

The SCAR-3 study: 5-year adhesion-related readmission risk following lower abdominal surgical procedures

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Received 18 May 2005; accepted 22 May 2005

Abstract

Objective The Surgical and Clinical Adhesions Research (SCAR) and SCAR-2 studies demonstrated that the burden of adhesions following lower abdominal surgery is considerable and appears to remain unchanged despite advances in strategies to prevent adhesions. In this study, we assessed the adhesion-related readmission risk directly associated with common lower abdominal surgical procedures, taking into account the effect of previous surgery, demography and concomitant disease.

Methods Data from the Scottish National Health Service medical record linkage database were used to assess the risk of an adhesion-related readmission following open lower abdominal surgery during April 1996–March 1997.

Results Patients undergoing lower abdominal surgery (excluding appendectomy) had a 5% risk of readmission directly related to adhesions in the 5 years following surgery. Appendectomy was associated with a lower rate of readmission (0.9%), but contributed over 7% of the total lower abdominal surgery patient readmission burden. Panproctocolectomy (15.4%), total colectomy (8.8%) and ileostomy surgery (10.6%) were associated

with the highest risk of an adhesion-related readmission. Overall, the risk of readmission was doubled in patients who had undergone abdominal or pelvic surgery within 5 years of the incident operation. A higher risk of readmission was also recorded in patients aged < 60 years compared with those aged ≥ 60 yrs. The effect of gender was assessed. However, as the surgical codes used were found to be skewed towards women, these data have not been reported. Readmission risk was slightly higher in patients with concomitant peritonitis compared with patients without peritonitis. In contrast, Crohn's disease had no effect on risk. Patients with colorectal cancer had a lower risk of adhesion formation. However, this may have been due to the type of surgery performed in this patient group.

Conclusion The identification of high-risk patient subgroups may assist in effectively targeting adhesion-prevention strategies and the proffering of preoperative advice on adhesion risk.

Keywords Adhesions, adhesion prevention, adhesion-related readmissions, colorectal surgery, lower abdominal surgery, SCAR-3

Introduction

The incidence of intraperitoneal adhesions in patients following general abdominal surgery ranges from 63% to 97% [1–3]. Although the majority of patients remain asymptomatic, a considerable number experience serious complications, including bowel obstruction [4,5], female secondary infertility [6] and re-operative complications

[7]. The presence of adhesions from previous surgery significantly increases the length of time required in subsequent surgical procedures, adversely affecting the workloads of surgical teams [8], and increases the risk of postoperative morbidity when inadvertent enterotomies are created during adhesiolysis.

Awareness of the problems associated with adhesions has increased in recent years, due partly to the publication of data from the Surgical and Clinical Adhesions Research (SCAR) study [9,10]. This comprehensive epidemiological study assessed the frequency of adhesion-related complications in patients undergoing open lower abdominal

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surgery in Scotland in 1986. It showed that up to 33% of patients were readmitted to hospital an average of 2.2 times during the following 10 years for a disorder directly or possibly related to adhesions or for surgery that could be complicated by adhesions. Economic modelling of these data indicate that the cost associated with adhesion-related readmissions following lower abdominal surgery in the UK over 10 years is over £500 million [11].

The more recent SCAR-2 study [12] assessed the real-time burden of adhesion-related readmissions in three incident patient cohorts undergoing colorectal surgery in the financial years (April – March) 1996–97, 1997–98 and 1998–99. The results of this study showed that there was no change in the rate of readmissions during this period, despite advances in strategies for the prevention of adhesions prior to the study [13].

The patient consent process requires surgeons to inform patients of any significant risks associated with surgery. Published evidence on adhesion-related readmissions indicates that patients undergoing colorectal surgery are at significant risk [1,10,12], however, the data presented are according to the site of surgery, such as the colon or rectum, rather than by specific surgical procedure. Furthermore, the data include an element of uncertainty in the risk values generated due to the necessary inclusion of possible adhesion-related readmissions when determining the total burden of adhesions.

This study, the third in the series of epidemiological assessments defining the extent of adhesion-related readmissions in Scotland (SCAR-3), aimed to assess the adhesion-related readmission risk directly associated with common abdominal and pelvic surgical procedures. The influence of patient surgical history, age, gender and concomitant disease was assessed.

