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# Mortality in patients with and without colectomy admitted to hospital for ulcerative colitis and Crohn's disease: record linkage studies

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## ABSTRACT

**Objective** To compare mortality outcomes in the three years after elective colectomy, no colectomy, and emergency colectomy among people admitted to hospital for inflammatory bowel disease, to inform whether the threshold for elective colectomy in clinical practice is appropriate.

**Design** Record linkage studies.

**Setting** Oxford region (1968-99) and England (1998-2003).

**Participants** 23 464 people with hospital stay for more than three days for inflammatory bowel disease, including 5480 who had colectomy.

**Main outcome measures** Case fatality, relative survival, and standardised mortality ratios.

**Results** In the Oxford region, three year mortality was lower after elective colectomy than after either no colectomy or emergency colectomy, although this was not significant. For England, mortality three years after elective colectomy for ulcerative colitis (3.7%) and Crohn's disease (3.3%) was significantly lower than that after either admission without colectomy (13.6% and 10.1%; both P<0.001) or emergency colectomy (13.2% and 9.9%; P<0.001 for colitis and P<0.01 for Crohn's disease). Three or more months after elective colectomy, mortality was similar to that in the general population. Adjustment for comorbidity did not affect the findings.

**Conclusions** In England, the clinical threshold for elective colectomy in people with inflammatory bowel disease may be too high. Further research is now required to establish the threshold criteria and optimal timing of elective surgery for people with poorly controlled inflammatory bowel disease.

## INTRODUCTION

Inflammatory bowel disease often causes debilitating morbidity, particularly among young adults. It can also be life threatening. It currently affects about a quarter of a million people in the United Kingdom.[1 2] A sharp increase in the incidence of Crohn's disease occurred from the 1950s to the 1980s in the United Kingdom[3-7] and in other European countries.[8-10] Since the 1980s the incidence of Crohn's disease has continued to increase in some regions[11-15] but not in others.[10 16-18] The incidence of ulcerative colitis in the United Kingdom and Europe has been more stable than that for Crohn's disease in the past 50 years,[7-21] although some studies have reported increases[9 15 22] and reductions[12 14] over time.

Currently about 35 000 total or partial colectomies are carried out each year in England (surgical rate 70 per 100 000 population),[23] and about 2000 people undergo colectomy specifically for inflammatory bowel disease each year. The lifetime risk of surgery is 70-80% for Crohn's disease,[2] about 20-30% for total ulcerative colitis,[2] and about 50% for chronic relapsing colitis,[24] although rates for colectomy vary between countries and regions.

Although several studies have reported on outcome after colectomy among people with inflammatory bowel disease,[25-30] they are mainly small, short term studies in specialist departments, which have reported a relatively good prognosis. We used routinely collected data to investigate mortality after colectomy for inflammatory bowel disease in large population based settings. We compared mortality after elective colectomy with mortality after hospital stay with no colectomy or emergency colectomy.

## METHODS

We compared mortality after elective colectomy, emergency colectomy, or no colectomy in people admitted to hospital for inflammatory bowel disease. Firstly, we used the unique longstanding Oxford record linkage study[21] to investigate admissions to hospital and numbers of colectomies for inflammatory bowel disease from 1 April 1968 to 31 March 1996 in the Oxford region, with systematic follow-up of death certificates to 31 March 1999. We followed this with a larger analysis using newly available record linkage for England from 1 April 1998 to 31 March 2000, with systematic follow-up of deaths up to 31 March 2003. Both the Oxford and the England studies incorporate systematic linkage of hospital discharge abstracts from NHS hospitals with mortality data from the Office for National Statistics. The Oxford record linkage covered two health districts and the constituent hospitals in the former Oxford NHS region from 1968-74 (population

0.9 million), six health districts from 1975-86 (1.8 million), and eight health districts from 1987-99 (2.5 million). The England record linkage started in 1998 and covers all of England (49.2 million in 2001).

We included people admitted to hospital for inflammatory bowel disease when coded as the main diagnosis, and colectomy when recorded in any field for operational procedures on the patient's hospital discharge record. Codes for Crohn's disease were 563.0, 555, and K50 (international classification of diseases, eighth, ninth, and 10th revisions, respectively) and for ulcerative colitis were 563.1, 556, and K51 (eighth, ninth, and 10th revisions, respectively). Surgical codes for colectomy from the Office of Population Censuses and Surveys were 452, 453, 471, and 472 (first revision), 460, 461, 471, and 472 (second and third revisions), and H4-H11 and H33 (fourth revision). These cover both partial and total excision of the large bowel.

