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Original article

Postoperative stay following colorectal surgery: a study of factors associated with prolonged hospital stay

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Aim: **To study the factors that contribute to postoperative stay following colorectal surgery.**
Design: **A prospective observational study.**
Setting: **Three colorectal surgical units – a teaching hospital, a large district general hospital and a district general hospital.**
Participants: **350 patients undergoing colorectal surgery.**
Main outcome measures: **28 pre-, peri- and postoperative patient- and treatment-related factors.**
Results: **Stepwise regression analysis suggests that the factors that significantly lengthen postoperative stay include a low albumin on admission, stoma formation, operative blood loss, urinary and respiratory complications, wound infections, postoperative ventilation and social delay at the time of discharge. The postoperative stay was not affected by patient age or by the seniority of the surgical team.**
Conclusions: **Factors have been identified that determine the postoperative length of stay. These data may allow better planning and treatment of patients undergoing colorectal surgery.**

Key words: Postoperative stay – Hospital costs – Colorectal – Surgery

The length of postoperative stay contributes significantly to the cost of general surgical care. A single day's stay on a surgical ward costs approximately £220 and on a high-dependency unit £550. Postoperative stay has been a target for cost-cutting,[1] but there is insufficient understanding of the factors that lengthen postoperative stay. This study was designed to identify features that significantly increase the length of postoperative stay using colorectal resection as a model.

Patients and Methods

The study group was 350 consecutive patients who underwent colorectal resection as elective or emergency procedures at one of Queen Elizabeth Hospital (King's Lynn), Norwich Hospital (Norwich) and St George's Hospital (London). This was performed over a 12-month period between 1998–1999. The only exclusions were patients who died following surgery. Patients had hemicolectomies (right-

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or left-sided) or pelvic surgery (AP-resection or anterior resection). A conventional open surgical technique was used in all cases. Colonic lavage and NG tubes were not used.

The three hospitals have similar surgical practices concerning peri-operative management and similar discharge criteria. Patients left hospital only when: (i) they had opened their bowels; (ii) they had passed urine; (iii) they were capable of changing a stoma bag, if needed; and (iv) social circumstances were satisfactory for discharge.

General anaesthesia was used for all cases. A neuro-axial block was used unless contra-indicated.

For each patient, the length of postoperative stay was determined, day 1 being the day after surgery, and details were collected of pre-, peri- and postoperative features (Table 1A). For the patient group, associations were determined between length of postoperative stay and these features. Social delay was defined as the number of days a patient remained on the surgical ward after having

Table 1A Factors documented for each patient

Pre-operative factors		Peri-operative factors		Postoperative factors	
Hospital	(Q/N/G)	Surgeon	(cons/non cons)	Post operative ventilation	(y/n)
Age	(years)	Anaesthetist	(cons/non cons)	DVT	(y/n)
Sex	(M/F)	Anaesthetic time	(min)	PE	(y/n)
		Blood loss	(ml)	UTI	(y/n)
Elective/emergency		Stoma formation	(y/n)	Urinary retention	(y/n)
Surgery for malignancy	(y/n)			Wound infection	(y/n)
				Anastomotic leak	(y/n)
WCC	(x 10^9)			Social delay	(days)
Plasma creatinine	(μmol/l)				
Albumin	(g/l)				
Hx of cardiac disease	(y/n)				
Hx of respiratory dis ease	(y/n)				
Hx of diabetes	(y/n)				

Table 1B Summary of binary data collected on 350 patients

Variable	Yes	No	Unknown	Total
Cardiac history	89	253	8	350
Respiratory history	49	295	6	350
Diabetic history	187	163	4	350
Sex	Male: 187	Female: 163	0	350
Malignant histology	269	79	2	350
Emergency	50	296	4	350
Stoma formation	153	189	8	350
Grade of surgeon	Consultant: 209	Registrar: 139	2	350
Grade of anaesthetist	Consultant: 200	Registrar: 142	8	350
Ventilated	17	331	2	350
Deep vein thrombosis	2	346	2	350
Pulmonary embolus	0	348	2	350
Urinary tract infection	23	325	2	350
Retention of urine	20	326	4	350
Wound infection	25	321	4	350
Anastomotic leak	5	345	0	350

Table 1C Summary of continuous variables collected for 350 patients

Continuous data	Mean	Minimum	Maximum
Age (years)	64.6	18.0	92.0
White blood count (x 10^9)	8.41	4.0	23.0
Creatinine (μmol/l)	93.4	27.0	750.0
Albumin (g/l)	38.7	3.0	42.0
Blood loss (l)	0.8	0.0	6.9
Anaesthetic time (min)	159.0	60.0	340.0
Social delay (days)	0.3	0.0	22.0
Length of operative stay (days)	14.0	5.0	119.0

been declared fit for discharge by the surgeon. Statistical analysis was performed using stepwise regression.

Results

The mean length of postoperative stay was ~10 days with no significant difference between the three hospitals.

Table 1A–C summarises the data. Tables 2 and 3 show the results of statistical analysis.

An increase in the length of postoperative stay was associated with: (i) postoperative ventilation (mean increase, 17.6 days); (ii) wound infection (11.7 days); (iii) stoma placement (4.6 days); (iv) urinary complications (4.3 days); (v) each litre of blood transfused (2.2 days); and (vi) inadequate social circumstances (1 day).

The length of postoperative stay was increased by 3.7 days for each 10 g/l decrease in pre-operative serum albumin.

Variables considered separately that did not affect the length of postoperative stay included patient age, white blood cell count and creatinine levels on admission, seniority of surgeon and anaesthetist, and the nature of the surgery, *i.e.* whether hemicolectomy or pelvic surgery.

