PAPER

Hospitalization for Acute Diverticulitis Does Not Mandate Routine Elective Colectomy

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Background: Previous studies suggest that elective colectomy is often required after an episode of acute diverticulitis.

Hypothesis: Acute diverticulitis initially treated nonoperatively does not require elective colectomy.

Design: Retrospective cohort study.

Setting: Twelve Kaiser Permanente hospitals in Southern California.

Patients: Three thousand one hundred sixty-five patients with acute diverticulitis.

Interventions: Colectomy or nonoperative treatment with or without percutaneous abscess drainage.

Main Outcome Measures: Recurrent diverticulitis.

Results: Emergency colectomy was performed in 614 patients (19.4%). Nonoperative treatment was initially used in 2551 patients (80.6%). Of these, 185 patients (7.3%) had an elective colectomy and the remaining 2366 patients (92.7%) did not. Factors associated with undergoing elective colectomy compared with nonoperative treatment were younger age of the patient, fewer comorbidities, and percutaneous abscess drainage. Mean follow-up was 8.9 years, with a maximum of 12 years. After nonoperative treatment, 314 patients (13.3%) recurred—222 patients had a single recurrence and 92 patients had a rerecurrence. After adjusting for other variables, older age (hazard ratio, ≥50 years vs <50 years=0.68; 95% confidence interval, 0.53-0.87) was associated with a lower recurrence, whereas higher comorbidity was associated with higher recurrence. Gender and percutaneous abscess drainage had no influence on recurrence. All 92 rerecurrences were treated nonoperatively. The risk of a rerecurrence (29.3%) was significantly higher than a first recurrence ($P<.001$). Age, gender, Charlson comorbidity index, and percutaneous abscess drainage did not predict rerecurrence.

Conclusions: Very few patients with acute diverticulitis treated nonoperatively have recurrence. Younger age was associated with recurrence. A first recurrence was the only factor that predicted rerecurrences. The low recurrence rate argues against routine elective colectomy after successful nonoperative management of acute diverticulitis.

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ACUTE UNCOMPLICATED DIverticulitis can usually be treated medically, and after discharge from the hospital routine elective colectomy is often recommended within a few months. Elective colectomy has been recommended after just one episode of acute diverticulitis.[1] The Standards Task Force of the American Society of Colon and Rectal Surgeons recommends colectomy after 1 or 2 episodes of uncomplicated diverticulitis, and after 1 episode of complicated diverticulitis.[2,3]

One factor used in the decision for resection after acute diverticulitis is the age of the patient. Younger patients are usually treated more aggressively, often using surgery early after disease manifestation. This aggressive approach has been suggested because younger patients may have a more virulent form of acute diverticulitis and a higher recurrence rate.[1,4-7] However, there are also data that support treating younger patients without resection, because the risk of subsequent perforation is low, and many are successfully treated with antibiotic therapy alone.[8-12]

Unfortunately, the reported recurrence rate of diverticulitis after nonoperative management has been gleaned from small retrospective studies. The recurrence rate of diverticulitis treated nonop-

eratively ranges from 22% to 67% over 3 to 9 years.[13-15] The largest study of patients with diverticulitis treated nonoperatively was reported in 1969; of 317 patients treated medically, there was a 24.6% recurrence rate, but only 20 required subsequent elective colectomy.[16]

We hypothesize that the recurrence rate of diverticulitis is low, and that nonoperative management is appropriate for most patients. The objective of the current study was to evaluate in a large regional population the recurrence rate of acute diverticulitis in those patients undergoing initial nonoperative management of diverticulitis.

METHODS

DATA SOURCES AND STUDY SUBJECTS

The Southern California Kaiser Permanente Discharge Abstract Database was used to identify patients hospitalized in 12 acute care hospitals having a diagnosis of diverticulitis (*International Classification of Diseases [ICD-9]* code 562.11) between January 1, 1992, and December 31, 1997. This cohort was followed up using the Southern California Kaiser Permanente Discharge Abstract Database until December 31, 2003. Patients who were younger than 20 years were excluded from this study. Those patients treated on an outpatient basis for an initial episode or recurrence were not captured with this database. This study was approved by the institutional review board of Kaiser Permanente, Southern California, protocol 3934.

