar age, the main question still remains whether patients with diverticulitis have an increased ACN rate or not. To answer this question, most studies compared their prevalence with previous published data concerning colonic screening in asymptomatic populations or with epidemiologic data found in population-based registries, as we did. The number of colonoscopies that need to be performed in patients with an imaging-proven diagnosis of AD to detect 1 extra CRC is 122 ($1/([.015-.0068])$, based on our study’s pooled prevalence of 1.5\% and a general population prevalence of .68\%.

Another important limitation of this study is selection bias in individual studies. First, in 2 studies the diagnosis of AD was not solely made by CT but was based on US as well.\textsuperscript{10,11} As a result, because this modality is more dependent on the accuracy of radiology interpretation, adverse events of AD could have been underestimated and smaller malignant lesions missed. Second, there is also a possibility of selection bias because the overall
detection rate could have been higher in those patients with CT findings of complicated features of diverticulitis. Schout et al\textsuperscript{11} also included patients with intra-abdominal abscesses and reported a CRC prevalence of 2.1%. Lau et al\textsuperscript{14} concluded that a significantly higher proportion of CRC was found in patients with abscess, local perforation, or fistula noted on the CT report compared with those without abscess. Elramah et al,\textsuperscript{20} an excluded study,

![Figure 3](image3.png)  
**Figure 3.** Forest plot of the included studies and the prevalence of CRC. 

![Figure 4](image4.png)  
**Figure 4.** Forest plot of the included studies and the prevalence of AA.
not report on AA yield, and therefore ACN prevalence could not be extracted.8,9,11

There is marked heterogeneity in types of reported data in included studies, thereby limiting the information that could be extracted. Age is an important known risk factor for developing ACN. Increasing age has a weak, but significant, association with ACN detected by colonoscopy with an odds ratio of 1.06 per year (95% CI, 1.03-1.10).36 Age was reported incompletely. A higher age at colonoscopy could have led to an overestimation of our reported ACN prevalence. Lau et al,14 however, described that the incidence rate ratios for CRC appear to be much higher in the younger age group (aged 40-64 years) compared with older patients.

Another limitation is the inability to know in which studies patients had undergone colonoscopy before AD because not all studies reported these data. The expected incidence rate of neoplasia may be higher in individuals who have not undergone prior colonoscopy. Furthermore, more than half of the studies did not mention adverse events because of colonoscopy, thereby limiting our ability to assess safety of colonoscopy after AD. Colonoscopy, however, is not without risk, with the most serious adverse event being perforation at nearly 1%.37 In a prospective study on early colonoscopy in complicated sigmoid diverticulitis, no endoscopy-related adverse events occurred,32 although in patients with diverticulitis there is a potential risk of turning a sealed perforation into a free one while performing colonoscopy.

The interpretation of this systematic report might be hampered by publication bias because all funnel plots are asymmetric. In several studies no publications were found, only congress abstracts. We excluded abstracts in this study because not all data can be obtained or verified. Moreover, selective reporting never can be excluded.

Our review does not involve the possible higher lifetime risk of developing CRC. There are 2 studies concerning the lifetime relationship between diverticulitis and CRC.38,39 One described a longitudinal case-control study in 7159 patients with a prior diverticulitis and a follow-up of at least 20 years in which they find an increased risk (odds ratio, 4.2) for left-sided CRC.38 The other study was a cross-sectional retrospective study, analyzing the colonoscopy reports of complete colonoscopies and pathohistologic results of all patients referred for colonoscopy in a period of 3 months in 18 hospitals in The Netherlands.39 No increased risk for polyps or CRC was found in patients with diverticulitis. Despite common etiologic factors, similar epidemiologic characteristics, and corresponding disease localization between both disease entities, results on a possible association were contradictory.

A meta-analysis performed in 2008 involving 68,324 participants, aiming to determine the diagnostic yield of colonic evaluation in asymptomatic populations of 50 years and older, demonstrated that the overall prevalence of ACN was 5.8% (95% CI, 4%-6%) and of CRC .78%
Recent studies, however, suggest a higher prevalence of ACN and CRC. German registries reported ACN prevalence of 7.9% in the German colonoscopy screening program, more or less comparable with a recent Dutch invitational population-based screening program that demonstrated ACN prevalence of 8.7%. Quintero et al. reported an ACN rate of 10.8% in a Spanish colonoscopy screening program. The results of our review therefore suggest that patients with imaging-proven uncomplicated AD have a prevalence of ACN less than that of the general population but a prevalence of CRC somewhat higher.

A possible explanation for this remarkable finding may be the quality of the follow-up colonoscopy. First, only 3 studies had an adequate cecal intubation rate as defined by Rex et al. Incomplete colonoscopies are not unusual in patients with diverticulitis. In patients with diverticulitis, the failures mostly result from excessive pain. Luminal narrowing, spasm, muscular hypertrophy, and fixation can be the cause of technical difficulties in

