Adhesion-related hospital readmissions after abdominal and pelvic surgery: a retrospective cohort study

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Summary

Background Adhesions after abdominal and pelvic surgery are important complications, although their basic epidemiology is unclear. We investigated the frequency of such complications in the general population to provide a basis for the targeting and assessment of new adhesion-prevention measures.

Methods We used validated data from the Scottish National Health Service medical record linkage database to identify patients undergoing open abdominal or pelvic surgery in 1986, who had no record of such surgery in the preceding 5 years. Patients were followed up for 10 years and subsequent readmissions were reviewed and outcomes classified by the degree of adhesion. We also assessed the rate of adhesion-related admissions in 1994 for the population of 5 million people.

Findings 1209 (5.7%) of all readmissions (21347) were classified as being directly related to adhesions, with 1169 (3.8%) managed operatively. Overall, 34.6% of the 29790 patients who underwent open abdominal or pelvic surgery in 1986 were readmitted a mean of 2.1 times over 10 years for a disorder directly or possibly related to adhesions, or for abdominal or pelvic surgery that could be potentially complicated by adhesions. 22.1% of all outcome readmissions occurred in the first year after initial surgery, but readmissions continued steadily throughout the 10-year period. In 1994, 4199 admissions were directly related to adhesions.

Interpretation Postoperative adhesions have important consequences to patients, surgeons, and the health system. Surgical procedures with a high risk of adhesion-related complications need to be identified and adhesion prevention carefully assessed.

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Introduction

After laparotomy, almost 95% of patients are shown to have adhesions at subsequent surgery. Adhesions are internal “scars” that form after trauma through complex processes, involving injured tissues and the peritoneum. For most patients, adhesion formation has little effect. Some patients however, have clinical consequences.

Intestinal obstruction is the most severe consequence of adhesions. 30–41% of patients who require abdominal reoperation have adhesion-related intestinal obstruction. For small-bowel obstruction, the proportion rises to 65–75%. The clinical consequences of adhesions are not confined to the gut; adhesions are a leading cause of secondary infertility in women and can cause substantial abdominal and pelvic pain. A study of workload involved for 120 patients undergoing reoperative laparotomy estimated a mean increase of 24 min in total time of operation because of intra-abdominal adhesions from previous surgery (personal communication, BJM). A 21% risk of adhesion-related bowel perforation was identified in 274 patients undergoing relaparotomy (personal communication, H van Goor). This risk increased with age and increasing number of previous laparotomies. Although these data confirm the role of postoperative adhesions in morbidity and mortality, no large epidemiological studies have assessed the scale of adhesion-related outcomes over time.

The lack of epidemiological data on adhesions, combined with an inability effectively to prevent adhesion formation has limited the impetus to investigate this disorder. The advent of products offering potential adhesion decrease has, however, led to new interest in this subject. We investigated, in the Surgical and Clinical Adhesions Research (SCAR) study, the epidemiology of the disorder and clinical outcomes caused by postoperative adhesions.

Patients and methods

Patients

We used data from the Scottish National Health Service medical record linkage database from its information and statistics division. This database holds data on individual linked patients’ records on every inpatient and day-case hospital admission from 1981 onwards in Scotland, excluding psychiatric or maternity admissions. Follow-up of individual patients’ hospital admissions over time is included. We
analysed hospital readmissions in patients undergoing initial abdominal or pelvic surgery in 1986. We chose 1986 to allow identification of an incident population, defined as individuals who had had no abdominal or pelvic surgery in the previous 5 years. To limit the potential impact of adhesions due to previous surgery we analysed separately all patients who had undergone abdominal or pelvic operations in the 5 years before 1986. This group was thought to be likely to influence the eventual results because of pre-existing adhesions. All patients were followed up for readmissions for defined outcomes over 10 years. To show the annual prevalence of adhesion-related hospital admissions, we analysed all such operative and non-operative admissions in the general population of Scotland in 1994 alone, according to the same classifications as in the incident population. This approach provided the full yearly burden, which could not be obtained from the incident-population analysis. Exclusion of patients who had had surgery in the previous 5 years lowered the number of adhesion-related admissions and 10-year follow-up would not capture all the adhesion-related readmissions, since reports suggest that some patients have recurrent adhesion-related complications over many years and others have a latent period of more than 10 years. 1994 was chosen because it was the last year in which a fully audited and validated dataset of complete linked data was available from the information and statistics division.