SURGICAL PROCEDURES AND NONOPERATIVE TREATMENT

Surgical therapy was determined according to the *ICD-9* procedure codes for different types of colectomy (*ICD-9* codes 45.71, 45.74-45.80) performed with or without colostomy (*ICD-9* codes 46.10-46.13) or those with or without ileostomy (*ICD-9* codes 46.20-46.23) Those patients who had a cecectomy or right hemicolectomy (*ICD-9* 45.72 or 45.73, respectively) were excluded from this study. Those who had any type of colectomy in the initial hospitalization were classified as having had an emergency colectomy. Patients who were admitted and did not undergo colectomy in the initial hospitalization were classified as having nonoperative treatment. Nonoperative patients included those treated with percutaneous abscess drainage (PAD) for diverticulitis (*ICD-9* code 54.91).

DEFINITION OF RECURRENT ACUTE DIVERTICULITIS AND ELECTIVE COLECTOMY

Recurrences were only evaluated in the patients who were treated nonoperatively during their initial hospitalization. Recurrent diverticulitis was defined using the following criteria: (1) a patient who was hospitalized after the initial hospitalization discharge date having an *ICD-9* diagnosis of 562.11 and treated nonoperatively, or (2) a patient who was hospitalized having an *ICD-9* diagnosis of 562.11 more than 6 months after the initial hospitalization discharge date and who underwent a colectomy. If a colectomy was performed on the second hospitalization and the admission date was 6 months or less after discharge from the initial hospitalization, then it was defined as an elective colectomy. The 6-month cutoff was arbitrarily chosen for this definition. A rerecurrence was defined as any hospitalization for acute diverticulitis that occurred after discharge from the second hospitalization.

STATISTICAL ANALYSIS

Data from the Southern California Kaiser Permanente Discharge Abstract Database were exported to SAS version 8 (SAS Institute Inc, Cary, NC) statistical software for all analyses. Associations between predictor variables and recurrent acute diverticulitis or the likelihood of undergoing elective colectomy compared with nonoperative treatment were assessed separately using Cox proportional hazards modeling and logistic regression, respectively. Variables analyzed for their influence on either outcome were age (in categories $\leq$50 or $\geq$50 years), gender, Charlson comorbidity index (CCI),[17] and PAD. The strength of associations was expressed as hazard ratios (HRs) and 95% confidence intervals (CIs) for having a recurrent episode, or odds ratio for the likelihood of undergoing an elective colectomy vs observation only. We determined the independent effect of potential predictor variables using multivariable Cox regression modeling for recurrences and logistic regression for treatment, adjusting for the same variables used in the univariate analysis: age, gender, CCI, and use of PAD. Recurrence-free survival time was calculated as the time from admission to the hospital until a recurrence, last follow-up visit, or December 31, 2003, whichever came first. Recurrence-free survival was estimated using the Kaplan-Meier method, and survival curves for the 2 age groups were compared using the log-rank test. Rerecurrences were compared using the Poisson heterogeneity test, which in our case is a goodness-of-fit χ^2 test comparing the number of rerecurrences with the number that would be expected under a Poisson model of recurrence (assuming the same rates as initially). Estimates were considered statistically significant if $P<.05$ and if the 95% CI did not overlap 1.0. All P values reported were 2-tailed.

RESULTS

PATIENT DEMOGRAPHICS

There were 3165 patients initially hospitalized for acute diverticulitis. The fifth and sixth decades of life were the most common age group represented; most patients (54%) were women (**Table 1**). Overall most patients were healthy, but a small proportion had associated comorbidities as measured using the CCI.

Emergency colectomy was performed in 614 patients (19%) during their initial hospitalization (Table 1). Nonoperative treatment was used initially in the remaining 2551 patients (81%). Of these, 185 patients (7.3%) underwent an elective colectomy; the remaining 2366 patients (92.7%) did not (**Table 2** and **Figure 1**). Factors associated with a greater likelihood of having an elective colectomy compared with nonoperative treatment were younger age, fewer comorbidities, and PAD (**Table 3**).