We included all types of admissions except patients who were admitted as day cases, as they usually only require elective endoscopy. We undertook two sets of analyses in patients with inflammatory bowel disease who did not undergo operation. Firstly, we excluded patients with hospital stay of less than four days as such patients would be less likely than those with longer stay to have severe inflammatory bowel disease. We then repeated the analyses including the patients with short stay. Data from the Oxford record linkage study covered 32 years from 1968. We identified and followed up each patient for three years after admission. At the end of the three years we included the next subsequent admission for the patient for a further three years' follow-up. We excluded any readmissions within the three years. For England we selected each patient's first admission for inflammatory bowel disease during the two years from 1998-2000 and followed each case for three years. We categorised the type of colectomy as elective if undertaken during an elective admission and as an emergency if carried out during an emergency admission. We also identified major comorbidities from secondary diagnoses on the inpatient records —that is, ischaemic heart disease, all other circulatory diseases, colorectal malignancies, all other malignancies, diabetes mellitus, liver disease, chronic obstructive pulmonary disease, and asthma.

### Statistical analysis

We calculated case fatality rates using number of colectomies and hospital admissions for inflammatory bowel disease as the denominators and subsequent deaths from any cause as the numerators. When comparing case fatality between the patients who underwent elective colectomy, no colectomy, and emergency colectomy we split the three years of follow-up into several intervals; one month, 2-3 months, 4-6 months, and 7-36 months.

To compare mortality in the surgical patients and those admitted to hospital with those in the corresponding general populations of the Oxford region and England we calculated standardised mortality ratios using the indirect method. We calculated cause specific standardised mortality ratios from the underlying cause of death on the death certificates, using data from the Oxford region; data on cause of death were not available for the England study. We used multiple logistic regression to adjust case fatality for age, sex, and major comorbidities.

We calculated the relative survival during the three years after colectomy for inflammatory bowel disease as the ratio of the observed survival in surgical patients and those admitted to hospital to the expected survival in the corresponding general populations in the Oxford region and England, adjusted for age, sex, and time period.

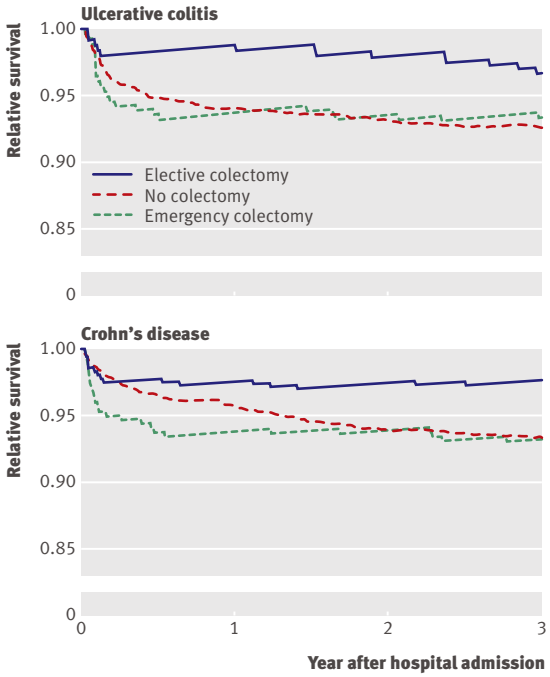


**Fig 1** | Relative survival during three years after elective colectomy, emergency colectomy, or no colectomy in Oxford region (1968-96) for patients admitted with ulcerative colitis and for Crohn's disease, adjusted for age and sex and compared with general population. Survival in general population is 1. Slight ascent of survival curves is largely due to small numbers of surgical cases

## RESULTS

The study population comprised 23 464 people from the record linkage studies in the Oxford region (1968-99) and in England (1998-2003) admitted to hospital for more than three days for inflammatory bowel disease (table 1). Table 2 summarises the case fatality rates at three years for both populations and figures 1 and 2 show the relative survival after elective or emergency colectomy or no colectomy for patients with ulcerative colitis or Crohn's disease in both areas.

In the Oxford region, case fatality at three years (table 2) and relative survival after elective colectomy for ulcerative colitis and for Crohn's disease (fig 1)

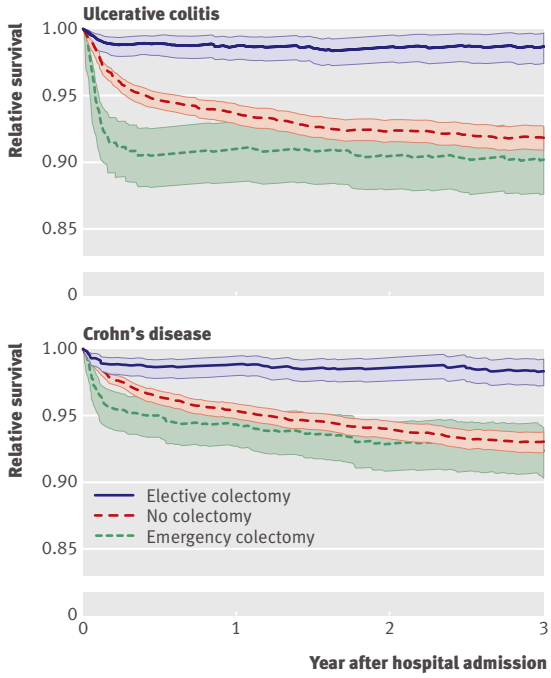


**Fig 2** | Relative survival during three years after elective colectomy, emergency colectomy, and no colectomy in England (1998-2000) for patients admitted for ulcerative colitis and for Crohn's disease, adjusted for age and sex and compared with general population. Survival in general population is 1. Shaded areas are 95% confidence intervals

were better than after either no colectomy or emergency colectomy ; this did not, however, reach statistical significance.

