Towards patient-centered colorectal cancer surgery : focus on risks, decisions and clinical auditing

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Chapter 8:

THE DUTCH SURGICAL COLORECTAL ANASTOMOTIC LEAKAGE AS AN OUTCOME MEASURE FOR QUALITY OF COLORECTAL CANCER SURGERY

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Abstract

Introduction: When comparing mortality rates between hospitals to explore hospital performance, there is an important role for adjustment for differences in case-mix. Identifying outcome measures that are less influenced by differences in case-mix may be valuable. The main goal of this study was to explore whether hospital differences in anastomotic leakage (AL) and postoperative mortality are due to differences in case-mix, or to differences in treatment factors.

Methods: Data of the Dutch Surgical Colorectal Audit were used. Case-mix factors and treatment related factors were identified from the literature, and their association with anastomotic leakage and mortality were analyzed with logistic regression. Hospital differences in observed anastomotic leakage and mortality rates; and adjusted rates based on the logistic regression models were shown. The reduction in hospital variance after was adjustment was analyzed with a Levene's test for equality of variances.

Results: 17 out of 22 case-mix factors and 4 out of 11 treatment factors related to anastomotic leakage derived from literature were available in the database. Variation in observed AL rates between hospitals was large with a maximum rate of 17%. This variation could not be attributed to differences in case-mix, but more to differences in treatment factors. Hospital variation in observed mortality rates was significantly reduced after adjustment for differences in case-mix.

Discussion: Hospital variation in anastomotic leakage is relatively independent of differences in case-mix. In contrast to 'postoperative mortality' the observed anastomotic leakage rates of hospitals evaluated in our study were only slightly affected after adjustment for case-mix factors. Therefore, anastomotic leakage rates may be suitable as an outcome indicator for measurement of surgical quality of care.

Introduction

Nowadays there's a growing public interest in quality of medical and surgical care, with an increasing urge for outcome measures that represent hospital performance. The outcome measure postoperative mortality is often used to benchmark surgical performance.[1-3] When comparing mortality rates between hospitals, there is an important role for risk adjustment.[4, 5] Observed variations in mortality may be caused by differences in patient and tumor characteristics (case-mix), and high risk patients may not be evenly distributed between hospitals.[6]

However, valid case-mix adjustments require a substantial amount of reliable data collected on a patient level. These data are rarely available and require a substantial registration effort. Therefore, it may be valuable to identify outcome measures that are less influenced by differences in case-mix and represent the actual differences in quality of care processes.

Colorectal cancer is a significant source of mortality with nearly 10,000 new cases diagnosed in the Netherlands each year.[7] The cornerstone of this treatment is surgical resection. Patients undergoing surgical resection have a considerable risk for postoperative complications, which can lead to significant morbidity, mortality and large costs. Internationally, several quality improvement programs have therefore been initiated to reduce postoperative complications after colorectal surgery.

Anastomotic leakage is one of the most feared complications after colorectal surgery, often causing prolonged hospital stay, morbidity, mortality and possibly worse oncological outcomes.8 The percentage of patients developing anastomotic leakage depends on multiple factors. In literature, several elements have been identified as risk factors. These can be patient- or tumor-related, often referred to as case-mix, such as height of the anastomosis, a malnourished status, steroid use and male gender.[9-13] Treatment related factors such as surgeons' experience, operative duration, blood loss, preoperative radiation and a defunctioning stoma have also demonstrated to be associated with the occurrence of anastomotic leakage.[9-13]

The aim of this study was to explore whether hospital differences in anastomotic leakage rates are related to differences in case-mix. We compared the role of case-mix adjustment for anastomotic leakage and postoperative mortality. With this objective, the following research questions were drawn:

1. Which case-mix and treatment related risk factors are associated with anastomotic leakage and postoperative mortality after colorectal surgery?
2. What are differences in anastomotic leakage and mortality rates between hospitals and are these due to differences in case-mix or due to differences in treatment-patterns?