RECURRENCE

Patients were followed up for a mean of 8.9 years (range, 6-12 years). Thirty-eight patients were lost to follow-up: 28 patients withdrew from membership at Kaiser Permanente and 10 were nonmembers treated initially and had no follow-up. After initial nonoperative treatment, 314 (13.3%) of 2366 patients had recurrences (**Figure 2**). There were 222 patients (9.4%) who had a single recurrence, and 92 patients (3.9%) who had a re-

recurrence. Older age was associated with a lower recurrence (12.2%) compared with younger patients (16.2%) (**Figure 3**). Using univariate analysis, age was significantly associated with recurrence (HR ≥50 years vs <50 years = 0.75; 95% CI, 0.59-0.95). A CCI of 1 was found to be associated with a higher recurrence (1 vs 0, HR = 1.45; 95% CI, 1.12-1.89; 2 vs 0, OR = 0.81; 95% CI, 0.51-1.30). Gender (HR males vs females = 1.03; 95% CI, 0.83-1.29) and PAD (HR = 1.04; 95% CI, 0.39-2.77) had no influence on recurrence (**Table 4**).

In multivariable analyses, age (hazard ratio [HR] ≥50 years vs <50 years = 0.68; 95% CI, 0.53-0.87) and CCI = 1 (CCI 1 vs 0, HR = 1.59; 95% CI, 1.21-2.07) remained associated with a risk of recurrence independent of all other variables, whereas gender (HR males vs females = 0.98; 95% CI, 0.78-1.24) and PAD (HR = 1.11; 95% CI, 0.41-2.97) had no independent influence on recurrence (Table 4).

Of the 92 patients who had a rerecurrence, all 92 rerecurrences were treated nonoperatively. The risk of rerecurrence (29.3%) was significantly higher than a first recurrence ($P<.001$). The only factor predictive of a rerecurrence was a first recurrence. Age, gender, CCI, and PAD were not independently predictive of a rerecur-

Table 1. Characteristics of Patients Hospitalized With Acute Diverticulitis in Kaiser Permanente, Southern California Hospitals Between 1992-1997

Characteristic	No. (%)
Age, y	
20-29	23 (0.7)
30-39	238 (7.5)
40-49	609 (19.2)
50-59	714 (22.6)
60-69	725 (22.9)
70-79	590 (18.6)
80-89	241 (7.6)
90-99	25 (0.8)
Gender	
Female	1723 (54.4)
Male	1442 (45.6)
Charlson comorbidity index	
0	2381 (75.2)
1	543 (17.2)
≥2	241 (7.6)
Initial therapy	
Emergency colectomy	614 (19.4)
Nonoperative	2551 (80.6)
Subsequent elective colectomy	185 (5.9)
No PAD	176 (5.6)
PAD	9 (0.3)
No elective colectomy	2366 (74.7)
No PAD	2331 (73.6)
PAD	35 (1.1)

Abbreviation: PAD, percutaneous abscess drainage.

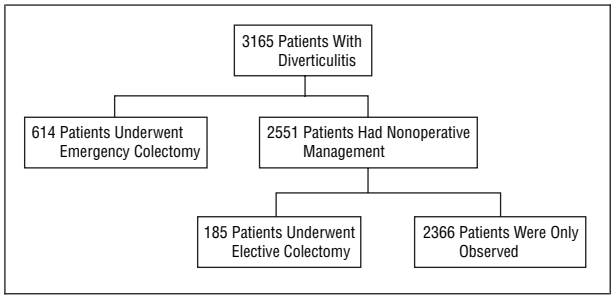

Figure 1. Outcome of patients admitted with acute diverticulitis. Recurrent diverticulitis was evaluated in the 2366 patients who were observed.

Table 2. Characteristics of Patients With Acute Diverticulitis in Kaiser Permanente, Southern California Hospitals and Their Initial Therapy

		Nonoperative Treatment			
		Subsequent Elective Colectomy		No Elective Colectomy	
Initial Therapy	Emergency Colectomy	No PAD	PAD	No PAD	PAD
Age, y					
20-29	1	3	0	19	0
30-39	46	30	2	160	0
40-49	116	47	2	439	5
50-59	144	50	4	506	10
60-69	173	33	0	513	6
70-79	113	10	1	457	9
80-89	19	3	0	214	5
90-99	2	0	0	23	0
Gender					
Female	274	93	3	1330	22
Male	340	83	6	1001	13
Charlson comorbidity index					
0	470	157	7	171	28
1	100	17	2	418	6
≥2	44	2	0	194	1
Subtotals	**614**	**176**	**9**	**2331**	**35**
		185		2366	
			2551		
Total	**3165**				

Abbreviation: PAD, percutaneous abscess drainage.

