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Medicine

PERITONEAL ADHESION SYNDROME AND HOSPITAL READMISSIONS AFTER OPEN ABDOMINAL AND PELVIC SURGERY

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ABSTRACT
THE PURPOSE OF THE PRESENT STUDY IS TO DEMONSTRATE THE HIGH INCIDENCE OF THE PERITONEAL ADHESIONS AFTER OPEN ABDOMINAL OR PELVIC SURGERY, IN ORDER TO PROVIDE A BASIS FOR THE FUTURE STUDIES REGARDING THE NEW AND EFFICIENT PREVENTION METHODS.
MATERIAL. DATA FROM THE MEDICAL RECORD DATABASE OF THE SURGICAL DEPARTMENT OF "SFÂNTUL PANTELIMON"EMERGENCY HOSPITAL FROM BUCHAREST, ROMANIA, WERE USED IN ORDER TO IDENTIFY PATIENTS UNDERGOING OPEN ABDOMINAL OR PELVIC SURGERY IN 2014, WHO HAD NO RECORD OF SUCH SURGICAL INTERVENTIONS IN THE PRECEDING 5 YEARS, BEING FOLLOWED UP FOR 3 YEARS, UNTIL JANUARY 2018, ANALYSING THE SUBSEQUENT READMISSIONS. THE RATE OF ADHESION-RELATED ADMISSIONS AMONG THE TOTAL NUMBER OF ADMISSIONS BETWEEN JANUARY 2014 AND JANUARY 2018 IN THE GENERAL SURGERY DEPARTMENT WAS, ALSO, ASSESSED.
RESULTS. 7% OF ALL READMISSIONS WERE RELATED TO POSTOPERATIVE PERITONEAL ADHESIONS, MOST OF THEM BEING MANAGED OPERATIVELY. 35% OF THE PATIENTS WHO UNDERWENT ABDOMINAL OR PELVIC SURGERY IN 2014 WERE READMITTED FOR AT LEAST ONE TIME OVER THE 3 YEARS OF FOLLOW-UP FOR A COMPLICATION OF THE PERITONEAL ADHESION SYNDROME, MOST OF THE RADMISSIONS OCCURING IN THE FIRST YEAR AFTER THE INITIAL INTERVENTION, BUT CONTINUING STEADILY THROUGHOUT THE 3-YEAR PERIOD. BETWEEN JANUARY 2014 AND JANUARY 2018, 15% OF THE ADMISSIONS WERE DIRECTLY RELATED TO POSTOPERATIVE ADHESIONS.
CONCLUSIONS. POSTOPERATIVE PERITONEAL ADHESION SYNDROME HAS AN IMPORTANT IMPACT UPON PATIENTS, SURGEONS AND THE HEALTHCARE SYSTEM, HIGHLIGHTING THE NECESSITY OF EFFICIENT PREVENTION METHODS.

KEYWORDS: PERITONEAL ADHESIONS, READMISSION, SURGERY, PREVENTION.

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INTRODUCTION

The incidence of peritoneal adhesion syndrome in patients following general pelvic and abdominal surgery ranges from 63% to 97%[5].

The postoperative peritoneal adhesion syndrome significantly increases the length of time required in subsequent surgical procedures, affecting the workloads of surgical teams [8], and increasing the risk of postoperative morbidity, especially by causing enterotomies during laborious adhesiolysis.

Although asymptomatic in it's early stages, this syndrome is frequently associated with serious complications, such as bowel obstruction[6], female secondary infertility[7], chronic abdominal pain and complications related to surgical reintervention[8].

Awareness of the severe complications that affect the patients' evolution and of the health care system problems associated with adhesions has increased in recent years, due to the publication of scientific data, one of the important studies being represented by the Surgical and Clinical Adhesions Research (SCAR) analysis[9].

The first Surgical and Clinical Adhesions Research (SCAR) study, developed in Scotland in 1986, aimed to determine the frequency of adhesion-related complications in patients undergoing open abominal surgery. 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 the resulted data showed that the cost associated with adhesion-related readmissions following abdominal surgery in the UK over 10 years is over £500 million[10].

The following similar study, SCAR-2 study[11] analysed 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 1998–9. It was demonstrated 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[12].