Methods
The investigators, including upper gastrointestinal, colorectal, and gynaecological surgeons, as well as a health economist, formed as a steering group to advise on and direct the work. We used Office of Population Censuses and Surveys—3rd Revision of the Classification of Surgical Operations and Procedures (OPCS-3) codes to define all initial abdominal or pelvic operations that could cause adhesion development. Hospital readmissions (operative and non-operative) after initial surgery were defined by the steering group according to OPCS-3 and OPCS-4 (fourth revision) operative codes and International Classification of Diseases, ninth edition (ICD-9) diagnostic codes.

The steering group decided on three outcome classifications: directly related to adhesions (adhesiolysis, non-operative readmissions for adhesions, and adhesiolysis operations on female reproductive tract); possibly related to adhesions (gynaecological operations, abdominal surgery, and non-operative readmissions); and open or laparoscopic reoperations that could potentially be complicated by adhesions. Classification was done by the extent of adhesion involvement according to relevant codes. Such classification enabled assessment of the workload involved in the treatment of adhesion-related disorders, and, specifically, the workload associated with readmissions confirmed to be directly related to adhesions.

We recognised that this approach would provide an underestimate of directly related adhesion disorders. For a readmission to be classified as directly related to adhesions, an explicit adhesion reference was required in the operative (OPCS-3 or OPCS-4) or diagnostic (ICD-9) coding. ICD-9 diagnostic codings for adhesions are not precise and, without surgical confirmation, may not be coded. Many adhesion-related complications can only be diagnosed at the time of operation when the surgeon can confirm the presence of adhesions. To overcome this limitation, an explicit reference to adhesions in the operative code was required.

<table>
<thead>
<tr>
<th>Site of initial open surgery</th>
<th>Patients with readmission</th>
<th>Total number of hospital readmissions</th>
<th>Mean number of readmissions per patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid and hind gut (n=12 584)</td>
<td>4101 (32·6%)</td>
<td>8861</td>
<td>2-2</td>
</tr>
<tr>
<td>Fore gut or other abdominal (n=8717)</td>
<td>3294 (37·8%)</td>
<td>7053</td>
<td>2-1</td>
</tr>
<tr>
<td>Female reproductive tract (n=8489)</td>
<td>2931 (34·5%)</td>
<td>5433</td>
<td>1-9</td>
</tr>
</tbody>
</table>

Table 1: Number of readmissions
related admissions without an operation may, therefore, have been coded as abdominal pain, nausea, and vomiting, and were classified in our study as non-operative readmissions possibly related to adhesions.

We used seven confirmatory OPCS-3 or OPCS-4 codes specific for the surgical treatment of adhesions to identify gynaecological readmissions directly related to adhesions. The remaining gynaecological readmissions were classified into gynaecological surgery possibly related to adhesions, which included tubal fertility investigations, or as abdominal surgery readmissions possibly related to adhesions. Abdominal and pelvic pain, a possible consequence of gynaecological adhesions, were underestimated in this analysis.

The code-selection process was set up to ensure that each single hospital readmission would be listed in only one classification and would be mutually exclusive of all others. Because laparoscopy was used mainly for diagnostic purposes in 1986, and therefore, adhesion-related outcome readmissions in these patients were likely to be the result of subsequent open surgery, we analysed separately patients undergoing open or laparoscopic surgery. We did detailed analysis in the incident population only of patients who underwent open abdominal or pelvic surgery. In selection and classification of readmissions, however, laparoscopic surgical procedures were included, since these may have been for the treatment of adhesion-related disease or were reoperations that could have been complicated by adhesions.

We did analyses by anatomical site of the initial procedure, rather than by the specialty of the surgeon. The three major subdivisions were: mid and hind gut (small intestine, abdominal wall, appendix, rectum, and colon); fore gut or other abdominal organs (stomach, gall bladder, pancreas, kidney, bladder, and hernia); and the female reproductive system.