Table 2 Influence of pre-operative and peri-operative variables

Variable	B	T	*P*	95% CI
Age	0.008	0.50	0.617	–0.02 to 0.04
WCC	0.019	0.14	0.890	–0.25 to 0.29
Creatinine	0.017	0.68	0.494	–0.03 to 0.07
Albumin	**–0.37**	–3.79	**<0.001**	–0.57 to 0.18
Cardiac history	0.60	0.41	0.681	–2.29 to 3.50
Respiratory history	0.08	0.05	0.964	–3.452 to 3.614
Diabetic history	0.59	0.26	0.794	–3.86 to 5.04
Hospital	1.44	1.691	0.092	–0.24 to 3.11
Surgical emergency	1.62	0.88	0.379	–1.998 to 5.24
Type of surgery	–0.86	–0.56	0.579	–3.91 to 2.19
Anaesthetic time	0.016	1.06	0.291	–0.01 to 0.05
Blood loss	**2.21**	2.274	**0.024**	0–4
Stoma formation	**4.65**	2.86	**0.005**	1.45–7.84
Malignant histology	–0.23	–0.14	0.89	–3.47 to 3.02
Consultant surgeon	–2.25	–1.65	0.101	–4.95 to 0.44
Consultant anaesthetist	–0.47	–0.36	0.718	–3.02 to 2.09

Coefficient B indicates the number of days increased stay per unit increase in the variable (for continuous variables) or in the presence of the variable (for binary – y/n – variables).

Discussion

Of pre-operative features, a low albumin concentration was associated with a prolonged postoperative stay. Since albumin is the most specific of the variables reflecting nutritional status,[2] the present study indicates an association between poor nutritional status pre-operatively and a prolonged postoperative stay. This is consistent with the finding for cardiac surgery linking poor nutritional status with an adverse postoperative course.[3]

The present study does not associate a prolonged postoperative stay with other pre-operative risk factors – cardiac disease, respiratory disease, diabetes mellitus or ASA grading – that have been said by others[4,5] to predict poor clinical outcome nor, unlike other studies,[5,7] does it link prolonged postoperative stay with advanced patient age.

Concerning peri-operative features, a longer post-operative stay was associated with increased operative blood loss and the creation of a stoma, findings consistent with previous reports.[6,7] On average, for each litre of blood replaced, the postoperative stay increased by 2 days. This may be attributed to the physiological insult of blood loss and its replacement. It is possible that increased operative difficulty was a common factor linking increased blood loss and prolonged postoperative stay, but there was no significant correlation between another index of surgical difficulty, the length of operation, and the length of post-operative stay.

On average, stoma placement increased the postoperative stay by 5 days. Patients need time to learn to manage their stomas, and there may be delay while patients wait for the

Table 3 Postoperative coefficients

Variable	B	T	*P*	95% CI
Social delay	**1.012**	3.135	**0.002**	0.38–1.65
Postoperative ventilation	**17.606**	7.388	**< 0.001**	12.92–22.29
Wound infection	**11.720**	5.905	**< 0.001**	7.82–15.62
Anastomotic breakdown	–1.220	–0.272	0.786	–10.056 to 7.62
Embolic events	1.734	0.371	0.711	–7.47 to 10.94
Urinary event	**4.271**	2.534	**0.012**	0.96–7.59

Coefficient B indicates the number of days increased stay per unit increase in the variable (for continuous variables) or in the presence of the variable (for binary – y/n – variables).

stoma bridge to be removed. However, these factors alone seem insufficient to explain a 5-day delay and other factors, unidentified here, are probably involved.

Postoperative complications are usually thought to be the factors most responsible for prolonging postoperative stay. In one study, the length of postoperative stay was almost doubled in patients with postoperative complications.[8] In the present study, the existence before surgery of cardiac or respiratory illness was not associated with a longer postoperative stay; however, postoperative respiratory failure requiring admission to ITU was a major feature, lengthening a patient's postoperative time in hospital, on average by 17.6 days. This association was independent of other factors. In a study of laparotomy, Lawrence *et al*.[6] also linked postoperative pulmonary complications (as well as cardiac complications) with a prolonged stay in hospital.

Not surprisingly, wound infection increased postoperative stay, on average by 11.7 days.

On average, urinary complications delayed patient discharge by over 4 days. This may be due to the slow recognition and treatment of urinary tract infection and to delays in referring patients to urologists.

Unexpectedly, anastomotic leakage was not associated with an increased postoperative stay. The incidence of leakage may have been too low for sufficient statistical study of its impact. Defunctioning of low anastomoses may have reduced the incidence of leakage. Since the report is concerned only with the survivors of surgery, some patients with anastomoses may have leaked, died, and been excluded from the study.

Relatively few patients had discharge delayed on social grounds; however, in individual cases, this delay was as long as 22 days. This resulted in 'social delay' being statistically significant as a factor determining postoperative length of stay for the patient group as a whole. We suggest that all patients undergoing colorectal surgery should have pre-operative assessment of their likely social needs in addition to their fitness for surgery. At this pre-operative assessment, other measures such as alimentation programmes and pre-admission stoma training could be implemented also.

Concerning the clinical practice of colonic resection and the length of postoperative stay and its determinants, we believe the present study is representative of current surgery in the UK. However, the sample size may not have been large enough for this study to identify the association found by other authors between increased postoperative stay and factors such as cardio-respiratory disease and anastomotic dehiscence.

In summary, hospital surgical teams should see what might be done to reduce the need for postoperative ventilation and to reduce the incidence and/or adverse consequences of poor pre-operative nutrition, postoperative wound infection, stoma placement, urinary complications and operative blood loss.

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