Table 3. Univariate and Multiple Logistic Regression Analysis of the Association Between Predictor Variables and the Likelihood of Undergoing Elective Colectomy Compared With Nonoperative Treatment in Patients Admitted to Kaiser Permanente, Southern California Hospitals With Acute Diverticulitis

	Univariate Analysis		Multivariate Analysis	
Variable	Odds Ratio* (95% CI)	*P* Value	Odds Ratio* (95% CI)	*P* Value
Age, y				
20-29†	1.0	NA	1.0	NA
30-39	1.22 (0.34-4.37)	.76	1.17 (0.32-4.22)	.81
40-49	0.65 (0.19-2.29)	.50	0.63 (0.18-2.24)	.48
50-59	0.64 (0.18-2.22)	.48	0.64 (0.18-2.26)	.48
60-69	0.39 (0.11-1.39)	.15	0.42 (0.12-1.54)	.19
70-79	0.15 (0.04-0.58)	.006	0.17 (0.04-0.69)	.01
≥80	0.08 (0.02-0.42)	.003	0.09 (0.02-0.50)	.006
Gender				
Female†	1.0	NA	1.0	NA
Male	1.34 (0.99-1.82)	.06	1.0 (0.72-1.37)	.98
Charlson comorbidity index				
0†	1.0	NA	1.0	NA
1	0.47 (0.29-0.77)	.003	0.67 (0.40-1.13)	.13
≥2	0.11 (0.03-0.46)	.002	0.20 (0.05-0.82)	.03
PAD				
No†	1.0	NA	1.0	NA
Yes	3.56 (1.50-7.49)	.002	3.75 (1.65-8.55)	.002

Abbreviations: CI, confidence interval; NA, not applicable; PAD, percutaneous abscess drainage.
*An odds ratio of 1 indicates no difference compared with the referent group; an odds ratio greater than 1 indicates a higher likelihood of undergoing an elective colectomy compared with the referent group; and an odds ratio less than 1 indicates a higher likelihood of undergoing nonoperative treatment compared with the referent group.
†Referent group.

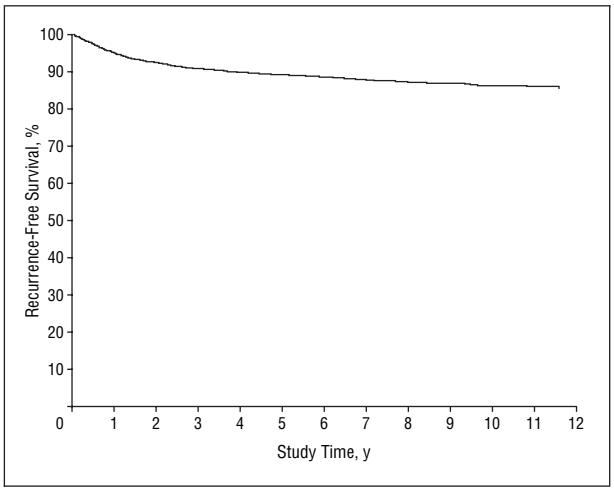

Figure 2. Recurrence-free survival in 2366 patients admitted to Kaiser Permanente, Southern California hospitals with acute diverticulitis who were initially treated nonoperatively. Overall recurrence rate was 13.3%.