Methods

Patients

Data was derived from the Dutch Surgical Colorectal Audit (DSCA), a national quality improvement project in which over 200 variables concerning the patient, co-morbidity, diagnostics, disease-specific details, treatment, and outcomes are collected prospectively. The DSCA contains data of patients registered by 92 hospitals (all hospitals performing colorectal cancer surgery). The data set is disease-specific for colorectal cancer and shows a nearly 100% accordance on most items, including anastomotic leakage on validation against the National Cancer Registry (NKR) data set.[14]

All patients undergoing resection for primary colorectal cancer between the 1st of January 2009 and 31st of December 2011 and registered in the DSCA before March 15th 2012 were evaluated. Minimal data requirements for inclusion in analyses were information on tumor location, date of surgery and mortality. Patients with metastases at time of primary surgery and resections for multiple synchronous colorectal tumours were excluded, because these represent subgroups of patients with other treatment perspectives and subsequent different expected outcomes. Also, patients in which a primary end-colostomy was constructed were excluded form analysis.

Risk Factors

Since part of the dataset of the DSCA was designed with the objective of performing case-mix adjustment particularly for postoperative mortality, variables have been determined as risk factors for postoperative mortality in an early stage of conduction of the dataset. These factors were based on existing evidence on potential risk factors for mortality and determined by an expert panel using a Delphi method.6

To assess whether there are additional case-mix and treatment related risk factors that need to be taken into account when adjusting for anastomotic leakage, we performed a systematic search for literature published between 1990 and 2012 on biomedical bibliographical databases Pubmed and the Cochrane Library. The search headings "anastomotic leak and colorectal surgery" were used in combination with the keyword "risk factor". The "related articles" function was used to expand the search. References from the articles were also used when appropriate. Letters, reviews without original data, non-English language papers, overlapping patient populations and animal studies were excluded.

From the articles retrieved from the literature search, different risk factors for anastomotic leakage were selected. A distinction was made between patient and tumor related factors (case-mix factors) and treatment related factors. We selected risk factors with a statistical significance of $p < 0.05$, which were analyzed with multivariate logistic regression.

Outcomes

Various definitions of AL have been previously presented.15 The definition of anastomotic leakage in this study was 'a clinically relevant anastomotic leak requiring a re-intervention'. Both radiological and surgical re-interventions were included. Postoperative mortality was defined as 'death during postoperative hospital stay or within 30 days after the date of surgery'.

Analyses

The association of case-mix and treatment factors and both anastomotic leakage and mortality were tested with multivariate logistic regression models. Separate models were used for each outcome.

To analyze the differences in anastomotic leakage and mortality between hospitals and investigate whether these were due to differences in case-mix or due to differences in treatment-patterns we applied 3 different models. model 1: unadjusted (observed) variation in outcome; model 2: adjusted for patient (case-mix) characteristics; model 3: 'adjusted' for case-mix and treatment characteristics. Adjustment was performed by calculating expected outcomes (E) using case-mix (model 2) and both case-mix and treatment (model 3) coefficients from the regression analysis. Next, for each hospital, the observed percentage (O) was divided by the expected value (E) and multiplied by the overall mean (observed/E * mean) to obtain the adjusted percentages.

Hospital differences in anastomotic leakage and mortality rates before and after adjustment were plotted in a graph; a summary measure of the between hospital variance was given with ranges and standard deviations. The reduction in between center variance after adjustment for (model 2) case-mix and (model 3)case-mix and treatment factors was analyzed with a Levene's test for equality of variances. A p-value <0,05 was considered statistically significant.

Furthermore, a mixed logistic regression model with hospitals as random effects was performed A likelihood ratio test was used to test whether the variance of the random effects was statistically significant after adjustment for case-mix and treatment factors.
Hospitals with more than 15% missing case-mix factors were excluded from multivariate analyses. All statistical analyses were performed in PASW Statistics, Rel. 18.0.2009. Chicago: SPSS and R version 2.14.16

Results

On March 15th 2012, 92 hospitals (8 university, 47 teaching and 37 non-teaching hospitals) registered a total of 25,555 eligible primary colorectal cancer patients with a date of surgery between January 1st 2009 and December 31 2011 in the DSCA. Nine hospitals had more than 15% missing case-mix factors in total, and were therefore excluded (n=1,460). After additional exclusion of patients with multiple synchronous tumors (n=598), distant metastases (n=2,032) and without an anastomosis (n=5,480), a total of 15,236 patients were included in the analysis. Characteristics of the included patients are shown in Table 1.

Of all patients, 1207 patients (8%) developed anastomotic leakage and 525 patients (3.4%) died within 30 days or during hospital admission.