Methods

The study used anonymised data from the Scottish National Health Service (NHS) medical record linkage database, which is managed by the Scottish NHS Information Services Division (ISD). The database has been described in detail in previous publications [9,10]. It holds one of the largest patient-linked data sets and allows the robust tracking of all hospital inpatient and day-case hospital admissions, excluding maternity and psychiatric admissions, within Scotland as far back as 1981. A steering group rigorously investigated and tested the data prior to deciding to employ this database.

Using data provided by the ISD, the risk of an adhesion-related readmission in an incident cohort of patients who underwent open lower abdominal surgery in the financial year April 1996–March 1997 was assessed. This incident cohort was defined by the Office of

Population Censuses and Surveys, Fourth Edition (OPCS-4) surgical codes and subdivided into the four levels of the OPCS-4 coding system: levels 1/2 describe the surgical site (e.g. H0, lower digestive tract/colon); level 3 describes the type of procedure (e.g. H05, excision of colon); and level 4 describes the procedure subtype (e.g. H05.1, total colectomy and ileo-rectal anastomosis). Where necessary, some level 3 codes were combined to reflect common surgical procedures. Demography and diagnostic disease code details according to the International Code of Diseases, Tenth Edition (ICD-10) [14] were available for the incident cohort.

The incident cohort was followed up for adhesion-related readmissions over 5 years until March 2002. Adhesion-related readmissions and procedures that may be complicated by them were identified by OPCS-4 surgical or ICD-10 diagnostic codes using patient record linkage. Readmissions were classified as directly related to adhesions, possibly related to adhesions, or as procedures that may be complicated by adhesions. To minimize the uncertainty of patient risk, this report only details directly related readmissions. However, this approach will underestimate the actual risk of patient adhesion-related readmissions.

In contrast to earlier studies, which primarily reported the total number of episodes of readmission including all episodes reported for each patient during the selected follow-up period, this study reports the total number of patients readmitted. While this approach underestimates the total burden of adhesion-related readmission, the data can be easily compared with the risk associated with other types of surgery.

The influence of previous operations on adhesion-related readmission was determined for all surgical sites. Patients were grouped according to those who had or had not undergone previous abdominal or gynaecological surgery during the 5 years prior to incident surgery. Adhesion-related readmission rates were reported based on the site of the initial surgical procedure (appendix, lower gastrointestinal and abdominal wall) and then subdivided by recognized surgical procedures within each site and, where appropriate, by specific surgical code.

The effect of age at the time of incident surgery on the risk of adhesion-related readmission was assessed; patients were categorized as aged < 16 years or aged \geq 16 years for operations on the appendix and as aged < 60 years or aged \geq 60 years for all other procedures. In addition, the effect of concomitant disease on risk, including malignancy, peritonitis and Crohn's disease, was assessed for each surgical procedure site. The effect of gender on risk was assessed; however, as there are specific codes for gynaecological adhesiolysis, the readmission codes were

weighted towards women. Therefore, these data are not comparable and have not been presented in detail here.

In line with previous publications from this group, confidence intervals for readmission rates have not been calculated as the findings are based on the total population of Scotland and not on a sample of the population. The statistical significance of differences in directly related readmission rates 5 years after surgery between selected surgical populations has been determined using a mid-probability approach to Fisher's exact test. Multi-variate regression analysis of the data has not been possible due to restrictions in the release of this data from ISD Scotland in order to maintain individual patient confidentiality.

Results

A total of 12 756 patients underwent open lower abdominal surgical procedures in the financial year 1996–97 (excluding gynaecological interventions). In this group as a whole, the risk of readmission directly related to adhesions within 5 years following surgery was 3.8% (5.2% excluding appendicectomy procedures).

Small bowel procedures

An assessment of patients who underwent surgery on the small intestine showed that procedures on the duodenum and jejunum had a 1.8% risk of readmission directly related to adhesions (Table 1); this was significantly reduced in the subgroup of patients who underwent open duodenal ulcer repair compared with those who did not have ulcer repair (0.9%; $P = 0.0145$). In contrast, surgery on the ileum had an overall risk of readmission of 7.7%; this increased to 10.6% in the subset of patients

who underwent ileostomy surgery and decreased to 7.0% in those who had ileal resection.