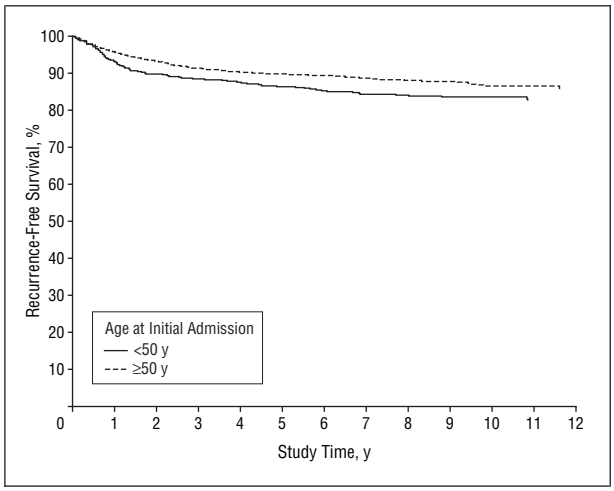

Figure 3. Recurrence-free survival in younger patients compared with older patients with acute diverticulitis initially treated nonoperatively in Kaiser Permanente, Southern California hospitals. The recurrence rate was 16.2% for those patients younger than 50 years compared with 12.2% for those 50 years or older (*P*=.01).

rence. After 4 recurrences, there was a plateau in the incidence of additional recurrences, but only 9 patients had 4 recurrences or more (**Table 5**). Overall, the recurrence rate in those who were treated nonoperatively was about 2.1 events per 100 patients per year (Table 5).

COMMENT

In this study of a large population with acute diverticulitis, we found the risk of recurrent diverticulitis after initial nonoperative management was significantly lower than many previous reports would suggest. The overall recurrence of 13.3% and an approximate annual recurrence rate of 2% per year argue against routine elective colectomy after an initial episode of acute diverticulitis.

Our study found a higher rate of recurrent diverticulitis in patients younger than 50 years. Diverticulitis in the younger patient (aged <50 years) has traditionally been regarded as more virulent than in the older patient

Table 4. Analysis of the Likelihood of Recurrent Diverticulitis in the Patients Treated Initially With Nonoperative Management and Who Did Not Undergo Elective Colectomy

Variable	Recurrence	Univariate Analysis		Multivariate Analysis	
	No. of Patients/ Total No. of Patients, (%)	Hazard Ratio* (95% CI)	*P* Value	Hazard Ratio* (95% CI)	*P* Value
Age, y					
<50†	101/623 (16.2)	1.0	NA	1.0	NA
≥50	213/1743 (12.2)	0.75 (0.59-0.95)	.02	0.68 (0.53-0.87)	.003
Gender					
Female†	178/1352 (13.2)	1.0	NA	1.0	NA
Male	136/1014 (13.4)	1.03 (0.83-1.29)	.78	0.98 (0.78-1.24)	.89
Charlson comorbidity index					
0†	236/1747 (13.5)	1.0	NA	1.0	NA
1	56/424 (13.2)	1.45 (1.12-1.89)	.005	1.59 (1.21-2.07)	<.001
≥2	22/195 (11.3)	1.12 (0.75-1.67)	.58	1.26 (0.84-1.90)	.26
PAD§					
No†	310/2336 (13.3)	1.0	NA	1.0	NA
Yes	4/30 (13.3)	1.04 (0.39-2.77)	.95	1.11 (0.41-2.97)	.84

Abbreviations: CI, confidence interval; NA, not applicable; PAD, percutaneous abscess drainage.
*A hazard ratio of 1 indicates no difference compared with the referent group; a hazard ratio greater than 1 indicates a higher likelihood of recurrence compared with the referent group; and a hazard ratio less than 1 indicates a lower likelihood of recurrence compared with the referent group.
†Referent group.

Table 5. Analysis of the Likelihood of Recurrent Acute Diverticulitis in the Patients Treated Initially With Nonoperative Management and Who Did Not Undergo Elective Colectomy

No. of Recurrences	No. of Patients	Mean Follow-up Time, y	Cumulative Patient-Years	Recurrence Rate, %
0	2052	8.92	18 298.2	0
1	222	8.82	1958.54	11.3
2	65	9.58	622.62	20.9
3	18	9.04	162.69	33.2
4	5	7.05	35.25	56.7
5	2	7.52	15.03	66.5
6	2	10.37	20.74	57.9
Overall	2366	8.92	21 113.08	2.1

(aged ≥50 years). Some authors have suggested that younger patients have more long-term sequelae and higher recurrence rates and, therefore, should be offered an elective colectomy after the first episode of diverticulitis, especially if they are obese.[4,6,7] This is controversial; other studies have shown that there is no significant difference between younger and older patients.[8-13,18] Given the overall low rate of recurrence, however, it would be difficult to recommend operative intervention based solely on age. At least 4 of 5 young patients would not be expected to have recurrence.