We chose the Scottish medical record linkage database because of its size, comprehensiveness, and proven quality of records. A major benefit was the demography of Scotland, which geographically is self-contained and has a stable population of about 5·1 million, with less than 1% annual migration. High degrees of accuracy, data quality, and confidence in the information were major influences in our choice.7,8 The data source was rigorously investigated and challenged by the steering group before the decision was made to use the data.

The accuracy of the database is ensured through an established process of intensive quality assurance in training, coaching, and monitoring of staff, combined with an annual audit of 1% of hospital returns by the information and statistics division of the National Health Service in Scotland. The linkage of patients’ records has an accuracy of 99%. For every diagnosis and procedure that has been reviewed, results show a 90% and a 94% accuracy, respectively. Analysis of specific codes used in the study from the 1% audit confirmed the validity of accuracy for our analysis. In the rigorous review process, we proposed additional audit of selected samples of hospital clinical records from patients in the study cohort. The study steering group believed, however, that the existing quality assurance processes meant that further audit was unnecessary. Any inaccuracies in the various coded groups in the SCAR study cohort would be likely to underestimate adhesion-related complications. The steering group’s main concern was to ensure no overestimation.

**Results**

54 380 patients had initial surgery during 1986, as defined by the OPCS-3 codes (figure 1). Of the 12 539 patients excluded for previous surgery, 7494 (59·8%) had outcome readmissions over 10 years compared with 15 069 (36·0%) of 41 841 in the incident population. A large proportion of the pre-existing burden associated with adhesions was therefore not included in the main incident population or in the open-surgery group after laparoscopic surgery was excluded.

One in three patients (34·7%) of 29 790 patients in the open-surgery group experienced at least one outcome readmission over the 10 years (table 1). 21 347 outcome readmissions were recorded for the 10 326 patients who had one or more readmissions, a mean of 2·1 readmissions per patient. These results were similar for the three surgery groups.

Analysis of the actual number of readmissions that these patients experienced over the 10 years showed that 53·8% of patients had only one hospital readmission, 41·4% two to five admissions, and 4·8% had six or more readmissions.

768 outcome readmissions were for operations directly related to abdominal adhesions (table 2), of which 280 (36·5%) had small-bowel obstruction. A further 40 readmissions were for operative treatment of gynaecological adhesions, and, therefore, 808 readmissions were for surgery directly attributable to adhesions. Additionally, 401 (33·2%) of 1209 admissions were for non-operative treatment of adhesions, of which 98 had small-bowel obstruction. At least 5·7% of all readmissions were directly due to adhesions. Open surgery on the female reproductive tract was associated with intra-abdominal adhesions in

### Table 2: Outcome readmissions

<table>
<thead>
<tr>
<th>Site of initial surgery</th>
<th>Adhesiolysis procedures with or without small-bowel obstruction</th>
<th>Adhesions with or without small-bowel obstruction treated non-operatively</th>
<th>Gynaecological adhesions treated surgically</th>
<th>Abdominal surgery possibly related to adhesions</th>
<th>Non-operative readmission possibly related to adhesions</th>
<th>Gynaecological surgery possibly related to adhesions</th>
<th>Repeat surgery potentially complicated by adhesions</th>
<th>Total readmissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid and hind gut</td>
<td>430 (4.9%)</td>
<td>197 (2.2%)</td>
<td>16 (0.2%)</td>
<td>817 (9.2%)</td>
<td>2341 (26.4%)</td>
<td>438 (4.9%)</td>
<td>4622 (52.2%)</td>
<td>8861</td>
</tr>
<tr>
<td>Fore gut or other abdominal</td>
<td>174 (2.5%)</td>
<td>147 (2.1%)</td>
<td>0</td>
<td>450 (6.4%)</td>
<td>1512 (21.4%)</td>
<td>203 (2.9%)</td>
<td>4567 (64.7%)</td>
<td>7053</td>
</tr>
<tr>
<td>Female reproductive tract</td>
<td>164 (3.0%)</td>
<td>57 (1.0%)</td>
<td>24 (0.4%)</td>
<td>530 (9.8%)</td>
<td>1201 (21.1%)</td>
<td>748 (13.8%)</td>
<td>2709 (49.9%)</td>
<td>5433</td>
</tr>
<tr>
<td>Total</td>
<td>768 (3.6%)</td>
<td>401 (2.9%)</td>
<td>40 (0.2%)</td>
<td>1797 (8.4%)</td>
<td>5064 (23.7%)</td>
<td>1389 (6.5%)</td>
<td>11 989 (56.7%)</td>
<td>21 347 (100%)</td>
</tr>
</tbody>
</table>