Risk factors

The literature search gave a total of 39 studies describing risk factors for anastomotic leakage.8, 10-13, 17-49 In total, 22 case-mix factors and 11 treatment related factors for were identified. Table 1 shows the results.

Case-mix factors described most frequently were gender, American Society of Anesthesiologists (ASA) score and location of the tumor and/or anastomosis. Treatment factors often described were blood loss/transfusion, duration of the operation and the use of a defunctioning stoma.

Of the 22 case-mix factors for anastomotic leakage identified in literature, 17 were available in the DSCA. The database had no information on the factors weight loss, nutrition status, alcohol abuse, smoking and leukocytosis. Treatment factors were less often available; 4 out of 11 were available in the dataset.

The case-mix and treatment related risk factors that were found for anastomotic leakage in literature were similar to those that have been used for risk adjustment for postoperative mortality in the DSCA dataset.

A multivariate analysis has been performed to investigate the association of case-mix and treatment factors with anastomotic leakage and postoperative mortality; results of the analysis are shown in *table 2*.

Individual case-mix factors predicting anastomotic leakage were male gender, urgency of the resection, renal disease and tumor location. Treatment related factors associated with anastomotic leakage were short preoperative radiotherapy, the absence of a defunctioning stoma and postoperative blood transfusion. For postoperative mortality the case-mix factors age, gender, ASA score, pulmonary disease, tumor location sigmoid, urgency of the resection were individual predicting factors. Treatment related factors were chemo-radiotherapy and blood transfusion.

Hospital variation

Anastomotic leakage

Unadjusted hospital variation in anastomotic leakage rates was large: the hospital with the lowest percentage had an anastomotic leakage rate of 0% (n=0/166); the hospital with the highest percentage had an anastomotic leakage rate of 18% (n=12/70) (SD 0.036,, *Figure 1a*). After adjustment for case-mix, there was still a large variation between hospitals: the adjusted anastomotic leakage rates per hospital ranged from 0 to 17% (SD 0.033). The reduction in variation after adjustment for case-mix was not statistically significant (p=0.52).

The variance in anastomotic leakage rates significantly decreased after including treatment factors in the adjustment model (p<0.01). Case-mix and treatment adjusted anastomotic leakage rates varied from 0 to 12% (SD 0.024).

For 60% of the hospitals (50/83), the unadjusted anastomotic leakage rate was similar to the case-mix adjusted anastomotic leakage rate. In 36% of the hospitals, anastomotic leakage rates slightly in-or decreased with 1%, and in 4% of the hospitals with 2% (*Figure 2a*).
For 75% of the hospitals (63/83), unadjusted anastomotic leakage rate altered after adjustment for treatment factors with at least 1%; for 32% of the hospitals, the unadjusted rate altered with more than 3% and for 10% with more than 5%.

Although hospital variance decreased after adjustment for case-mix and treatment factors, there was still variability between hospitals as a likelihood ratio test showed that the variance of the random effects was statistically significant in all models.

Postoperative mortality

Hospitals' unadjusted mortality rates ranges from 0 to 10% (SD 0.017). The variance in postoperative mortality significantly decreased after case-mix adjustment (p<0.01) (range 0-6%, SD 0.012, Figure 1b).
The variance in postoperative mortality rates slightly increased (range 0-6%, SD 0.013) after including treatment factors in the adjustment model, although not statistically significant (p=0.81).

For 84% of the hospitals (70/83), the unadjusted postoperative mortality rate altered after adjustment for treatment factors with at least 1%; for 24% of the hospitals, the unadjusted rate altered with more than 3% and for 6% with more than 5% (*Figure 2b*).
Adjustment for treatment factors had a slight effect on two hospitals when compared to the case-mix adjusted mortality rate. In these hospitals, case-mix adjusted mortality rate altered with 1% after adjustment for treatment factors.
Hospital variability in postoperative mortality was still significant after adjustment for case-mix and treatment factors, as a likelihood ratio test showed that the variance of the random effects was statistically significant in all models.