The third study in the series of epidemiological assessments defining the extent of adhesion-related readmissions in Scotland (SCAR-3), aimed to evaluate the adhesion-related

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[5] Menzies D, Ellis H. Intestinal obstruction from adhesions – how big is the problem? *Ann R Coll Surg Engl* 1990; 72: 60–3; Weibel MA, Majno G. Peritoneal adhesions and their relation to abdominal surgery. A post-mortem study. *Am J Surg*1973*;* 126*:* 345–53

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readmission risk directly associated with common abdominal and pelvic surgical procedures, the impact of patient surgical history, age, gender and concomitant disease being, also, assessed. Data from the Scottish National Health Service medical record linkage database were used in order to determine the risk of adhesion-related readmission secondary to open abdominal surgery, during April 1996-March 1997. Through this study it was demonstrated that the identification of high-risk patient subgroups may be of great help in effectively targeting adhesion-prevention strategies and preoperative advice- offering on adhesion risk.

The purpose of the present study, an epidemiological analysis, is to assess the adhesion-related readmission risk directly associated with common abdominal and pelvic surgical procedures and the influence of patient surgical history, age, gender and concomitant disease upon this risk, thus, providing a basis for the future studies regarding the new, targeted and efficient prevention methods.

MATERIAL AND METHODS

The present study used anonymised data from the medical record database of the General Surgery Department of "Sfântul Pantelimon" Emergency Hospital from Bucharest, Romania.

The resulted data were used in order to identify patients that underwent open abdominal or pelvic surgery throughout the calendar year of 2014, who had no record of such surgical interventions in the preceding 5 years, who had been followed up for until January 2018.

Using results provided by the analysis of the database, the risk of an adhesion-related readmission in the group of patients who underwent open abdominal or pelvic surgery in the calendar year January– December 2014 was analysed.

The population of the present study was defined using ROv1DRG surgical codes[13] describing the surgical site, the type of procedure and the procedure subtype (e.g. total colectomy and ileo-rectal anastomosis). Demography and diagnostic disease code details according to the International Code of Diseases, Tenth Edition (ICD-10)[14] were available for the study group.

A robust tracking of all hospital inpatient and day-case hospital admissions, excluding maternity and psychiatric admissions, within the hospital, from January 2014, until January 2018, was assessed, rigorously investigating and testing the data prior to deciding to employ this database. Adhesion-related readmissions and procedures that may be complicated by them were identified by ROv1DRG 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.

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. Adhesion-related readmission rates were reported based on the site of the initial

[13] Rov1DRG Classification. URL www.drg.ro/DocDRG

[14] National Center for Health Statistics. (2004) *International Classification of Diseases, 10th revision (ICD-10)*.URL http://www.cdc.govnchsaboutmajordvsicd10des.htm

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 impact of age at the time of the primary surgical intervention on the risk of adhesion-related readmission was assessed, the patients being categorized as aged ≤ 60 years or aged ≥ 60 years for all the procedures.

The effect of comorbidities on risk, including malignancy, peritonitis and inflammatory bowel disease, was assessed for each surgical procedure site.

The effect of gender on risk was also analysed.

The rate of adhesion-related admissions among the total number of admissions between January 2014 and January 2018 in the General Surgery Department of "Sfântul Pantelimon" Emergency Hospital from Bucharest, Romania, was, also, assessed.

Individual patient confidentiality was respected. Patients were treated, as well as written informed consent for each procedure adopted was collected, according to the usual clinical practice. The study protocol conforms to the ethical guidelines of the "World Medical Association (WMA) Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects" adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964 and amended by the 64th WMA General Assembly, Fortaleza, Brazil, October 2013. Approval by the institutional review committee was obtained, since this study retrospectively analyzed patients' data.

Data were recorded regarding demographics, diagnosis, duration of hospital stay, complications and mortality. The analysis of the data was made using Microsoft Office Excel 2013 software.

RESULTS

A total of 1056 patients underwent open abdominal or pelvic surgical procedures in the calendar year of 2014 (excluding gynaecological interventions). Among the 1056 cases of open abdominal or pelvic interventions, 131 cases consisted of small bowel procedures, 568 cases of colo-rectal or abdominal wall surgical interventions and 357 appendectomies.