![Figure 2: Readmissions during study](image-url)
245 readmissions for adhesiolysis or non-operative treatment. This potential crossover of adhesion-related disorders between surgical specialties was also seen in the mid-gut and hind-gut open-surgery group, with a substantial number of gynaecological interventions on readmission, but not in the fore-gut or other abdominal organs group, which were mainly upper-abdominal procedures.

Readmissions in all outcome classifications showed a similar pattern, with the greatest percentage of readmissions occurring in the first year after initial surgery (22·1%) and continuing steadily thereafter over the 10 years. Mid-gut and hind-gut surgery had the highest rate of readmissions directly related to adhesions (table 3).

67 017 patients had 75 204 admissions in 1994, as defined by the outcome readmissions codes used in the 1986 incident population (25 934 men, 41 083 women). 4199 (5·6%) were definitely associated with adhesions (2·6% adhesions, 2·8% non-operative, 0·2% gynaecological), and 48 664 (64·7%) were possibly associated with adhesions (10·9% abdominal surgery, 46·3% non-operative, 7·6% gynaecological). 22 341 (29·7%) admissions were for operations that were potentially complicated by adhesions.

**Discussion**

Historically, studies of adhesions after abdominal or pelvic surgery have been limited in scale and scope. They have consisted of prospective analyses by surgeons of clinical outcomes in their own patients or analyses of patients presenting in a particular setting with small-bowel obstruction or adhesions. Our study was designed to overcome these limitations and to show long-term, population-based effects.

Our interpretation of adhesion-related disorders was cautious. We studied only patients undergoing initial open abdominal or pelvic surgery in 1986, with no history of abdominal or pelvic surgery in the previous 5 years to limit the potential impact of pre-existing adhesions. This decision was validated on analysis of their readmissions (59·8% of patients who had surgery in the previous 5 years had readmissions compared with 36·0% in the main incident population and 34·7% in the open-surgery analysis group).

Our approach probably substantially underestimated the number of readmissions for directly-related adhesion disease. Over 10 years, 23·7% of all readmissions studied were for disorders such as abdominal pain and vomiting and nausea, and were classified as non-operative readmissions possibly related to adhesions. There were more than six times as many operative and non-operative readmissions classified as possibly related to adhesions than as directly related to adhesions. A substantial proportion of patients in the possible classification probably, therefore, had adhesion-related disorders. Despite possible underestimation, 5·7% of hospital outcome readmissions over 10 years were directly attributable to adhesions, with 3·8% managed operatively. This proportion is in line with a major cross-sectional analysis done over 25 years in one surgical unit, in which the incidence was 3·5% of all readmissions for operative management of adhesional obstruction after laparotomy.

Mid-gut and hind-gut surgery had the highest percentage of readmissions directly related to adhesions (7·3%) and the highest rate of readmission (5·1 readmissions per 100 initial procedures). These procedures are therefore worthy of specific concern and should be targeted for adhesion-prevention strategies. Fazio and colleagues reported a 25% incidence of small-bowel obstruction after total colectomy with ileal-pouch reconstruction in a series of 1005 cases.

An important number of adhesion-related readmissions followed initial surgery in one organ area but had outcomes in another. After mid-gut and hind-gut surgery, 16 gynaecological adhesiolysis procedures (0·2%) and 438 possible gynaecological adhesion-related readmissions (4·9%) were recorded. These numbers are far higher than those seen in the fore-gut group, despite similar numbers of patients. Since this latter surgical group involved mainly upper abdominal surgery, the physical distance between the site of initial surgery and the female reproductive organs may have limited adhesion involvement.