Colorectal and abdominal wall procedures

The overall readmission risk for procedures on the colon and rectum were similar (5.0% and 5.2%, respectively; $P = 0.681$) and represented approximately a 1 in 20 risk of a direct adhesion-related readmission following surgery at each of these sites after 5 years (Table 2). For procedures on the colon, the highest risk of readmission occurred in the subgroups of patients who underwent panproctocolectomy (15.4%) or total colectomy (8.8%). The most common surgical procedure of the colon was hemicolectomy (7.1%); the risk of readmission ranged from 3.8% for a right-sided hemicolectomy to 4.9% for a left-sided operation ($P = 0.0911$). Colostomy procedures were associated with a risk of 5.8%. A similar readmission risk was also found for abdominal wall procedures (5.4%).

The large majority of rectal procedures were for excision of the rectum and had a readmission risk of 5.6%. In contrast, abdominal procedures for rectal prolapse carried a readmission risk of 1.4%.

Appendicectomy

Patients who underwent appendicectomy had a comparatively low overall direct risk of readmission (0.9%; Table 3). However, this procedure accounted for approximately 30% of all abdominal procedures and 7% of all patient readmissions during the 5 years following lower abdominal surgery. Appendicectomy therefore contributes significantly to the overall burden of adhesion-related readmissions.

Table 1 Directly adhesion-related readmission risk 5 years after small bowel surgical procedures.

Site and type of surgery	All % (<i>nR</i> /total <i>n</i>)	No previous surgery within 5 years		Previous surgery within 5 years	
		< 60 years % (<i>nR</i> /total <i>n</i>)	≥ 60 years % (<i>nR</i> /total <i>n</i>)	< 60 years % (<i>nR</i> /total <i>n</i>)	≥ 60 years % (<i>nR</i> /total <i>n</i>)
Duodenum/jejunum	1.8 (12/685)	1.7 (4/234)	0.4 (1/225)	3.1 (3/96)	3.1 (4/130)
Duodenal ulcer	0.9 (4/466)	1.7 (3/179)	0.5 (1/198)	0.0 (0/40)	0.0 (0/49)
Ileum	7.7 (70/912)	6.8 (13/191)	2.5 (5/199)	14.6 (40/274)	4.8 (12/248)
With Crohn's	6.9 (9/131)	6.3 (2/32)	0.0 (0/7)	8.8 (7/80)	0.0 (0/12)
Without Crohn's	7.8 (61/781)	6.9 (11/159)	2.6 (5/192)	17.0 (33/194)	5.1 (12/236)
Excision of ileum	7.0 (32/459)	4.8 (5/105)	2.4 (3/124)	17.4 (19/109)	4.1 (5/121)
With Crohn's	8.4 (8/95)	8.3 (2/24)	0.0 (0/6)	10.7 (6/56)	0.0 (0/9)
Without Crohn's	6.6 (24/364)	3.7 (3/81)	2.5 (3/118)	24.5 (13/53)	4.5 (5/112)
Ileostomy surgery	10.6 (21/198)	14.8 (4/27)	0.0 (0/8)	12.4 (12/97)	13.2 (5/66)

nR, total number of patients readmitted; total *n*, total number of procedures.

Table 2 Directly adhesion-related readmission risk 5 years after colorectal or abdominal wall surgical procedures.