In our study, each episode of diverticulitis requiring hospitalization predicts a higher risk of recurrence up to about 3 recurrences, but the overall risk of rerecurrence was very low. After an initial recurrence, the increase in subsequent recurrences argues in favor of performing elective colectomy in these patients, but only before 4 recurrences. This is in contrast to 2 recent publications that have evaluated the optimal timing of an elective colectomy for diverticular disease using decision analysis in hypothetical patients. Richards and Hammitt[19] determined that the optimal timing for elective colectomy is after a third episode of diverticulitis, whereas Salem et al[20] concluded that elective colectomy should be considered after a fourth attack for it to be cost-effective. Although our study is not a cost-effectiveness study, our actuarial recurrence data do not agree with waiting until after 4 recurrences, because there are very few recurrences that will occur; elective colectomy should be offered when the beneficial effect will be highest, such as after the first or second recurrence. At the extreme of the spectrum, other studies question if prophylactic colectomy should ever be done, because major complications such as perforation or obstruction occur without any antecedent symptomatic hospitalized episodes of diverticulitis.[21,22] If elective colectomy is not performed, it is important for patients to undergo colonoscopy once the episode of acute diverticulitis has subsided to ensure there is no underlying carcinoma.

There was no association between higher recurrence rates and patients who underwent PAD. This challenges conventional wisdom, including the standards of the American Society of Colon and Rectal Surgeons. The traditional view presumes that those patients with a drainable percutaneous abscess (ie, complicated diverticulitis) have worse disease. Our findings suggest that those

patients who have undergone successful PAD during their initial hospitalization do not require elective colectomy.

Our study found that patients chosen for elective colectomy tended to be younger and healthier and have a higher incidence of PAD. This probably reflects the surgeons' willingness to operate on better surgical candidates, and also the widely held belief that younger patients and those who have undergone PAD have more severe disease. As our data have shown, however, patients treated nonoperatively have a low risk of recurrent disease and would be expected to do well without elective colectomy.

Our study has some limitations. The results are based on discharge abstract data, and the *ICD-9* coding has not been independently validated. Similarly, we did not match pathologic or radiologic diagnoses with the *ICD-9* discharge diagnoses. Furthermore, there may be unmeasured clinical factors not coded in the database that could predict for recurrence, such as severity on computed tomography. The rate of recurrence may have been overestimated or underestimated: there may be instances in which a patient hospitalized for abdominal pain is incorrectly diagnosed as having acute diverticulitis, causing an overestimate of recurrence. Alternatively, if a patient is diagnosed and coded for nonspecific abdominal pain who truly had diverticulitis, the recurrence rate would be underestimated. Finally, a recurrence was counted only if the patient was hospitalized, but often a patient with mild diverticulitis is treated with oral antibiotics as an outpatient. These presumably milder episodes would not qualify as recurrences in our study. By the same token, most authors require hospitalization as a criterion for a clinically significant recurrence. If our study underestimated the recurrence rate, at least it represents clinically important recurrent diverticulitis.

CONCLUSIONS

Routine elective colectomy is rarely necessary in patients hospitalized with a first episode of uncomplicated acute diverticulitis, with or without an abscess, who are successfully treated nonoperatively. The recurrence rate in patients treated nonoperatively is low and, therefore, does not mandate elective colectomy.

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DISCUSSION

Bruce G. Wolff, MD, Rochester, Minn: I have a few brief comments and 3 questions for the authors. This is truly an impressive study. It is probably one of the largest, if not the largest, study in the literature on diverticulitis. The authors rightly concluded, I think, that surgery is unnecessary after the initial episode of diverticulitis. I have some concerns about their definition of recurrence, however, particularly within 6 months, as some of these patients underwent elective colectomy in accord with the guidelines of the practice parameters of the American Society of Colon and Rectal Surgeons, and they were deemed to have an elective colectomy. Others who were readmitted within 6 months who were not operated on were deemed to have a recurrence. Clearly that leads to an underestimation, as some of those patients who went to surgery could have had smoldering diverticulitis and were readmitted for that reason.