<table>
<thead>
<tr>
<th>Study, year (and country)</th>
<th>Study design</th>
<th>Reason(s) for exclusion</th>
<th>No. of patients</th>
<th>Type of patients</th>
<th>Age</th>
<th>ACN CRC AA</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmeidat et al, 2012</td>
<td>Retrospective</td>
<td>Abstract only</td>
<td>44</td>
<td>CT-confirmed AD</td>
<td>61 (19-92)</td>
<td>NR 0 (99%)</td>
<td>FU colonoscopy had low diagnostic yield in case of a confident CT diagnosis of AD</td>
</tr>
<tr>
<td>Alexandersson et al, 2012</td>
<td>Retrospective</td>
<td>Abstract only</td>
<td>118</td>
<td>CT-verified diverticulitis</td>
<td>57 (50-67)</td>
<td>1 (0%)</td>
<td>Routine colonoscopy in the absence of other clinical signs of CRC seems hardly necessary</td>
</tr>
<tr>
<td>Alatawi et al, 2012</td>
<td>Retrospective</td>
<td>Abstract only</td>
<td>121</td>
<td>CT diagnosis AD (in 7 tumor-like lesions)</td>
<td>62</td>
<td>3 (2.8%)</td>
<td>Elective colonoscopy should be proposed only in highly selected patients with reasonable doubt on initial CT</td>
</tr>
<tr>
<td>Daker et al, 2012</td>
<td>Retrospective</td>
<td>Abstract only</td>
<td>47</td>
<td>CT-confirmed diverticulitis</td>
<td>NR</td>
<td>NR 0 (99%)</td>
<td>No support for performing a colonoscopy after clinical diverticulitis confirmed on CT</td>
</tr>
<tr>
<td>Eframah et al, 2010</td>
<td>Retrospective</td>
<td>Abstract only</td>
<td>130</td>
<td>CT-confirmed diverticulitis (mass-like lesion, abscess, perforation included)</td>
<td>63.7</td>
<td>3 (2.3%)</td>
<td>Support for routine colonoscopy, patients with a mass effect are at greatest risk</td>
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<tr>
<td>Kratt et al, 2010</td>
<td>Prospective</td>
<td>Abstract only</td>
<td>45</td>
<td>CT-proven diverticulitis (19 Hinchey II, 3 stenosis/fistula)</td>
<td>NR</td>
<td>NR 1 (2.2%)</td>
<td>Early (&lt;2 weeks) elective colonoscopy is not associated with an increased perforation risk</td>
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<tr>
<td>Lahat et al, 2008, Israel</td>
<td>Prospective</td>
<td>1. Duplicate data (Lahat et al, 2007) 2. Persistent diverticulitis</td>
<td>23</td>
<td>Persistent course of CT-confirmed AD</td>
<td>NR</td>
<td>NR 3 (13%)</td>
<td>Early colonoscopy should be considered in all patients with a protracted clinical course</td>
</tr>
<tr>
<td>Hjern et al, 2007, United States</td>
<td>Prospective comparative (control group: CTC)</td>
<td>Not all CT diagnosis (3 based on clinical signs and 3 on surgical findings instead)</td>
<td>57</td>
<td>Recent episode of AD</td>
<td>NR</td>
<td>NR 0 (99%)</td>
<td>CTC reasonable alternative in the follow-up of patients with symptomatic DD</td>
</tr>
</tbody>
</table>

ACN, Advanced colonic neoplasia; CRC, colorectal carcinoma; AA, advanced adenoma; AD, acute diverticulitis; NR, not reported; FU, follow-up; CTC, CT-colonography; DD, diverticular disease.

*Values are means (± standard deviation).

|Values are medians (range).
intubating the sigmoid. Thus, the ACN detection rate can be underestimated in our review because of incomplete colonoscopies. This is reflected by the relatively low ADR of less than 15%. Some studies only reported the most advanced detected lesion. Our reported ADR could therefore be an underestimation of the true prevalence.

Withdrawal time is a modifiable factor related to the ADR in CRC screening colonoscopies. Included studies, however, did not present their withdrawal times. Most studies did not identify who performed the colonoscopy, although most authors were from surgical departments. Provider specialty is related to colonoscopy effectiveness; a colonoscopy performed by a gastroenterologist is more likely to result in the removal of polyps than a colonoscopy performed by providers who are not gastroenterologists. In average-risk populations, ADRs of less than 20% are associated with interval CRC. Therefore, quality guidelines proposed this percentage as the lower achievable limit. The low ADR in this review suggests low-quality follow-up colonoscopies and therefore an underestimation of polyp detection, as well as ACN detection. Finally, colonoscopy is not infallible: tandem studies have shown that 2% of large adenomas and 22% of all adenomas are missed during colonoscopy.

Most included studies reported periods between AD and follow-up colonoscopy of less than 6 months. Elmi et al., however, had a longer period of 5.3 years (34.8% was performed within 6 months). This could possibly have resulted in a higher ACN rate because of the development of interval CRC. Indeed, the CRC rate was 2.2%, which was relatively high. Other included studies, apart from Westwood et al., who did not present exact data on the period, presented periods of less than 6 months. Therefore, we believe the proportion of patients who may have developed interval cancers after their diagnosis of AD to be minimal. None of studies mentioned results on serrated polyps, although these account for 10% to 20% of all CRC and more than 30% of interval cancers in average-risk individuals.

In conclusion, the available data presented in this systematic review suggest that the malignancy rate as detected with colonoscopy after imaging-proven uncomplicated AD is low; the ACN rate is lower and the CRC rate somewhat higher than in asymptomatic populations. Convincing data are lacking, however, because of limitations of included studies, such as moderate methodologic quality, lack of an adequate control group, selection bias, and low quality of colonoscopies. The available data, although limited, do not support the current recommendation to routinely perform colonoscopy after uncomplicated diverticulitis. We believe a more refined approach to the general recommendation of colonoscopy after an imaging-proven diagnosis of AD may be considered. The question arises whether follow-up colonoscopy should be targeted to higher-risk patients. These might be cases with complicated diverticulitis, suspicious radiologic findings, or a protracted clinical course. Patients who have not undergone age-appropriate screening recently can safely undergo colonoscopy after AD, because an increased risk of adverse events has not been documented in these patients. A definitive study would require a large prospective cohort of patients with colonoscopy after an episode of AD compared with an asymptomatic screening cohort with an appropriate power analysis and colonoscopies that fulfilled the criteria as advised in colonoscopy quality guidelines.

REFERENCES
Daniels et al. Routine colonoscopy after left-sided acute uncomplicated diverticulitis


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