Site and type of surgery	All % (<i>nR</i> /total <i>n</i>)	No previous surgery within 5 years		Previous surgery within 5 years	
		< 60 years % (<i>nR</i> /total <i>n</i>)	≥ 60 years % (<i>nR</i> /total <i>n</i>)	< 60 years % (<i>nR</i> /total <i>n</i>)	≥ 60 years % (<i>nR</i> /total <i>n</i>)
Colon	5.0 (158/3176)	5.0 (18/364)	3.5 (33/945)	9.8 (67/685)	3.4 (40/1182)
With cancer	3.8 (60/1597)	6.5 (9/138)	2.9 (18/621)	7.9 (11/140)	3.2 (22/698)
Without cancer	6.2 (98/1579)	4.0 (9/226)	4.6 (15/324)	10.3 (56/545)	3.7 (18/484)
With diverticulitis	3.1 (8/259)	0.0 (0/25)	4.2 (2/48)	4.0 (2/50)	2.9 (4/136)
Without diverticulitis	5.1 (150/2917)	5.3 (18/339)	3.5 (31/897)	10.2 (65/635)	3.4 (36/1046)
Panproctocolectomy	15.4 (19/123)	11.1 (1/9)	11.1 (1/9)	19.3 (16/83)	4.5 (1/22)
Total colectomy	8.8 (14/160)	6.7 (1/15)	9.1 (3/33)	11.0 (8/73)	5.1 (2/39)
Right hemicolectomy	3.8 (47/1235)	6.5 (11/169)	2.8 (13/463)	7.7 (13/169)	2.3 (10/434)
Left hemicolectomy	4.9 (50/1023)	1.8 (2/110)	5.1 (16/314)	8.9 (15/169)	4.0 (17/430)
Sigmoid hemicolectomy	4.7 (37/779)	1.3 (1/78)	4.3 (10/233)	9.5 (13/137)	3.9 (13/331)
Colostomy	5.8 (24/416)	7.1 (2/28)	0.0 (0/62)	9.1 (13/143)	4.9 (9/183)
Rectum	5.2 (88/1690)	8.4 (14/167)	5.2 (30/573)	7.4 (18/245)	3.7 (26/705)
Excision of rectum	5.6 (86/1539)	9.2 (14/152)	5.7 (30/522)	7.7 (17/222)	3.9 (25/643)
Prolapse of rectum	1.4 (2/140)	0.0 (0/14)	0.0 (0/46)	4.3 (1/23)	1.8 (1/57)
Abdominal wall	5.4 (118/2180)	4.2 (26/624)	3.9 (22/564)	9.7 (50/514)	4.2 (20/478)

nR, total number of patients readmitted; total *n*, total number of procedures.

Table 3 Directly adhesion-related readmission risk 5 years after appendicectomy.

Site and type of surgery	All % (<i>nR</i> /total <i>n</i>)	No previous surgery within 5 years		Previous surgery within 5 years	
		< 16 years % (<i>nR</i> /total <i>n</i>)	≥ 16 years % (<i>nR</i> /total <i>n</i>)	< 16 years % (<i>nR</i> /total <i>n</i>)	≥ 16 years % (<i>nR</i> /total <i>n</i>)
Appendix (only)	0.9 (36/4113)	0.3 (4/1275)	0.9 (22/2393)	0.0 (0/27)	2.4 (10/418)
With peritonitis	1.3 (8/614)	0.6 (1/174)	1.0 (4/392)	0.0 (0/1)	6.4 (3/47)
Without peritonitis	0.8 (28/3499)	0.3 (3/1101)	0.9 (18/2001)	0.0 (0/26)	1.9 (7/371)

nR, total number of patients readmitted; total *n*, total number of procedures.

Surgical history

Previous surgery was found to increase risk; patients who had undergone abdominal or pelvic surgery within the previous 5 years faced a readmission risk of 5.8%, compared with 2.5% of patients who had not undergone surgery ($P < 0.0001$) (Fig. 1).

Patient age

Age was found to be an important factor in readmission risk; overall patients aged < 60 years had a much greater risk than those aged ≥ 60 years ($P < 0.0001$; Fig. 2). This trend was supported by data on each individual site of surgery. In those patients who had not had surgery within the previous 5 years, the directly related risk of readmission was higher for patients aged < 60 years who underwent procedures on the duodenum/jejunum ($P =$

0.2171) or ileum ($P = 0.0342$) (Table 1) and also for procedures on the colon ($P = 0.2096$), rectum ($P = 0.1014$) or abdominal wall ($P = 0.7723$) (Table 2). In this patient group, the increment in risk was greatest in patients who underwent surgery on the ileum (< 60 years *vs* ≥ 60 years: 6.8% *vs* 2.5%) or duodenum/jejunum (1.7% *vs* 0.4%), where the readmission risk in patients aged < 60 years was almost three times that reported for patients aged ≥ 60 years.

In those patients having had previous surgery, the risk was higher for patients aged < 60 years who had undergone procedures on the ileum ($P = 0.0001$), colon ($P < 0.0001$), rectum ($P = 0.0223$) or abdominal wall ($P = 0.0005$) (Tables 1 and 2). Again, the risk of readmission in patients aged < 60 years following procedures on the ileum or colon was approximately three times that reported for patients aged ≥ 60 years (ileum, 14.6% *vs* 4.8%; colon, 9.8% *vs* 3.4%, respectively).