In this group as a whole, the risk of readmission directly related to adhesions within 3 years following surgery was 8,14% (11,87% excluding appendicectomy procedures-Table 1).

Table 1. The adhesion-related readmission risk in the sudy population

Surgical site	Total number of readmissions	Total number of procedures	Rate of readmission %
Small bowel surgery	30	131	22,9
Colo-rectal and abdominal wall surgery	53	568	9,33
Subtotal (excluding appendectomy)	83	699	11,87

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Appendectomy	3	357	0,84
Total	86	1056	8,14

SMALL BOWEL PROCEDURES

An assessment of patients who underwent surgery on the small intestine showed that procedures on the duodenum and jejunum had a 22,9% risk of readmission directly related to adhesions (Table 1).

The readmission risk was lower in the subgroup of patients who underwent open duodenal ulcer repair compared with those who did not have ulcer repair (Table 2).

Surgical interventions on the ileum had an overall risk of readmission of 13,33%, with an increased risk of readmission of 33,33% in the subset of patients who underwent ileostomy surgery and decreased risk of 12,5% for those who had ileal excision. The risk of readmission was higher in the subgroup of patients with Crohn disease (Table 2).

Table 2. Directly adhesion-related readmission risk 3 years after small bowel surgical procedures.

Site and type of surgery	**Total number of readmissions (nR)**	**Total number of procedures (nTP)**	**Rate of readmission % (nR/nTP)**
Duodenum/ jejunum	4	16	25
Duodenal ulcer	4	34	11,76
Ileum	4	30	13,33
With Crohn disease	4	23	17,39
Without Crohn's	0	7	0
Ileal excision	6	48	12,5
With Crohn disease	4	23	17,39
Without Crohn's	2	25	8
Ileostomy surgery	1	3	33,33
Total	30	131	22,9

Age was found to be an important factor with impact upon the risk of readmission. Patients aged ≤60 years had a much greater risk than those aged ≥60 years (Table 3). This trend was supported by data on each individual site of surgery.

Table 3. Directly adhesion-related readmission risk 3 years after small bowel surgical procedures, influenced by age.

Site and type of surgery	≤60 yrs			>60 yrs		
	nR	nTP	Readmission rate % (nR/ nTP)	nR	nTP	Readmission rate % (nR/ nTP)
Duodenum/jejunum	2	9	22,22 (2/9)	2	7	28,57 (2/7)
Duodenal ulcer	2	25	8 (2/25)	2	9	22,22 (2/9)
Ileum	4	27	14,8 (4/27)	0	3	0/3
With Crohn disease	4	22	18,18 (4/22)	0	1	0/1
Without Crohn disease	0	5	0/5	0	2	0/2
Ileal excision	3	20	15 (3/20)	3	28	10,71 (3/28)
With Crohn disease	3	18	16,66 (3/18)	1	5	20 (1/5)
Without Crohn disease	0	2	0/2	2	23	8,69 (2/23)
Ileostomy surgery	0	1	0/1	1	2	50 (1/2)

COLORECTAL AND ABDOMINAL WALL PROCEDURES

The overall readmission risk for procedures on the colon was higher than the risk for those on rectum, with 7,96% risk of readmission and 5,03% respectively (Table 4).

For surgical procedures on the colon, the highest risk of readmission occurred in the subgroups of patients who underwent total colectomy (33,33%).

The most common surgical intervention on the colon was hemicolectomy, with 98 cases out of 568, the total number of procedures on the colon (17,25%).

The risk of readmission ranged from 10,2% for a right-sided hemicolectomy to 1,35% for a sigmoid hemicolectomy. Colostomy procedures were associated with a risk of 3,22% of readmission.

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A higher readmission rate was found for abdominal wall procedures (7,1%).

Table 4. Directly adhesion-related readmission risk 3 years after colorectal or abdominal wall surgical procedures.