In England, case fatality at three years (table 2) and relative survival after elective colectomy for ulcerative colitis and for Crohn's disease (fig 2) were significantly better than after no colectomy ($P<0.001$ for both diseases). Case fatality at three years and relative survival were also significantly better after elective colectomy than after emergency colectomy for both diseases (ulcerative colitis $P<0.001$, Crohn's disease $P<0.01$). These differences in mortality across the three patient groups remained similar when patients with short stays of 1-3 days and therefore presumed to have less severe disease were included with the more severe cases.

For people who underwent emergency colectomy the risk of death was increased substantially in the four to six months after operation for ulcerative colitis (fig 2). For ulcerative colitis, after about two months following elective colectomy and after about four months following emergency colectomy, mortality levelled off to that in the general population of equivalent age (fig 2).

For Crohn's disease, a short term drop in survival occurred in the two months after surgery; but then the mortality for patients who had elective colectomy levelled off at the rate of that in the general population (fig 2). In contrast with the profile for elective surgery, the survival of people with Crohn's disease who had emergency colectomy continued to worsen throughout much of the three year follow-up when compared with that in the general population. In people with ulcerative colitis or Crohn's disease who did not undergo colectomy, mortality was worse than that in the general population throughout the three years of follow-up (table 2 and fig 2).

In the England study, significant differences were found in case fatality between the elective and no colectomy groups for ulcerative colitis during each follow-up duration period within the three years and between the elective and emergency colectomy groups up to three months (table 3). For Crohn's disease, significant differences in case fatality were found between the elective and no colectomy groups at two months and subsequently up to the three years of follow up, and between the elective and emergency colectomy groups up to three months and at 7-36 months.

### Adjusting for comorbidities

In the England study, adjusting for major comorbidities made little difference to the finding of increased mortality after emergency colectomy and no colectomy compared with elective colectomy (table 4). The increased odds of mortality in patients after elective colectomy compared with no colectomy was unchanged after adjusting for comorbidities in those with ulcerative colitis (2.18), and the odds of mortality was marginally reduced in those with Crohn's disease (2.51 to 2.49). For elective colectomy compared with emergency colectomy the increased odds for the emergency colectomy group fell slightly for patients with either disease (ulcerative colitis, 3.28 to 3.04; Crohn's disease, 2.86 to 2.68). When patients with short stays of one to three days were included, with inflammatory bowel disease presumed to be less severe, the mortality differentials across the three patient groups were similarly unaffected by comorbidities (table 4).

### Mortality from intestinal disease

Data on cause specific mortality was not available from the England study. Of 544 deaths within three years of admission for inflammatory bowel disease without colectomy in the Oxford region, almost one third (165; 30.3%) resulted from intestinal disease; including 24 (4.4%) from malignancies. The cause specific standardised mortality ratio for Crohn's disease at three years, among people admitted for the disease in the Oxford region, was 1750 (95% confidence interval 1345 to 2209, based on 63 deaths, compared with a standardised mortality ratio of one in the general population). The corresponding cause specific standardised mortality ratio for ulcerative colitis, among people admitted for the disease, was 648 (487 to 833, based on 54 deaths).

### Extent of surgery

Table 5 shows the more limited surgical approach to colectomy in the emergency setting, which results in two further procedures to complete excision and

restore continuity of the bowel. The possibility of a single procedure, however, is often realised in the elective situation.

### Subsequent colectomy after an admission with no colectomy

The main analysis was based on whether colectomy was undertaken at the patient's first identified admission with a length of stay of four or more days. For those who did not undergo colectomy during this admission, colectomy was possible in subsequent admissions. In England, of those who initially did not undergo colectomy, 9.9% of those with ulcerative colitis and 4.5% of those with Crohn's disease underwent colectomy during follow-up. Whether these patients were included or not made little difference to the study findings. For patients with ulcerative colitis who did not undergo colectomy in their first admission, case fatality was 11.8% for those who subsequently had colectomy and 13.8% for those who did not. For Crohn's disease, case fatality was almost identical (10.0% and 10.1%) for those who did or did not subsequently undergo colectomy. The results were similar for those patients admitted to hospital for inflammatory bowel disease with a hospital stay of one to three days or four or more days (table 2).