Figure 1 Readmissions directly related to adhesions in patients undergoing lower abdominal surgery; effect of previous surgery.

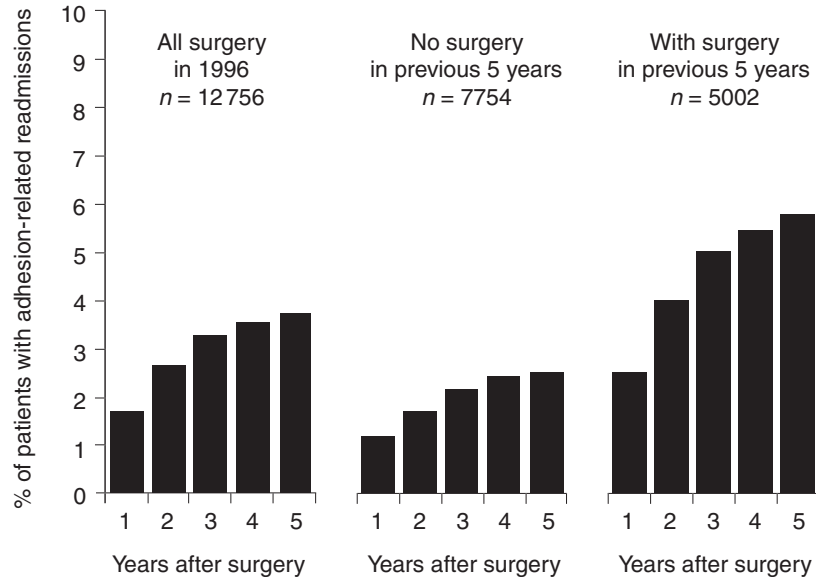
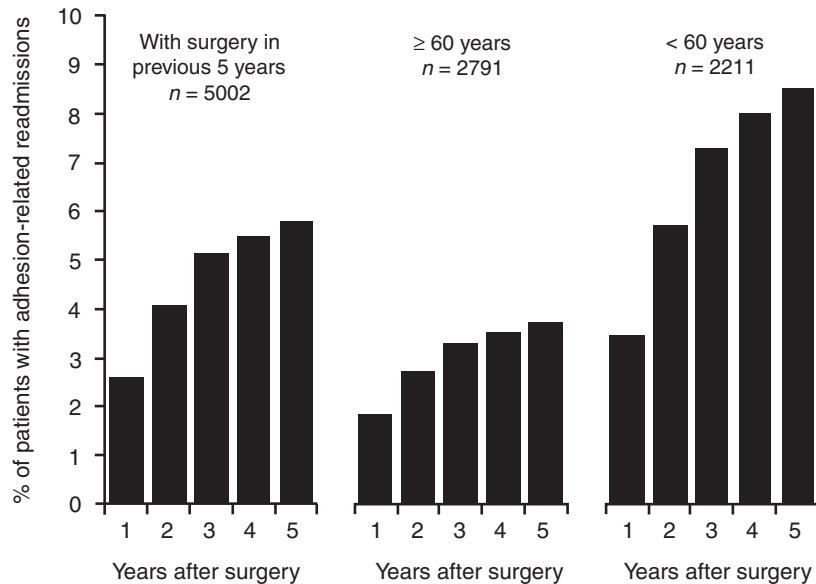


Figure 2 Readmissions directly related to adhesions in patients undergoing lower abdominal surgery; effect of age.



The age of patients undergoing appendicectomy was generally much lower compared with other procedures, and therefore the readmission risk for this procedure was reported in patients aged < 16 years and ≥ 16 years. Risk was found to be higher in those aged ≥ 16 years, both in those who had not had previous surgery (<16 years *vs* ≥ 16 years, 0.3% *vs* 0.9%; $P = 0.0249$) and in those who had undergone previous surgery (0.0% *vs* 2.4%; Table 3 – the P -value was not assessed for patients aged < 16 years, due to the low incidence of previous surgery).