We included readmissions for repeat abdominal or pelvic surgery to provide a base for analyses and because open and laparoscopic reoperation can be complicated by adhesions. BJM has shown an important additional time requirement during operations on patients who had previous open surgery. A 21% risk of adhesion-related bowel perforation in reoperated patients has been shown by H van Goor, with serious consequences for morbidity and increased duration of hospital stay. These results suggest an additional burden from adhesions for surgeons and operating-room planners, because of increased use of operating-room resources required in opening the abdomen and carrying out adhesiolysis, with the attendant risks, before being able to undertake the planned operative procedure.

We also obtained results from a non-operative health-care planning perspective. Our results confirm the findings of previous studies that most adhesion-related events are seen in the first year after surgery, with 22·1% of total abdominal adhesiolysis admissions being recorded during this period. However, of particular importance is the incidence of adhesion-related...
disorders after the first year, which did not decline with time (despite the decline in the cohort number through death) and which was seen in all outcome readmission classifications throughout the study. Postoperative adhesions are associated with substantial morbidity and present a risk over time that can run into decades.

The rate of readmission after initial mid-gut and hind-gut surgery in 1986 was substantially higher than the rates after gynaecological and other abdominal surgery. This finding provides an indication of the relative risk of directly related adhesion disorders after initial surgery and confirms results of smaller-scale studies. This information may be useful in the planning of adhesion-prevention strategies, and further analysis of readmission rates after specific surgical procedures could be useful to surgeons, health planners, and patients.

The prevalence of admissions directly attributable to adhesions in 1994 was substantially higher than readmissions recorded in the 1986 study group. This difference reflects the inclusion of data from patients who had had surgery in the previous 5 years, and took into account the fact that adhesion-related outcomes continue beyond the 10-year study period, and confirms our cautious approach. The total number of admissions directly related to adhesions in 1994 for Scotland was similar to the total numbers of hip replacements (4394), coronary-artery bypass grafts (4020), appendix operations (4846), and haemorrhoid surgery (4226) during the same period in the same population, which highlights the scale of adhesion-related disorders.

The important question of adhesion-related mortality in operative and non-operative readmissions had not been studied, but it is anticipated that studies to look at this population will be done, as well as studies of adhesion-related complications in the major groups of abdominal operations (appendicectomy, large-bowel resections, hysterectomy, &c). The cost of adhesion-related complications is not included in this analysis, but work is underway to assess the financial burden, which will be important in planning adhesion-prevention strategies.

One in three patients were readmitted at least twice over the 10-year period, and at least one in 18 outcome readmissions (for operative and non-operative treatment) were directly related to adhesions. We have shown that there is a substantial burden of readmissions for postoperative adhesion-related disorders that shows no sign of decline. The rate of complications related to adhesions among surgically treated patients is high and is likely to have long-term consequences. Greater priority needs to be given to the iatrogenic complications of post-operative adhesions. Advances in methods for adhesion prevention should be assessed to identify surgical procedures with a high risk of adhesion-related complications.

Contributors
Working as a steering group, all 12 investigators contributed to the initial planning and development of methods, review, and analysis of the data, and to the writing of the paper. Brendan Moran, Michael Parker, Don Menzies, Robert Hawthorn, and Adrian Lower were involved in selection of the operative and diagnostic codes, and, with Harold Ellis, Ailisur McGuire, Fiona O’Brien, Scot Buchan, and Alison Crowe, were closely involved in the initial planning process and development of methods. Fiona O’Brien was responsible for the abstraction of data from the Scottish medical record linkage database and the initial preparation of data for review. All authors participated in data review as a steering group and as subgroups. Scot Buchan and Fiona O’Brien undertook the analyses of the data abstractions under the direction and guidance of the other investigators. Harold Ellis, Brendan Moran, and Scot Buchan undertook initial development of the paper, and were involved in the editing of all subsequent drafts with Jeremy Thompson, Harold Ellis, and Alison Crowe as coordinators of drafts and the final paper. Alison Crowe coordinated the study and the steering group.

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References