## DISCUSSION

Three year mortality was significantly lower among people who underwent elective colectomy for inflammatory bowel disease than among those who were admitted to hospital without colectomy or who had emergency colectomy. Our study findings suggest that the threshold for elective colectomy for inflammatory bowel disease in England may be too high.

The main strengths of this study were its scale (> 20 000 people admitted to hospital with a primary diagnosis of inflammatory bowel disease, including 5500 who underwent colectomy, and 2500 deaths during follow-up) and that it was undertaken in two geographically defined but otherwise unselected populations. The study used two record linkage studies that are unique in England—the longstanding Oxford record linkage study and the new English national record linkage. The two studies are independent of one another and cover different periods. Our first study was undertaken for the Oxford region, and its main findings—improved long term mortality for patients admitted for inflammatory bowel disease who underwent elective colectomy compared with emergency colectomy or no colectomy—led us to investigate this further in the second study of England. The findings of the Oxford study were confirmed, with a high level of statistical significance.

The main limitations of these record linkage studies, based on routine administrative data, are a lack of detailed information about the history, severity, and management of patients' diseases. Thus we were unable to fully ascertain disease severity in the three groups studied. When we adjusted for inpatient

**Table 1** | Numbers of hospital admissions for ulcerative colitis and Crohn's disease and elective and emergency colectomies, along with sociodemographic and length of stay characteristics of patients in Oxford region (1968-96) and in England (1998-2000)

| | Study populations | | | |
|---|---|---|---|---|
| | Oxford region (1968-96) | | England (1998-2000) | |
| Reason for admission | Ulcerative colitis | Crohn's disease | Ulcerative colitis | Crohn's disease |
| Elective colectomy: | | | | |
| No of patients | 231 | 345 | 1198 | 1362 |
| Mean (SD) age (years) | 47.8 (15.7) | 42.0 (17.4) | 47.0 (15.5) | 419 (15.9) |
| No (%) men | 117 (50.6) | 128 (37.1) | 692 (57.9) | 530 (39.0) |
| Median (interquartile range) stay (days) | 15.0 (12.0-21.0) | 12.0 (9.0-17.0) | 13.0 (10.0-17.0) | 10.0 (7.0-13.0) |
| Emergency colectomy*: | | | | |
| No of patients | 246 | 271 | 785 | 1030 |
| Mean (SD) age (years) | 45.0 (18.2) | 41.9 (18.6) | 48.0 (18.8) | 43.0 (18.5) |
| No (%) men | 139 (56.5) | 128 (47.2) | 430 (55.0) | 475 (46.3) |
| Median (interquartile range) stay (days) | 28.0 (19.0-38.0) | 18.0 (12.0-31.0) | 27.0 (19.0-38.0) | 21.0 (10.0-28.5) |
| No colectomy: | | | | |
| No of patients | 2476 | 2336 | 6262 | 6910 |
| Mean (SD) age (years) | 48.4 (20.7) | 40.8 (19.7) | 50.4 (21.1) | 43.3 (19.8) |
| No (%) men | 1141 (46.1) | 879 (37.6) | 3062 (49.0) | 2722 (39.5) |
| Median (interquartile range) stay (days) | 10.0 (7.0-16.0) | 9.0 (6.0-15.0) | 9.0 (6.0-15.0) | 9.0 (6.0-14.0) |
| All admissions: | | | | |
| No of patients | 2959 | 2958 | 8245 | 9302 |
| Mean (SD) age (years) | 48.1 (20.2) | 41.0 (19.3) | 49.8 (21.1) | 43.1 (19.2) |
| No (%) men | 1402 (47.4) | 1137 (38.5) | 4184 (50.9) | 3727 (40.1) |
| Median (interquartile range) stay (days) | 11.0 (7.0-18.0) | 10.0 (7.0-16.0) | 11.0 (7.0-17.5) | 9.0 (7.0-15.0) |

*In the Oxford region, 240 of 246 non-elective colectomies (97.6%) for ulcerative colitis and 257 of 271 non-elective colectomies (94.8%) for Crohn's disease were emergency colectomies. In England, corresponding values were 752 of 785 (95.8%) for ulcerative colitis and 1010 of 1030 (98.1%) for Crohn's disease. Non-elective colectomies are therefore labelled as emergency colectomies. The small numbers of other colectomies refer to hospital transfers.