Discussion

The present study suggests that 'anastomotic leakage rate' is an outcome indicator for measurement of surgical quality of care that is relatively independent of differences in case-mix between hospitals. We found a large variation in anastomotic leakage rates between Dutch hospitals, which confirm the ability of this outcome indicator to be discriminative. In contrast to 'postoperative mortality' the observed anastomotic leakage rates of hospitals evaluated in our study could not be explained by differences in case-mix. In addition, we found that the influence of treatment factors on the variation in anastomotic leakage rates was substantial. These findings imply that anastomotic leakage rates may be much more related to treatment factors and in hospital care processes, than to characteristics of the patient population treated in a certain hospital. Anastomotic leakage rates may therefore be a good reflection of the quality of care provided.

Outcome measures

Optimizing surgical outcomes can be seen as 'the bottom line' of what surgeons do, and outcome indicators have the advantage that they have 'face validity' for surgeons as well as there patients. Also, measurement in itself may improve surgical outcomes – as suggested by the so-called Hawthorne effect. 4 As shown in our study, outcome indicators can present meaningful differences between hospitals. However, there was still significant variability in both anastomotic leakage and mortality rates, after adjustment for case mix factors and treatment factors in our study. This suggests that there are other characteristics of the hospital, its staff and the care they deliver, that may explain the observed differences. Although outcomes of care are important, process and structure information is essential to identify which area is susceptible for innovation. Therefore, adopting to the Donabedian paradigm50, a balanced indicator set needs to include information on structures, processes and outcomes.

Limitations

The results presented in this study should be interpreted in the light of some important limitations. First, despite the fact that most patient-related risk factors were available in the database of the DSCA, it lacked data on some important host-related factors, such as smoking, alcohol consumption, nutrition status and preoperative leukocytosis. Although unlikely, it is possible that a strong case-mix adjustment model for AL could have been made when exactly those four missing factors would have been available from the data set. Also, high risk patients according to the surgeons' preoperative risk judgment or patients with impaired continence at baseline may not have been selected for a primary anastomosis, and therefore excluded which may have caused a potential selection bias. It is not exactly clear how these differences in patient selection might affect the between hospital comparisons. Moreover, due to a lack of clear agreements on definitions, the factors we used may not have been identical to the ones we found in literature.

Although we found that case-mix adjustment does not seem to play a large role when comparing hospitals' anastomotic leakage rates, there are some limitations of using it as an outcome indicator that deserve mentioning. It may unintentionally lead to the perverse incentive of aiming for the lowest possible anastomotic leakage rate by constructing more end-colostomies or defunctioning stomas. This defensive attitude would not immediately contribute to a higher quality of care, as a surgeon or clinic that has zero AL rates at the cost of constructing defunctioning stomas or end-colostomies in all patients will not be regarded as the best practice. Obviously, anastomotic leakage rates are only calculated over patients in whom an anastomosis has been created. Therefore hospitals, with lower rates of patients with anastomoses could automatically have better scores, without immediately better quality of care, as the stoma itself may cause morbidity, lead to a higher need for readmissions[51, 52] and may be associated with morbidity at the time of surgical removal of the stoma.[53] In reality, there is probably an optimum percentage of defunctioning stoma's and end-colostomies to be created, and AL rates should always be seen in the light of these percentages. However, the exact optimum is unclear and it may vary between different surgeons or clinics. Auditing programs like the DSCA may help to clarify in what range this optimum should be. A composite quality measure might be a solution, that is a metric which includes whether or not AL occurred, creation of a defunctioning stoma or end-colostomy, readmissions or mortality. Patient reported outcomes are of additive value in this context. The choice between an anastomosis with or without a defunctioning stoma or an end-colostomy can and should always be influenced by patient preferences.

Improvement of outcomes

When anastomotic leakage is used in hospital comparisons, it should be under the condition that practices with higher anastomotic leakage rates have the opportunity to improve their performance. Unfortunately, the actual cascade of factors resulting in anastomotic leakage still remains a 'black box'. Our findings suggest that this black box consists of factors that represent multiple elements of the care processes taking place within a hospital. Per-operative factors, such as blood loss and duration of the operation have been described as important predictors for AL by several authors.[9-13] Longer duration, more blood loss than anticipated, an increased anastomotic strain and limited vascular supply at the anastomotic sites may be a proxy of a more complicated procedure, suggesting that anastomotic leakage rates might be related to surgical technical skill and experience. Additionally, factors more related to perioperative care than to surgical skill, such as oliguria during the operation, are are also said to enhance the risk for leakage.[54]
The ultimate challenge for outcome researchers is to understand the complex clinical mechanisms that lead to success or failure, so that the excellence of best practices can be transferred to all hospitals performing these procedures.