The authors choose to analyze recurrences using logistic regression. This analysis evaluates the end point as a simple binary outcome; either the patient had a recurrence or did not. The problem with this approach is that it assumes that everyone had the same "window of opportunity" to have a recurrence observed. This is definitely not true. The authors report

that the follow-up ranges from 1 month to 12 years. Clearly, because patients had different lengths of follow-up, their observation windows were of a different length. It is inaccurate to observe one patient for 8 months and another for 10 years, for example, then simply to report a binary outcome. The follow-up time should have been considered. The proper way to do this is to use a survivorship technique such the Cox proportional hazards model. In this way, the effects of follow-up time and censoring are incorporated into the analysis. The cumulative probability of recurrence could be estimated using the Kaplan-Meier method, as the authors did today. This also affects their conclusion that younger patients have an increased incidence of recurrence, but this may be simply because the younger patients were followed up for a longer period than the older patients, and thus had more opportunity for recurrence to develop.

I suggest that the authors carefully reread the practice parameters given by the Standards Task Force of the American Society of Colon and Rectal Surgeons, as, in the article, they are taken slightly out of context as far as elective resection after 1 episode of diverticulitis and also PAD. The authors have a total of 44 patients who underwent PAD out of this immense series. Nine of those underwent prompt elective colectomy, 35 were available for follow-up. The confidence variable on that issue was wide, and there is clearly a possibility of a type II error, and I do not think their conclusion in regards to PAD is valid, but they do add to the growing body of evidence on this subject.

The authors are very frank about the limitations of their study, one being that it is a cohort study, level III evidence, being entirely retrospective with no control group, and certainly no randomization. It further suffers from the lack of being a population-controlled or epidemiologic study. The criteria for hospital admission for diverticulitis are not stated, and this leads to the first of my questions. As we all know that anybody with abdominal pain gets a CT [computed tomographic] scan, what proportion of patients in this study had a CT scan or other definitive objective radiologic evidence for acute sigmoid diverticulitis?

The authors are also aware that diverticulitis has become principally an outpatient disease, with the vast majority of episodes being treated in this manner. Do the authors have any idea how many patients in their series had a recurrent episode that was treated strictly on an outpatient basis, and therefore would not be captured by their data and how does this reflect on the accuracy of these data, and how many patients in this study were lost to follow-up?

Finally, the authors state in their conclusion that after the first recurrence of sigmoid diverticulitis it is reasonable to consider an elective colectomy. This seems to be the standard of care across the country. Therefore, I would ask them why it is that the 92 patients who had a rerecurrence, or presumably a third episode, were all treated nonoperatively, as this clearly goes against conventional wisdom and the current standards of care?

In closing, I congratulate the authors on making good use of their data, and this certainly adds significantly to the body of modern evidence that we must acquire. Why is this important? The current standards of surgical management for diverticulitis are based on data that are 30 to 50 years old, long before the era of colonoscopy and CT, advanced antibiotics, and critical care. In our own institution, we have recently completed a study in complicated diverticulitis that also challenges the status quo, and in the near future I hope we will all reexamine these issues with newer evidence, particularly in the form of randomized controlled trials, where ethically and practically feasible, to avoid the many unnecessary elective resections that undoubtedly we are performing.

Dr Collins: I would like to begin by describing Kaiser Permanente for those who may not be familiar. We were gratified to get some press in *The New York Times* recently. Kaiser Permanente is a nonprofit health maintenance organization that serves 8.1 million patients in 8 different regions, mostly in the West. In Southern California we have 3 million patients divided among 12 medical centers. This large volume gave us the opportunity to acquire the large database that made this study possible.

Dr Wolff outlined some of the inherent limitations of any administrative database study. There are certain value judgments or estimations that one needs to make to construct the proxy variables that allow us to do the mathematical modeling and computation. He has correctly determined that there are opportunities for recurrence that may be difficult to assess now that the treatment of milder cases typically is done on an outpatient basis.