**Table 2** | Number of hospital admissions, deaths, and case fatality rates three years after admission for ulcerative colitis or Crohn's disease in patients who underwent elective, emergency, or no colectomy in Oxford region (1968-96) and England (1998-2000)

| | Ulcerative colitis | | | Crohn's disease | | |
|---|---|---|---|---|---|---|
| Study region: type of admission | No of admissions | No of deaths at 3 years | Case fatality (95% CI) at 3 years (%) | No of admissions | No of deaths at 3 years | Case fatality (95% CI) at 3 years (%) |
| Oxford region: | | | | | | |
| Elective colectomy | 231 | 14 | 6.1 (3.4 to 10.0) | 345 | 16 | 4.6 (2.7 to 7.4) |
| Emergency colectomy | 246 | 24 | 9.8 (6.4 to 14.2) | 271 | 25 | 9.2 (6.1 to 13.3) |
| No colectomy | 2476 | 315 | 12.7 (11.4 to 14.1) | 2336 | 229 | 9.8 (8.6 to 11.1) |
| All admissions* | 2959 | 355 | 12.0 (10.9 to 13.2) | 2958 | 271 | 9.2 (8.1 to 10.3) |
| England†: | | | | | | |
| Elective colectomy | 1198 | 44 | 3.7 (2.7 to 4.9) | 1362 | 45 | 3.3 (2.4 to 4.4) |
| Emergency colectomy | 785 | 104 | 13.2 (11.0 to 15.8) | 1030 | 102 | 9.9 (8.2 to 11.9) |
| No colectomy | 6262 | 854 | 13.6 (12.8 to 14.5) | 6910 | 697 | 10.1 (9.4 to 10.8) |
| All admissions* | 8245 | 1002 | 12.2 (11.5 to 12.9) | 9302 | 844 | 9.1 (8.5 to 9.7) |

*In the Oxford region it was not recorded whether colectomy was elective or emergency in six people who underwent colectomy for ulcerative colitis and in six who underwent colectomy for Crohn's disease.
†When patients with short inpatient stays of 1-3 days were included in the England study, case fatality rates were similar at three years for elective, emergency, and no colectomy for patients with ulcerative colitis (3.7%, 13.4%, and 11.8%) and with Crohn's disease (3.3%, 9.9%, and 8.2%).

comorbidity using secondary diagnoses available from routine inpatient data, the main study finding of lower mortality after elective colectomy compared with no colectomy was scarcely altered, indicating strongly that this finding cannot be attributable to case mix. The most likely explanation is that the higher mortality among patients who had no colectomy would have been reduced if planned colectomy had been undertaken on some of the patients in this group, particularly as almost one third of all deaths in the Oxford region in the three years after admission without colectomy were from intestinal disease.

We chose mortality after at least four days' hospital stay as the main analysis as we wanted to exclude patients with mild disease who were admitted for investigation rather than for treatment. The findings were not, however, altered when we included patients with stays of one to three days.

Overall postoperative mortality after colectomy in our study is broadly comparable with that reported from other smaller studies, with shorter follow-up; these reported case fatality rates of 0-5% from specialised centres in Birmingham, Chicago, Copenhagen, London, and Oxford.[25-30] Our study has highlighted the increased mortality after emergency colectomy and has also documented the longer term outcomes both with and without surgery. For both forms of inflammatory bowel disease we found that three year survival was improved among people who underwent elective colectomy, and that the short term increased risks of mortality after elective surgery were confined to the first two months. Importantly, after the postoperative period, survival among people who underwent elective colectomy for ulcerative colitis and for Crohn's disease became similar to that in the general population. Also, as quality of life is normally

**Table 3** | Mortality at follow-up intervals up to three years after elective colectomy, emergency colectomy, and no colectomy for patients admitted to hospital for ulcerative colitis and for Crohn's disease in England, 1998-2000

| | | One month | | 2-3 months | | 4-6 months | | 7-36 months | |
|---|---|---|---|---|---|---|---|---|---|
| Type of admission | No of admissions | No of deaths | Case fatality (95% CI) | No of deaths | Case fatality (95% CI) | No of deaths | Case fatality (95% CI) | No of deaths | Case fatality (95% CI) |
| Ulcerative colitis: | | | | | | | | | |
| Elective colectomy | 1198 | 9 | 0.8 (0.3 to 1.4) | 8 | 0.7 (0.3 to 1.3) | 1 | 0.1 (0.0 to 0.5) | 26 | 2.2 (1.4 to 3.2) |
| Emergency colectomy | 785 | 45 | 5.7 (4.2 to 7.6) | 27 | 3.4 (2.3 to 5.0) | 7 | 0.9 (0.4 to 1.8) | 25 | 3.2 (2.1 to 4.7) |
| No colectomy | 6262 | 113 | 1.8 (1.5 to 2.2) | 167 | 2.7 (2.3 to 3.2) | 113 | 1.8 (1.5 to 2.2) | 461 | 7.4 (6.7 to 8.0) |
| All admissions | 8245 | 167 | 2.0 (1.7 to 2.4) | 202 | 2.5 (2.1 to 2.8) | 121 | 1.5 (1.2 to 1.8) | 512 | 6.2 (5.7 to 6.8) |
| Crohn's disease: | | | | | | | | | |
| Elective colectomy | 1362 | 10 | 0.7 (0.4 to 1.3) | 7 | 0.5 (0.2 to 1.1) | 5 | 0.4 (0.1 to 0.9) | 23 | 1.7 (1.1 to 2.5) |
| Emergency colectomy | 1030 | 30 | 2.9 (2.0 to 4.1) | 19 | 1.8 (1.1 to 2.9) | 6 | 0.6 (0.2 to 1.3) | 47 | 4.6 (3.4 to 6.0) |
| No colectomy | 6910 | 74 | 1.1 (0.8 to 1.3) | 112 | 1.6 (1.3 to 2.0) | 97 | 1.4 (1.1 to 1.7) | 414 | 6.0 (5.4 to 6.6) |
| All admissions | 9302 | 114 | 1.2 (1.0 to 1.5) | 138 | 1.5 (1.3 to 1.8) | 108 | 1.2 (1.0 to 1.4) | 484 | 5.2 (4.8 to 5.7) |