Definition of AL

Comparison of AL between hospitals also requires the use of standard definitions and methods of measurement of AL. It has however been stated before that the definition of AL varies; a systematic review done by Bruce et al found 56 separate definitions for AL used in literature.[15] A valuable feature of an audit registration system is that it applies one definition that is used by all participants. In the DSCA; only clinical apparent leaks requiring re-intervention have been registered, and a distinction has been made between radiological and surgical re-intervention. Further (international) agreement on a standard definition that is valid and reliable, and can distinguish between clinical minor and major anastomotic leaks are explicitly important when using anastomotic leakage as an outcome indicator.

Conclusion

Hospital variation in anastomotic leakage rates is relatively independent of differences in case-mix. Differences in treatment factors contributed more to the variation of anastomotic leakage rates. Further exploration of in-hospital factors may give insight in further improvement possibilities and understanding the multifactorial process that underlies anastomotic leakage. Audit programs may provide data for targeted visitation of clinics with bad outcomes, as well as best practices, aiding in identification of the most important areas for improvement.

Figure 1. Boxplots presenting the range in hospitals' anastomotic leakage rates (A) and mortality rates (B). The unadjusted range (left), the range after adjustment for case-mix (centre), and the range after adjustment for case-mix and treatment factors (right) are shown. p Values describe the statistical significance of the reduction in variance (Levene's test); a p value <0.05 was considered statistically significant.

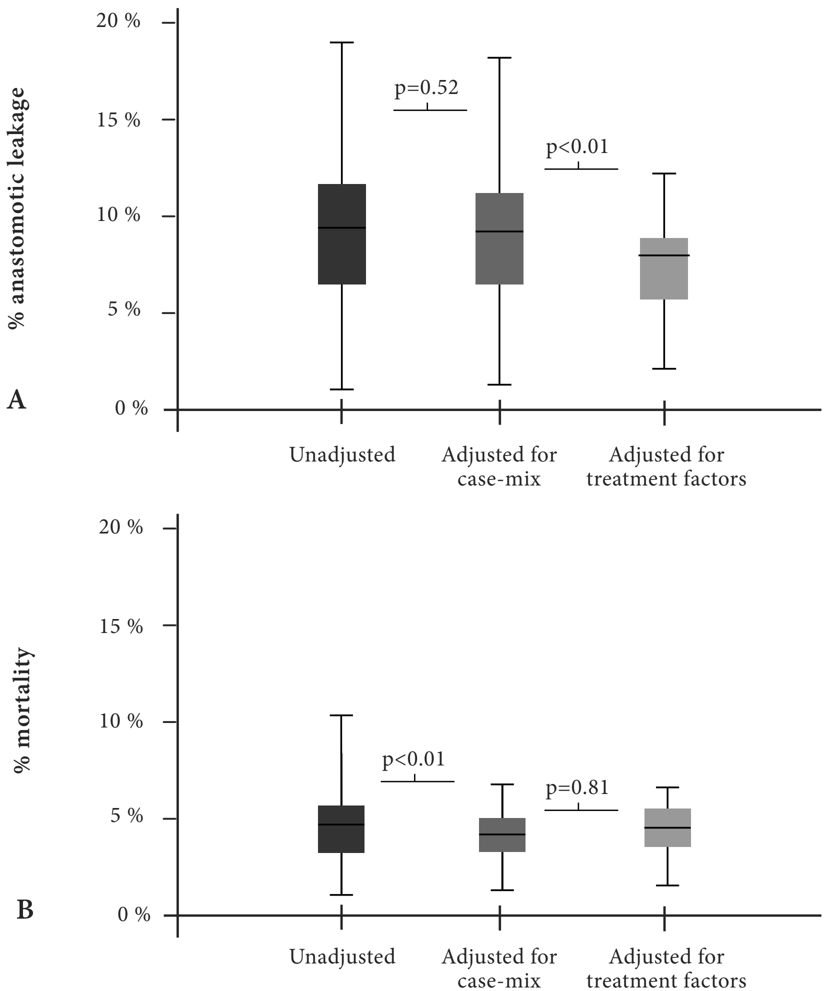
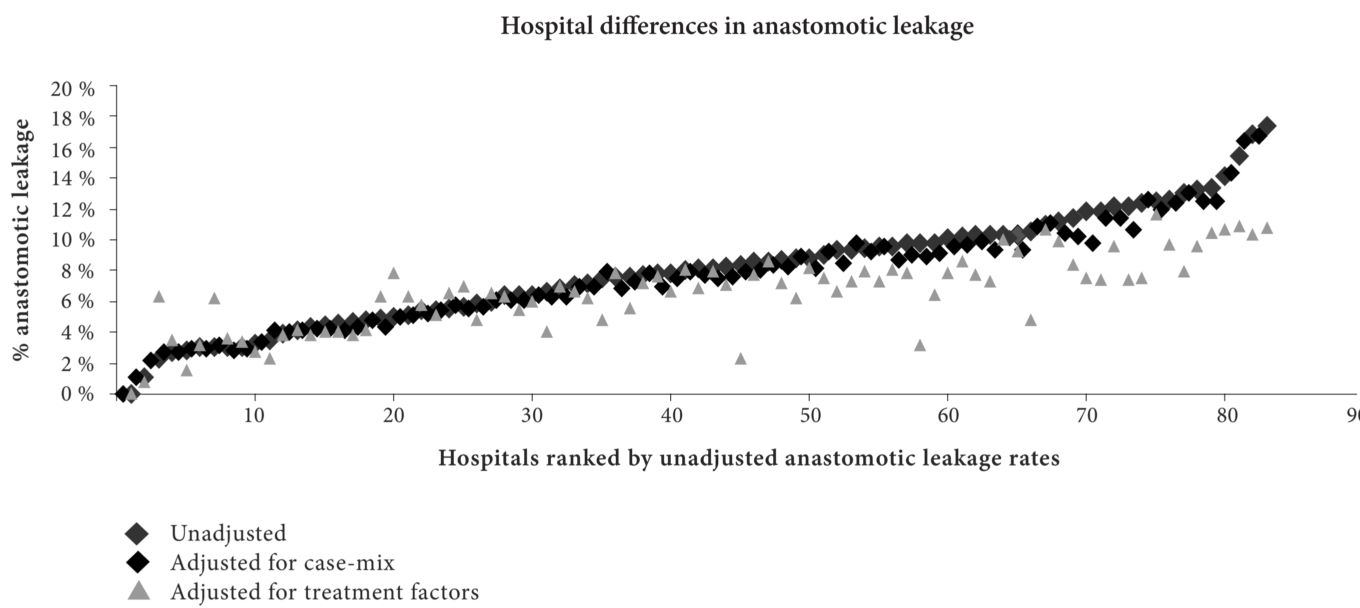