Concomitant disease

Crohn's disease recorded at the time of incident surgery did not appear to have a major effect on the directly

related risk of readmission in patients who underwent procedures on the ileum ($P = 0.7271$).

An analysis of the effect of peritonitis on readmission risk showed that patients who underwent surgery on the appendix had a slightly increased risk of readmission if they were diagnosed with peritonitis (1.3%) compared with those who were not (0.8%; Table 3); however, this was not significant ($P = 0.1675$). A subanalysis suggested that this difference was most prominent in those patients who had undergone previous surgery ($P = 0.0488$).

The effect of diverticular disease (without peritonitis) on adhesion-related readmission risk in colon surgery was examined. The risk of readmission in patients with the disease (3.1%) was slightly lower than in those patients

who did not have the disease (5.1%; $P = 0.1381$; Table 2); however, the percentage of patients diagnosed with diverticular disease was comparatively small (8.2% of colon procedures).

Finally, readmission risk was assessed in patients diagnosed with colorectal cancer (CRC). Those patients with CRC who underwent procedures on the colon had a lower risk of readmission (3.8%) than those patients without cancer (6.2%; $P = 0.002$; Table 2). This difference remained when the data were censored for mortality (3.2% and 7.3%, respectively; $P = 0.0002$).

Discussion

The results of the SCAR study suggested a high burden of adhesion-related readmissions in patients undergoing lower abdominal surgery in 1986 [9,10]. In a more recent study (SCAR-2), no change was found in the rate of adhesion-related readmissions following colorectal surgery in 1996, 1997 and 1998 [12]. The rate of directly or possibly related readmissions 4 years after colorectal surgery was similar in the 2 incident years studied (25.5% in patients undergoing surgery in 1986; 29.7% in patients undergoing surgery in 1996–97). Consequently, there appears to have been little change in the rate of adhesion-related readmissions despite advances in surgical technique. These readmissions pose a significant burden to patients, surgeons and healthcare providers [12,15,16]. Clearly, a greater awareness of the nature of adhesions is needed. In this study, the aim was to identify procedures and patient subgroups associated with the highest risks of adhesion-related readmission.

It is important to note that only readmissions directly related to adhesion formation have been reported; possibly related readmissions or procedures that may be complicated by adhesions have not been included. The risk of adhesion-related readmission will therefore be greater than reported in this patient population.

This study is the first to investigate the risk of adhesions associated with specific types of abdominal surgery and with patient characteristics and comorbidities. It has previously been established that the Scottish NHS medical record linkage database is an excellent tool for this kind of research [9,17]. The study results provide valuable information to use in identification of lower abdominal surgery patients at an increased risk of adhesion formation, allowing for targeted adhesion-prevention strategies thereby potentially reducing the overall burden of adhesions and the individual risk to patients.

Patients undergoing lower abdominal surgery (excluding appendicectomy) have a 5% risk of readmission directly related to adhesions during the 5-year period of

the study. Panproctocolectomy, ileostomy surgery and total colectomy procedures were associated with the highest risk of an adhesion-related readmission. However, the greatest burden of readmission occurred following excision of the rectum, which was one of the most common procedures. Appendicectomy carried a relatively low risk of readmission, but contributed a high burden of adhesion-related readmissions. The study showed that readmission risk was doubled in patients who had undergone abdominal or pelvic surgery within the previous 5 years and patients aged < 60 years had a higher risk of readmission; censoring the data for mortality did not alter this difference. The data can be used to identify patients who are at considerable risk of adhesion-related problems. For example the data suggest that there is a 10% risk that a woman under the age of 60 years who had previously had abdominal surgery will have a directly related problem due to adhesions in a 5-year period following a further laparotomy. Although this increased risk may reflect the additional number of gynaecological surgical procedures classified as directly related to adhesions, it highlights that adhesion-related problems as a result of colorectal surgery can manifest as future gynaecological and fertility related issues.