**Table 4** | Odds ratios of mortality (logistic regression) three years after elective colectomy, emergency colectomy, and no colectomy among patients admitted for ulcerative colitis and for Crohn's disease in England, 1998-2000; adjusted for age and sex and for age, sex, and major comorbidities

| Type of admission | Odds ratio (95% CI) adjusted for age and sex | Odds ratio (95% CI) adjusted for age, sex, and major comorbidities* |
|---|---|---|
| Ulcerative colitis: | | |
| Elective colectomy | Reference group | Reference group |
| Emergency colectomy | 3.28 (2.20 to 4.89) | 3.04 (2.02 to 4.56) |
| No colectomy | 2.18 (1.56 to 3.05) | 2.18 (1.55 to 3.06) |
| Crohn's disease: | | |
| Elective colectomy | Reference group | Reference group |
| Emergency colectomy | 2.86 (1.95 to 4.19) | 2.68 (1.85 to 4.03) |
| No colectomy | 2.51 (1.81 to 3.46) | 2.49 (1.82 to 3.51) |
| **Inclusion of patients with less severe disease and short stay (1-3 days)** | | |
| Ulcerative colitis: | | |
| Elective colectomy | Reference group | Reference group |
| Emergency colectomy | 3.24 (2.19 to 4.80) | 3.02 (2.03 to 4.50) |
| No colectomy | 1.96 (1.42 to 2.72) | 1.99 (1.43 to 2.76) |
| Crohn's disease: | | |
| Elective colectomy | Reference group | Reference group |
| Emergency colectomy | 2.74 (1.87 to 4.00) | 2.58 (1.76 to 3.80) |
| No colectomy | 2.14 (1.56 to 2.93) | 2.16 (1.56 to 2.98) |

*Major comorbidities included were ischaemic heart disease, all other circulatory diseases, colorectal malignancies, all other malignancies, diabetes mellitus, liver disease, and chronic obstructive pulmonary disease and asthma. Since patients with inflammatory bowel disease are relatively young, prevalence of comorbidities is low. For patients with ulcerative colitis who had elective colectomy, emergency colectomy, and no colectomy the percentage of cases recorded with various comorbidities were: ischaemic heart disease (2.7%, 5.9%, 4.8%); all other circulatory diseases (6.7%, 12.2%, 8.5%); colorectal malignancies (0.8%, 0.5%, 0.1%); all other malignancies (0.4%, 0.5%, 0.6%); diabetes mellitus (3.3%, 3.8%, 4.6%); liver disease (0.3%, 0.6%, 0.5%); and chronic obstructive pulmonary disease and asthma (3.8%, 5.2%, 4.5%). Values for patients with Crohn's disease were: ischaemic heart disease (1.2%, 2.9%, 2.7%); all other circulatory diseases (4.5%, 8.4%, 5.7%); colorectal malignancies (0.1%, 0.3%, 0.0%); all other malignancies (0.3%, 0.7%, 0.5%); diabetes mellitus (0.7%, 1.7%, 2.2%); liver disease (0.1%, 0.1%, 0.4%); and chronic obstructive pulmonary disease and asthma (3.7%, 4.7%, 4.4%).

improved after surgery,[24] this illustrates further that, whenever indicated and possible, it is preferable for colectomy to be undertaken electively rather than risk the need for emergency surgery with its poorer prognosis.

Although mortality after emergency surgery for ulcerative colitis was initially higher than that in the general population, it returned to the level of the general population within a few months of surgery; this was not the case after emergency colectomy for Crohn's disease. This probably reflects the curative nature of successful surgery for ulcerative colitis, whereas such a cure cannot be achieved for Crohn's disease. Mortality three years after admission when colectomy was not carried out was almost as high as that after emergency colectomy. As the patients who underwent emergency colectomy were in general more severely ill than those who had no colectomy,