Figure 2a & 2b. Scatterplots showing the effect of adjustment for case-mix (model 2) and case-mix and treatment factors (model 3) for anastomotic leakage (A) and mortality (B) on an individual hospital level. Each scatter represents a single hospital's unadjusted, case-mix adjusted, and case-mix and treatment adjusted rate. On the x-axis, hospitals are ranked according to their unadjusted anastomotic leakage or mortality rate.



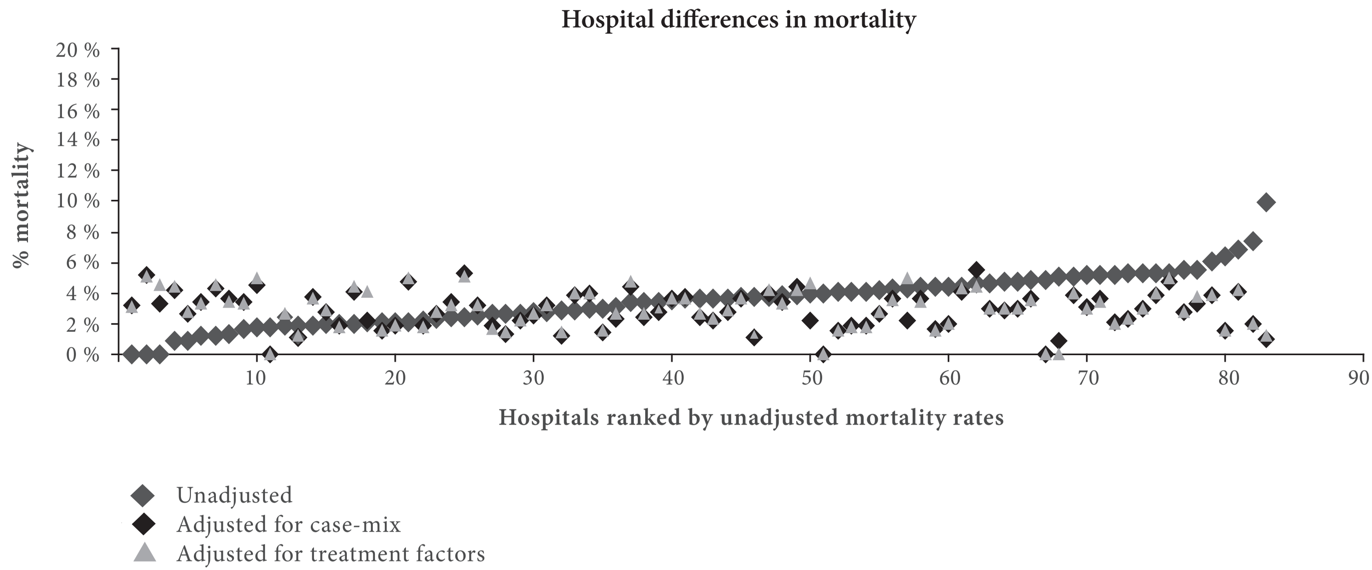

Hospital differences in mortality
% mortality
20 %
18 %
16 %
14 %
12 %
10 %
8 %
6 %
4 %
2 %
0 %
10
20
30
40
50
60
70
80
90
Hospitals ranked by unadjusted mortality rates
Unadjusted
Adjusted for case-mix
Adjusted for treatment factors

Table 1. Risk factors for AL described in literature and available patient and treatment characteristics of included patients in the DSCA.

FACTOR		***DSCA (n=15.236)*** ***N***	***%***
CASE-MIX FACTORS			
Age	>75	5464	38%
Gender	Male	8034	53%
ASA score	3+	3268	21%
BMI	<25	4048	27%
	25-30	4327	28%
	>30	1964	13%
	Unknown	4897	32%
2 or more comorbidities	Yes	6456	42%
Cardiovascular disease	Yes	6408	42%
Pulmonary disease	Yes	1858	12%
Diabetes	Yes	2186	14%
Crohn's disease	Yes	107	1%
Preoperative anemia	Yes	846	6%
Renal failure	Yes	461	3%
Steroid treatment	Yes	1174	8%
Previous abdominal surgery	Yes	5037	33%
Weight loss	N.a.		
Hypoproteinemia/nutritial status	N.a.		
Alcohol abusis	N.a.		
Smoking	N.a.		
Leukocytosis	N.a.		
Tumor stage	Stage 0/I	1156	8%
	Stage II	3068	20%
	Stage III	8940	59%
	Stage IV	1588	10%
Additional resection	Locally	1126	7%
Tumor location	Right-sided	5966	12%
	Transverse/descending	2003	39%
	Sigmoid	4468	13%
	Rectum	2799	29%
Urgent resection	Acute	1799	12%

Literature (n=39) ***Author***
Hun Yung et al (2006)
Van ‘t Sant (2010); Bertelsen (2010); Peng (2010); Lee (2008); Jestin (2008); Hun Yung (2006); Lipska (2006); Yuh Yeh (2005); Rudinskaite (2005); Peeters (2005); Law (2004); Mathiessen (2003); Poon (1999); Rulier (1998).
Van ‘t Sant (2010); Wang (2010); Eberl (2008); Bucher (2007); Jestin (2008); Choi (2006); Makela (2003); Alves (2002); Tang (2001)
Kim (2009); Biondo (2005); Makela (2003);
Iancu (2008); Makela (2003)
Iancu (2008); kruschewski (2007); Makela (2003); Tang (2001)
Akasu (2009); Iancu (2008); Makela (2003)
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Lipska (2006)
Iancu (2008);
Alves (2002)
Konoshi (2006); Alves (2002)
Lipska (2006)
Iancu (2008); Makela (2003)
Iancu (2008); Makela (2003)
Nickelsen (2005); Makela (2003)
Bertelsen (2010); Iancu (2008); Kruschewksi (2007)
Iancu (2008); Alves (2002)
Eberl (2008)
Yuh Yeh (2005)
Bertelsen (2010); Peng (2010); Cong (2009); Kim (2009); Lee (2008); Eberl (2008); Bucher (2008); Jestin (2008); Hun Yung (2006); Lipska (2006); Yuh Yeh (2005); Rudinskaite (2005); Law (2004); Matthiessen (2003); Marush (2002); Rulier (1998); Vignali (1997)
Choi (2006)