Site and type of surgery	Total number of readmissions	Total number of procedures	Rate of readmission %
Colon	**18**	**226**	**7,96**
With cancer	**9**	**201**	**4,47**
Without cancer	**9**	**25**	**36**
With Diverticulitis	**1**	**18**	**5,55**
Without Diverticulitis	**17**	**208**	**8,17**
Panproctocolectomy	**0**	**0**	**0**
Total colectomy	**1**	**3**	**33,33**
Right hemicolectomy	**10**	**98**	**10,2**
Left hemicolectomy	**1**	**53**	**1,88**
Sigmoid hemicolectomy	**1**	**74**	**1,35**
Colostomy	**1**	**31**	**3,22**
Rectum	**8**	**159**	**5,03**
Excision of rectum	**7**	**150**	**4,66**
Rectal prolapse	**1**	**9**	**11,11**
Abdominal wall	**13**	**183**	**7,1**
Total	**53**	**568**	**9,33**

Age had an important impact in the readmission risk in the colorectal and abdominal wall surgery subgroup; overall patients aged ≤60 years had a lower risk than those aged ≥60 years (Table 5). This trend was supported by data on each individual site of surgery.

Table 5. Directly adhesion-related readmission risk 3 years after colorectal or abdominal wall surgical procedures, influenced by age.

Site and type of surgery	≤60 yrs			>60 yrs		
	nR	nTP	Readmission rate % (nR/ nTP)	nR	nTP	Readmission rate % (nR/nTP)
Colon	4	77	5,19	14	149	9,4 (14/149)
With cancer	2	71	2,81	7	130	5,4 (7/130)
Without cancer	2	6	33,33	7	19	36,84 (7/19)
With Diverticulitis	0	1	0/1	1	17	5,88 (1/17)
Without Diverticulitis	4	76	5,26	13	132	9,84 (13/132)
Panproctocolectomy	-	-		-	-	
Total colectomy	0	1	0/1	1	2	50 (1/2)
Right hemicolectomy	1	6	16,66	9	92	9,78 (9/92)
Left hemicolectomy	0	4	0/4	1	49	20,4 (1/49)
Sigmoid hemicolectomy	0	5	0/5	1	69	1,44 (1/69)
Colostomy	1	3	33,33	0	28	0/28
Rectum	3	26	11,53	5	133	3,75 (5/133)
Excision of rectum	3	25	12	4	125	3,2 (4/125)
Rectal prolapse	0	1	0/1	1	8	12,5 (1/8)
Abdominal wall	5	85	5,88	8	98	8,16 (8/98)

The large majority of rectal procedures were for excision of the rectum and had a readmission risk of 4.66%. In contrast, abdominal procedures for rectal prolapse carried a

readmission risk of 11.11%, but the data is not statistically significant because of the low number of cases of rectal prolapse included in the study (Table 4 and 5).

APPENDICECTOMY

Patients who underwent appendicectomy had a comparatively low overall direct risk of readmission (0.84%; Table 6). However, this procedure accounted for approximately 33,80% of all abdominal procedures (357 out of 1056) and 3,4% of all patient readmissions during the 3 years following lower abdominal surgery (3 readmissions following appendectomy ot of the total number of readmissions of 86- Table 1). Appendicectomy therefore contributes significantly to the overall burden of adhesion-related readmissions.

Table 6. Directly adhesion-related readmission risk 3 years after appendicectomy.

Site and type of surgery	Total number of readmissions	Total number of procedures	Rate of readmission %
Appendectomy	**3**	**357**	**0,84**
With peritonitis	**2**	**214**	**1,61**
Without peritonitis	**1**	**143**	**0,69**

Table 7. Directly adhesion-related readmission risk 3 years after appendicectomy, influenced by age.

Site and type of surgery	≤60 yrs			>60 yrs		
	nR	nTP	Readmission rate % (nR/nTP)	nR	nTP	Readmission rate % (nR/nTP)
Appendectomy	**2**	**283**	**0,7 (2/283)**	**1**	**74**	**1,35 (1/74)**
With peritonitis	**1**	**160**	**0,6 (1/160)**	**1**	**54**	**1,85 (1/54)**
Without peritonitis	**1**	**123**	**0,8 (1/123)**	**0**	**20**	**0/20**

PATIENT AGE

It has been demonstrated that the age of the patient represents an important factor in readmission risk; overall patients aged >60 years had a greater risk than those aged ≤60 years. This trend was supported by data on each individual site of surgery.