Regarding the first question: How certain are we of the diagnosis? These patients were accrued in the mid 1990s over the interval 1992-1997. During that period the more frequent use of CT was gaining popularity. In the 1990s it was very common to obtain a CT scan for the diagnosis of abdominal pain, but not universal in our setting. I would say today in 2004 it is even more prevalent, as I am sure the rest of you have seen, as standards of practice in the emergency department have evolved. So, to our knowledge, these diagnoses were as certain as they could be under the circumstances. Certainly my practice at the time and that of my colleagues in our medical center would be to err on the side of evaluating the patient more rather than less, not jumping to a diagnostic conclusion. Furthermore, we did check with the analysts who audit the *ICD-9* codes. They periodically spot-check the data, and they find that the codes are about 97% correct. So, with respect to the question: What proportion of the patients had a CT scan? We do not have an answer. We believe that the diagnosis is fairly secure.

The second question, about outpatient recurrences: this is a limitation of almost every study in this area because, in general, the definition of a significant episode of acute diverticulitis requires that the patient be readmitted to the hospital. We did not examine outpatient recurrences, but by the same token, since all patients in our study were admitted, we can be sure that these were clinically significant recurrences.

Third, a total of 92 patients, indeed, did not undergo elective resection even after having at least 3 episodes. Now, to be fair, very few patients had more than 2 or 3 recurrences. How do we explain why a handful were treated nonoperatively despite multiple recurrences? It is difficult to say. We do not have information about the specific patients, but the database does show that older patients, especially at the extremes of age, and patients with higher comorbidities were a bit less likely to undergo resection. I think this probably reflects clinical judgment at work. Also, some patients may have refused elective resection despite a recommendation from the surgeon.

Raymond Joehl, MD, Maywood/Hines, Ill: How many patients in the Kaiser Permanente system leave the system? One of the assumptions of your methods is that there is a stable population in Kaiser Permanente, with 100% follow-up.

Dr Collins: An excellent question and one that relates to some of the analysis that we did. Kaiser Permanente has a relatively low "churn" or turnover rate, but we do have patients leave, and we do have patients come in. The patients who were cited in this study were followed over time, yet there were some patients lost to follow-up. Of 2366 patients being analyzed, 38 had no follow-up. Importantly, many of these 2366 patients were older and during the study follow-up period, 550 died of various causes. Those patients were accounted for in the Kaplan-Meier plots, so we are confident that they do not affect the interpretation of the study. Outside

of Olmsted County, Minnesota, perhaps the Veterans Affairs system, the Canadian system, and certain European health care systems, it is very difficult to have a truly captive population, but we think we come close.

Theodore J. Saclarides, MD, Chicago, Ill: I found your article very intriguing, and I just have a couple of quick comments. I think not having access to outpatient records is a serious problem. You commented that 2366 patients were treated nonoperatively. Are we to assume that nobody developed a colovesical fistula or a colovaginal fistula? And, if that is the case, is that a problem with your coding and retrieval of data, respectively, because those patients might have been just coded as having a fistula, but no coding was done for the underlying process? Second, was there any way to assess quality of life in these patients since many of them may have had their ongoing problems as an outpatient, including those with fistulas, and never be admitted for pneumaturia or fecaluria?

Dr Collins: Thank you for those important questions. Certainly, the coding aspect is a potential limitation of the study. In the recurrences, there were few or no colovesical or colovaginal fistulas. It is very highly probable that any patients with fistulas that appeared after a single episode were accounted for in the group that was operated on subsequently, but yes, that is a difficulty with any administrative database study, including the present one.

Thomas R. Biehl, MD, Seattle, Wash: Thank you very much for a nice presentation. The point of recommending an elective colectomy is to avoid recurrent disease and especially very serious recurrent disease that requires an emergency operation and colostomy. Of those patients who recurred, how many required urgent operation and colostomy?

Dr Collins: An excellent question. I do not have specific data regarding colostomy, but I am quite certain that the number is very low, and perhaps zero. Our practice has been to avoid colostomy or ileostomy as much as possible and, in fact, another member of our staff caught some heat for this at a meeting not too many years ago when he presented our data on primary resection and reanastomosis even for fairly advanced acute diverticulitis. We recognize that colostomies have their own set of potential complications and morbidities and so we try to make a judgment in the operating room about that. Recently, we published our study of a group of younger patients under the age of 40 years, of whom 35% were operated on for this diagnosis. None of them had colostomies, and none had wound infections or abscesses postoperatively.