**Table 5** | Extent of colectomy when undertaken electively or as emergency for people who were admitted to hospital for ulcerative colitis and for Crohn's disease in England, 1998-2000

| | Ulcerative colitis | | Crohn's disease | |
|---|---|---|---|---|
| Extent of colectomy | No (%) with elective colectomy (n=1198) | No (%) with emergency colectomy (n=785) | No (%) with elective colectomy (n=1362) | No (%) with emergency colectomy (n=1030) |
| Total excision of colon and rectum | 559 (46.7) | 87 (11.1) | 128 (9.4) | 37 (3.6) |
| Total excision of colon | 166 (13.9) | 323 (41.1) | 73 (5.4) | 75 (7.3) |
| Extended excision of right hemicolon | 2 (0.2) | 6 (0.8) | 53 (3.9) | 49 (4.8) |
| Other excision of right hemicolon | 12 (1.0) | 24 (3.1) | 805 (59.1) | 655 (63.6) |
| Excision of transverse colon | 2 (0.2) | 4 (0.5) | 12 (0.9) | 9 (0.9) |
| Excision of left hemicolon | 15 (1.3) | 8 (1.0) | 32 (2.3) | 20 (1.9) |
| Excision of sigmoid colon | 20 (1.7) | 17 (2.2) | 56 (4.1) | 32 (3.1) |
| Other excision of colon | 142 (11.9) | 306 (39.0) | 120 (8.8) | 126 (12.2) |
| Excision of rectum | 300 (25.0) | 20 (2.5) | 129 (9.5) | 50 (4.9) |

A small number of patients had more than one colectomy procedure: each has been counted.

## WHAT IS ALREADY KNOWN ON THIS TOPIC

Many people with severe inflammatory bowel disease require colectomy at some stage and emergency colectomy carries a significant risk

Mortality after elective colectomy is quite low, at least in the short term, but longer term follow-up data are lacking

## WHAT THIS STUDY ADDS

Three year mortality among people admitted for inflammatory bowel disease is significantly better after elective colectomy than after no colectomy or emergency colectomy

At three years the increased risk of mortality in people who did not undergo colectomy is almost as high as that in people after emergency colectomy for inflammatory bowel disease

This is strong evidence suggesting that the threshold for elective colectomy is too high

this suggests that the decision not to operate may be the more dangerous option for severe cases.

The threshold for elective colectomy for inflammatory bowel disease in England may be too high. About 15% of people with ulcerative colitis have a severe attack and require admission to hospital.[31] Of these, about 40% undergo colectomy and the remainder are treated medically. It has been recommended that approximately 85% of those who do not respond to treatment within three days should undergo colectomy.[32 33] To delay surgery further carries risks.[24 33 34] Our findings indicate that the threshold for surgery should probably be lower than at present, as recovery is still associated with an increased mortality at three years.

Although the current national UK audit of inflammatory bowel disease may provide more insight into these concerns, it will not provide a controlled comparison of surgical and medical treatment for severe disease nor give information on longer term outcomes. A large scale randomised controlled trial is required to establish the criteria for threshold and optimal timing for colectomy in people with poorly controlled inflammatory bowel disease.