The directly related risk of readmission for patients aged >60 years was 28,57% for those who underwent procedures on the duodenum/jejunum, 9,4% for those who underwent procedures on the colon, 3,75% for rectum procedure cases and 8,16% in those with abdominal wall surgery.

For patients aged ≤60 years, the risk of readmission was 22,22% after procedures on duodenum/jejunum, 5,19% after colonic surgery, 11,53% after rectal surgery and 5,88% secondary to abdominal wall surgery. The higher rates in the colon and rectum subgroups, that included patients ≤60 years, can be explained by the lower total number of procedures in this subgroups that limits the statistical significance of the research.

In this study population, the increment in risk was greatest in patients who underwent surgery on the duodenum/jejunum (≤ 60 years *vs* ≥ 60 years: 28,57%*vs* 22,22%) or abdominal wall surgery (8,16%*vs* 5,88%) (Figure 1).

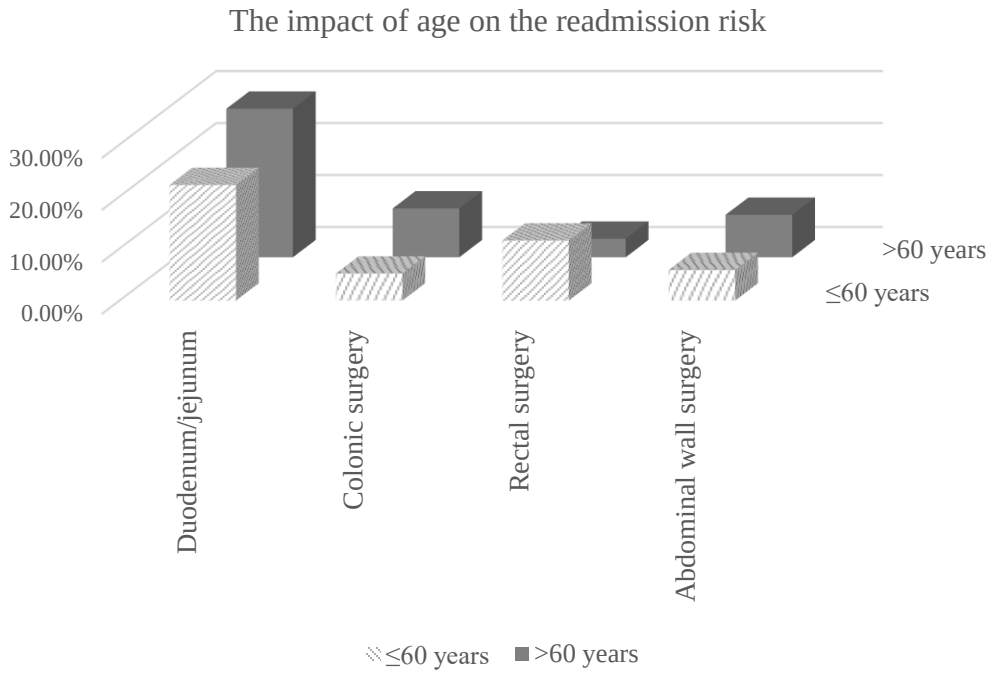

Figure 1. The impact of age on the readmission risk.

CONCOMITANT DISEASE

Crohn's disease recorded at the time of incident surgery increased the risk of readmission in patients who underwent procedures on the ileum or colon.

An analysis of the effect of peritonitis on readmission risk showed that patients who underwent surgery on the appendix had a higher risk of readmission if they were diagnosed with peritonitis compared with those who were not (Table 6).

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 (5,55%) was slightly lower than in those patients who did not have the disease (8,17%). However, the

percentage of patients diagnosed with diverticular disease was comparatively small (7,96% of colon procedures) (Table 4).

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 (4,47%) than those patients without cancer (36%).

The total mortality rate in the population study was 0,66% (7 cases out of 1056 patients included in the study), with a high mortality rate (1,05%) in the colo-rectal and abdominal wall surgery **(**Table 8**).**

Table 8. The mortality rate in the study population.

Surgical site	**Total number deaths**	**Total number of procedures**	**Rate of mortality%**
Small bowel surgery	**1**	**131**	**0,76**
Colo-rectal and abdominal wall surgery	**6**	**568**	**1,05**
Appendectomy	**0**	**357**	**0**
Total	**7**	**1056**	**0,66**

DISCUSSION

The results of the study demonstrated a high burden of adhesion-related readmissions in patients undergoing open abdominal and pelvic surgery.