FACTOR		DSCA (n=15.236) N	%
TREATMENT FACTORS			
Neoadjuvant therapy	5x5 GY Chemoradiation	1508 830	18% 10%
Defunctioning stoma	Yes	2467	16%
Blood loss/transfusion	Yes	2042	13%
Intra-operative contamination	N.a.		
Intra-operative adverse events	N.a.		
Pelvic drain	N.a.		
Incomplete donut	N.a.		
Stapling device	N.a.		
Duration of operation	N.a.		
Specialization surgeon	N.a.		
After-hours' surgery	N.a.		

ASA= American Society of Anesthesiologists score. BMI= Body Mass Index.

Literature (n=39) ***Author***
Eriksen (2005); Alves (2002);
Matthiessen (2007); Rullier (1998); Peeters (2005); Pakkastie (1997); Cong (2009)
Alves (2002); Sorensen (1999); Law (2004); Yuh Yeh (2005); Nesbakken (2002); Tang (2001); Akasu (2009); Boccola (2009); Telem (2010);
Alves (2002); Makela (2003); Konishi (2006)
Matthiessen (2003)
Peeters (2005); Tang (2001); Yuh Yeh (2005); Boccola (2010); Cong (2009)
Makela (2003); Schmidt (2003)
Boccola (2010)
Vignali (1997); Marusch (2002); Alves (2002);Konishi (2006); Bucher (2007); Choi (2010); Telem (2010)
Cong (2009)
Komen (2009)

ASA= American Society of Anesthesiologists score. BMI= Body Mass Index.

Table 2. Case-mix and treatment factors included in the multivariate logistic regression model for AL and mortality after colon and rectal carcinoma resections. Age and BMI were analyzed as continuous variables.

		AL			**Mortality**		
		OR	***95% C.I.***		***OR***	***95% C.I.***	
CASE-MIX FACTORS							
Age		0.99	0.98	1.02	2.65	2.33	3.04
Gender	male	1.31	1.11	1.55	1.82	1.39	2.37
ASA	2	1.01	.84	1.22	3.09	1.54	6.17
	3+	1.00	.80	1.24	6.44	3.46	13.12
BMI		.91	.74	1.13	.99	.97	1.02
2 or more comorbidities		.88	.70	1.10	1.17	.82	1.67
Cardiovascular disease		.85	.70	1.04	1.21	.90	1.62
Pulmonary disease		.92	.71	1.20	1.44	1.06	1.97
Diabetes		.99	.77	1.28	1.12	.81	1.55
Crohn's disease		1.06	.43	2.60	1.35	.36	4.98
Preoperative blood loss		.72	.42	1.25	.68	.23	2.00
Steriod treatment		1.27	.81	2.00	1.25	.72	2.15
Renal disease		1.34	1.01	1.78	.91	.62	1.34
Abdominal surgical history		1.03	.87	1.22	.87	.67	1.14
T-stage	T3	1.03	.87	1.21	1.05	.81	1.36
	T4	1.13	.78	1.64	1.22	.71	2.10
Additional resection		1.20	.88	1.64	.96	.59	1.55
Urgent resection		1.32	1.01	1.73	2.18	1.60	2.98
Tumor location	Transverse colon	1.93	1.49	2.50	1.25	.89	1.76
	Sigmoid	1.68	1.33	2.11	.70	.50	1.00
	Rectum	2.22	1.49	3.29	1.04	.52	2.04
TREATMENT FACTORS							
Neo-adjuvant therapy	5x5	1.70	1.13	2.54	.88	.42	1.85
	Chemoradiotherapy	1.33	.84	2.09	.30	.09	.98
Defunctioning Stoma		.54	.42	.70	1.15	.69	1.89
Transfusion		4.27	3.56	5.12	4.06	3.14	5.25

AL= anastomotic leakage; CI= confidence interval; OR= odds ratio; ASA= American Society of Anesthesiologists score; BMI = Body Mass Index. Bold printed numbers are significant odds ratios ($p < 0.05$).

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