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1 Rubin GP, Hungin AP, Kelly PJ, Ling J. Inflammatory bowel disease: epidemiology and management in an English general practice population. *Aliment Pharmacol Ther* 2000;14:1553-9.
2 Carter MJ, Lobo AJ, Travis SP; IBD Section, British Society of Gastroenterology. Guidelines for the management of inflammatory bowel disease in adults. *Gut* 2004;53(suppl 5):v1-16.
3 Miller DS, Keighley AC, Langman MJ. Changing patterns in epidemiology of Crohn's disease. *Lancet* 1974;2:691-3.
4 Fellows IW, Freeman JG, Holmes GK. Crohn's disease in the city of Derby, 1951-85. *Gut* 1990;31:1262-5.
5 Kyle J. Crohn's disease in the northeastern and northern Isles of Scotland: an epidemiological review. *Gastroenterology* 1992;103:392-9.
6 Thomas GA, Millar-Jones D, Rhodes J, Roberts GM, Williams GT, Mayberry JF. Incidence of Crohn's disease in Cardiff over 60 years: 1986-1990 an update. *Eur J Gastroenterol Hepatol* 1995;7:401-5.
7 Logan RF. Inflammatory bowel disease incidence: up, down or unchanged? *Gut* 1998;42:309-11.
8 Munkholm P, Langholz E, Nielsen OH, Kreiner S, Binder V. Incidence and prevalence of Crohn's disease in the county of Copenhagen, 1962-87: a sixfold increase in incidence. *Scand J Gastroenterol* 1992;27:609-14.
9 Bjornsson S, Johannsson JH, Oddsson E. Inflammatory bowel disease in Iceland, 1980-89. A retrospective nationwide epidemiologic study. *Scand J Gastroenterol* 1998;33:71-7.
10 Lapidus A, Bernell O, Hellers G, Persson PG, Lofberg R. Incidence of Crohn's disease in Stockholm County 1955-1989. *Gut* 1997;41:480-6.
11 Cosgrove M, Al-Atia RF, Jenkins HR. The epidemiology of paediatric inflammatory bowel disease. *Arch Dis Child* 1996;74:460-1.
12 Fonager K, Sorensen HT, Olsen J. Change in incidence of Crohn's disease and ulcerative colitis in Denmark. A study based on the National Registry of Patients, 1981-1992. *Int J Epidemiol* 1997;26:1003-8.
13 Armitage E, Drummond H, Ghosh S, Ferguson A. Incidence of juvenile-onset Crohn's disease in Scotland. *Lancet* 1999;353:1496-7.
14 Molinie F, Gower-Rousseau C, Yzet T, Merle V, Grandbastien B, Marti R, et al. Opposite evolution in incidence of Crohn's disease and ulcerative colitis in Northern France (1988-1999). *Gut* 2004;53:843-8.
15 Lakatos L, Mester G, Erdelyi Z, Balogh M, Szipocs I, Kamaras G, et al. Striking elevation in incidence and prevalence of inflammatory bowel disease in a province of western Hungary between 1977-2001. *World J Gastroenterol* 2004;10:404-9.
16 Pebody RG, Paunio M, Ruutu P. Measles, measles vaccination, and Crohn's disease. Crohn's disease has not increased in Finland. *BMJ* 1998;316:1745-6.
17 Yapp TR, Stenson R, Thomas GA, Lawrie BW, Williams GT, Hawthorne AB. Crohn's disease incidence in Cardiff from 1930: an update for 1991-1995. *Eur J Gastroenterol Hepatol* 2000;12:907-11.
18 Seagroatt V, Goldacre MJ. Crohn's disease, ulcerative colitis, and measles vaccine in an English population, 1979-1998. *J Epidemiol Community Health* 2003;57:883-7.
19 Srivastava ED, Mayberry JF, Morris TJ, Smith PM, Williams GT, Roberts GM, et al. Incidence of ulcerative colitis in Cardiff over 20 years: 1968-87. *Gut* 1992;33:256-8.
20 Tysk C, Jarnerot G. Ulcerative proctocolitis in Orebro, Sweden. A retrospective epidemiologic study, 1963-1987. *Scand J Gastroenterol* 1992;27:945-50.
21 Primatesta P, Goldacre MJ. Crohn's disease and ulcerative colitis in England and the Oxford record linkage study area: a profile of hospitalized morbidity. *Int J Epidemiol* 1995;24:922-8.
22 Tsianos EV, Masalas CN, Merkouropoulos M, Dalekos GN, Logan RF. Incidence of inflammatory bowel disease in north west Greece: rarity of Crohn's disease in an area where ulcerative colitis is common. *Gut* 1994;35:369-72.
23 Unit of Health-Care Epidemiology, University of Oxford. Epidembase. www.uhce.ox.ac.uk/Epidembase2/.
24 Oresland T. Review article: colon-saving medical therapy vs. colectomy in ulcerative colitis—the case for colectomy. *Aliment Pharmacol Ther* 2006;24(suppl 3):74-9.
25 Scammell BE, Andrews H, Allan RN, Alexander-Williams J, Keighley MR. Results of proctocolectomy for Crohn's disease. *Br J Surg* 1987;74:671-4.
26 Andrews HA, Lewis P, Allan RN. Prognosis after surgery for colonic Crohn's disease. *Br J Surg* 1989;76:1184-90.
27 Melville DM, Ritchie JK, Nicholls RJ, Hawley PR. Surgery for ulcerative colitis in the era of the pouch: the St Mark's Hospital experience. *Gut* 1994;35:1076-80.
28 Romanos J, Samarasekera DN, Stebbing JF, Jewell DP, Kettlewell MG, Mortensen NJ. Outcome of 200 restorative proctocolectomy operations: the John Radcliffe Hospital experience. *Br J Surg* 1997;84:814-8.
29 Michelassi F, Lee J, Rubin M, Fichera A, Kasza K, Karrison T, et al. Long-term functional results after ileal pouch anal restorative proctocolectomy for ulcerative colitis: a prospective observational study. *Ann Surg* 2003;238:433-41.
30 Jess T, Riis L, Vind I, Winther KV, Borg S, Binder V, et al. Changes in clinical characteristics, course, and prognosis of inflammatory bowel

disease during the last 5 decades: a population-based study from Copenhagen, Denmark. *Inflamm Bowel Dis* 2007;13:481-9.
31 Smart NJ. Avoid delaying surgery in patients with severe ulcerative colitis. *BMJ* 2006;333:501.
32 Travis SP, Farrant JM, Ricketts C, Nolan DJ, Mortensen NM, Kettlewell MG, et al. Predicting outcome in severe ulcerative colitis. *Gut* 1996;38:905-10.
33 Caprilli R, Latella G, Vernia P, Frieri G. Multiple organ dysfunction in ulcerative colitis. *Am J Gastroenterol* 2000;95:1258-62.
34 Travis S. Review article: saving the colon in severe colitis—the case for medical therapy. *Aliment Pharmacol Ther* 2006;24(suppl 3):68-73.

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