SCAR-3 study showed that there were no changes in the rate of adhesion-related readmissions following colorectal surgery in recent years[15]. Consequently, there appears to have been little change in the rate of adhesion-related readmissions despite advances in surgical technique. These readmissions determine a significant burden upon patients, surgeons and healthcare providers[16]. Thus, is important to admit that a greater awareness of the nature of postoperative peritoneal adhesions is needed. In this study, the aim was to identify procedures and patient subgroups associated with the highest risks of adhesion-related readmission.

An important factor that influences the results of the present study is represented by the fact that only readmissions directly related to adhesion formation have been reported, possibly related readmissions or procedures that may be complicated by adhesions not having been included. The risk of adhesion-related readmission should therefore be greater than reported by the results of the research.

[15] Parker MC, Wilson MS, Menzies D, Sunderland G, Clark DN, Knight AD, Crowe AM; Surgical and Clinical Adhesions Research (SCAR) Group. The SCAR-3 study: 5-year adhesion-related readmission risk following lower abdominal surgical procedures. Colorectal Dis. 2005 Nov;7(6):551-8

[16] Ray NF, Denton WG, Thamer M, Henderson SC, Perry S. Abdominal adhesiolysis: inpatient care and expenditures in the United States in 1994. *J Am Coll Surg* 1998; 186: 1–9

Through the results of the study, a greater purpose is aimed, that of allowing for targeted adhesion-prevention strategies, reducing, this way, the overall burden of adhesions and the individual risk to patients.

The patients undergoing open abdominal or pelvic surgery have a risk of readmission directly related to adhesions within 3 years following surgery of 8,14% (11,87% excluding appendectomy procedures-Table 1).

Total colectomy, right hemicolectomy and ileostomy/ ileal resection procedures were associated with the highest risk of an adhesion-related readmission.

A great burden of readmission occurred following excision of the rectum, which was one of the most common procedures (150 cases).

Appendectomy was associated with a low risk of readmission, but determined a high burden of adhesion-related readmissions.

Peritonitis at the time of the initial surgery increased the risk of adhesio-related readmission. The inflammatory response associated with Crohn disease or diverticular disease, and the extensive intraoperative dissection required in the management of the colo-rectal cancer, increase the risk of readmissions directly related to peritoneal adhesion syndrome.

The study demonstrated that there is a risk of readmission directly related to adhesions of approximately 8,14%. Therefore, it seems prudent to inform patients of the risk of adhesions as part of the consenting process prior to open abdominal or pelvic surgery.

Taking into account that a number of adhesion-prevention strategies are available, the failure to take precautions to prevent adhesion formation may have medico-legal consequences.

The present research made possible for the identification of patient subgroups associated with an increased risk of adhesion-related readmission, allowing surgeons to effectively offer information to patients regarding postoperative risks and to adopt targeted adhesion-prevention strategies.

There is no evidence regarding efficient and safe anti-adhesion agents capable of reducing adhesion-related complications and readmissions. The lack of conclusive data on the matter of peritoneal adhesion prevention methods can be explained by the fact that such studies require enormous numbers of patients, that imply considerable resource and ethical issues, thus making it difficult for the clinical reserach.

There is however, of great importance for surgeons to be aware of the consequences of adhesions in terms of complications for patients and of medico-legal considerations.

CONCLUSIONS

- Adhesion-related complications represent an important source of morbidity and mortality for patients undergoing open abdominal or pelvic surgery.
- In the present study, total colectomy, right hemicolectomy and ileostomy surgery appear to be associated with higher risk of adhesion-related readmission.
- Commorbidities, such as inflammatory bowel disease and peritonitis, at the moment of the initial surgery, were identified as risk factors in icreasing the rate of adhesion-related complications and readmission.
- Patient age (> 60 years) has been demonstrated as being an important risk factor for adhesion-related readmission.

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- The identification of high-risk patient subgroups may help in effectively targeting adhesion-prevention strategies, determining an improvement in patient outcomes and quality of life, as well as reduced surgical workloads.

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