The comparison of risk in patients undergoing appendicectomy with or without peritonitis at the time of surgery showed that peritonitis increased the risk of readmission, particularly in those who had undergone previous surgery. An increase in risk associated with peritonitis was observed in patients who underwent excision of the colon/rectum or left hemicolectomy; however, as the patient numbers were small, the data were not included in this paper. The inflammatory response associated with Crohn's and diverticular disease, and the potentially extensive surgery required in the management of CRC, suggest that readmission risk due to adhesions might be increased in these patients. Interestingly, no increase in risk was observed in patients with Crohn's disease. Patients with diverticular disease or CRC had a lower risk of readmission compared with those who did not. However, it is possible that the observed reduction in risk in patients with CRC may be due to the type of surgery performed in this patient group as hemicolectomy, which is the most common procedure in patients with CRC, was associated with a lower risk of adhesion-related readmission when compared with closure of colostomy and ileostomy surgery.

The disclosure of risks associated with medical treatment is becoming more important due to recent changes in legal requirements. Both English and Australian courts have moved away from accepting what a 'reasonable doctor' might do to what a 'reasonable patient' might expect [18]. This change in emphasis has led to increased

pressure on surgeons to ensure that patients are fully aware of the risks associated with surgery [19]. Importantly, in a recent case *Chester vs Afshar*, the House of Lords has effectively swept aside the requirement of causation (establishing a causal link between a breach and a patient's injury) where a medical practitioner has failed to obtain a patient's fully informed consent [20]. This judgement is of huge significance where there is a failure to warn of a risk which subsequently materializes.

This study indicates that there is a risk of readmission directly related to adhesions of approximately 10% in certain patient groups. Therefore, it seems prudent to inform patients of the risk of adhesions as part of the consenting process prior to lower abdominal surgery. As a number of adhesion-prevention strategies are available, the failure to take precautions to prevent adhesion formation may have medico-legal consequences. This has been reflected in a number of claims in recent years that have involved intra-abdominal lesions [21]. Information from the Medical Defence Union indicates that a total of 57 cases have been recorded since 1995, with total claims amounting to approximately £3.8 million [21]. The majority of these claims were for visceral damage or pain ascribed to adhesions, with 27 claims involving general or urological surgeons. The identification of patient subgroups shown to be at an increased risk of adhesion-related readmission in this study will allow surgeons to effectively confer information regarding risk to patients and to target adhesion-prevention strategies.

While there is no conclusive evidence that use of an anti-adhesion agent will reduce adhesion-related readmissions, there is mounting evidence of safety and efficacy for a number of these products. Work by members of the SCAR Study Panel has identified the significant problems in powering a study to show a reduction in adhesion-related problems [11]. Not only do such studies require enormous numbers of patients, but there are considerable resource and ethical issues to overcome which make embarking on clinical outcomes research very problematic. While as surgeons we may wish to have conclusive evidence of clinical outcomes, clearly in this field this will be difficult if not impossible.

There is however, an urgent need among surgeons for improved awareness of the consequences of adhesions in terms of complications for patients and for medico-legal considerations [20]. A recent study has indicated that using a low-cost anti-adhesion agent that leads to a 25% reduction in adhesion-related readmissions would save the UK NHS up to £71 million over the next 10 years [11]. Targeting such adhesion-prevention strategies at high-risk patients could further improve benefits to patients and health services.

Conclusions

Adhesion-related complications are an important source of morbidity in a substantial number of patients undergoing lower abdominal surgery. In this study, panproctocolectomy and ileostomy surgery appear to be associated with the greatest risk of an adhesion-related readmission. Previous surgery (within 5 years) and patient age (< 60 years) were also identified as important risk factors. The identification of these high-risk patient subgroups may assist in effectively targeting adhesion-prevention strategies, possibly leading to an improvement in patient outcomes and quality of life, as well as reduced surgical workloads.

Acknowledgements

The authors would like to acknowledge the contribution of fellow SCAR advisors: Harold Ellis, Guy's, King's and St Thomas' School of Biomedical Sciences, London, UK; Brendan Moran, North Hampshire Hospital, Basingstoke, UK; Adrian Lower, The London Clinic, London and Isis Fertility Centre, Colchester, UK; Robert Hawthorn, Southern General Hospital, Glasgow, UK; Ian Ford, Robertson Centre for Biostatistics, University of Glasgow, Glasgow, UK.

We also thank the ISD of the Scottish NHS for use of the Scottish medical record linkage database and specifically James Boyd and Alan Finlayson for the support they provided to David Clark. The study was supported by Shire Pharmaceuticals Group plc, Basingstoke, UK.

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