Original article

Identification of patients eligible for discharge within 48 h of colorectal resection

F. Grass[1,2], M. Hübner[2], K. L. Mathis[1], D. Hahnloser[2], E. J. Dozois[1], S. R. Kelley[1], N. Demartines[2] and D. W. Larson[1]

[1]Division of Colon and Rectal Surgery, Mayo Clinic, Rochester, Minnesota, USA, and [2]Department of Visceral Surgery, Lausanne University Hospital, Lausanne, Switzerland

Correspondence to: Professor D. W. Larson, Division of Colon and Rectal Surgery, Mayo Clinic, 200 First Street SW, Rochester, Minnesota 55905, USA (e-mail: larson.david2@mayo.edu)

Background: This study aimed to identify patients eligible for a 48-h stay after colorectal resection, to provide guidance for early discharge planning.

Methods: A bi-institutional retrospective cohort study was undertaken of consecutive patients undergoing major elective colorectal resection for benign or malignant pathology within a comprehensive enhanced recovery pathway between 2011 and 2017. Overall and severe (Clavien–Dindo grade IIIb or above) postoperative complication and readmission rates were compared between patients who were discharged within 48 h and those who had hospital stay of 48 h or more. Multinominal logistic regression analysis was performed to ascertain significant factors associated with a short hospital stay (less than 48 h).

Results: In total, 686 of 5122 patients (13·4 per cent) were discharged within 48 h. Independent factors favouring a short hospital stay were age below 60 years (odds ratio (OR) 1·34; $P = 0·002$), ASA grade less than III (OR 1·42; $P = 0·003$), restrictive fluid management (less than 3000 ml on day of surgery: OR 1·46; $P < 0·001$), duration of surgery less than 180 min (OR 1·89; $P < 0·001$), minimally invasive approach (OR 1·92; $P < 0·001$) and wound contamination grade below III (OR 4·50; $P < 0·001$), whereas cancer diagnosis (OR 0·55; $P < 0·001$) and malnutrition (BMI below 18 kg/m^2: OR 0·42; $P = 0·008$) decreased the likelihood of early discharge. Patients with a 48-h stay had fewer overall (10·8 per cent *versus* 30·6 per cent in those with a longer stay; $P < 0·001$) and fewer severe (2·6 *versus* 10·2 per cent respectively; $P < 0·001$) complications, and a lower readmission rate (9·0 *versus* 11·8 per cent; $P = 0·035$).

Conclusion: Early discharge of selected patients is safe and does not increase postoperative morbidity or readmission rates. In these patients, outpatient colorectal surgery should be feasible on a large scale with logistical optimization.

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Introduction

Avoiding prolonged hospital stay is critical to lowering the costs of healthcare[1,2]. Key prerequisites for uncomplicated early discharge after major surgery are threefold: minimizing surgical trauma; optimal perioperative care through enhanced recovery pathways; and patient-centred logistical optimization[3–5]. The feasibility of ambulatory management of patients undergoing colorectal surgery has been demonstrated by only a few groups in highly selective settings[6–9]. Moreover, reports from high-volume referral institutions dealing with unselected 'all-comers' are lacking. The safety of a hospital stay of less than 48 h after major colorectal resection needs to be assessed in order to identify patients who might be eligible for outpatient surgery. As adverse events occur rarely within 48 h of surgery, the ability to describe, predict and prescribe short-stay processes is necessary for innovation of surgery into an outpatient management environment[10].

This study aimed to identify patients eligible for a 48-h stay after colorectal resection from a joint data pool of two institutions that pioneer an enhanced recovery pathway (ERP).

Methods

This was a retrospective cohort study including merged data from two high-volume referral centres: the Division of

Colon and Rectal Surgery at Mayo Clinic, Rochester, Minnesota, USA, and the Department of Visceral Surgery, Lausanne University Hospital, Lausanne, Switzerland. Both facilities implemented enhanced recovery guidelines in 2010, which became standard of care in 2011[11,12]. Consecutive adults undergoing elective major (duration 2 h or more under general anaesthesia) colorectal resections for benign or malignant pathology between January 2011 and December 2017 were included. No relevant staff changes occurred over the study period in either institution. Data were collected prospectively in dedicated electronic databases by trained abstractors, with regular auditing of protocol compliance and outcomes. Ethical approval of the respective institutional review boards for this quality improvement initiative was obtained (Lausanne CER-VD, number 2017-01991; Rochester number 16-004192).

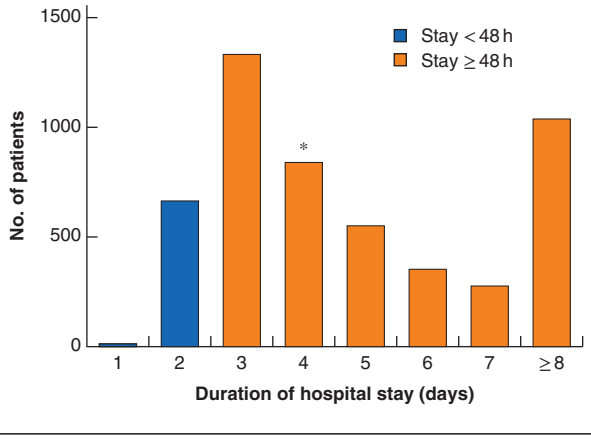
Demographic information and surgical details were retrieved in line with previously and extensively described methodology[13–15]. High overall compliance with the pathway had been documented previously by both institutions[12,16]. Blood samples included serum albumin, haemoglobin, white blood cell count and platelet count, and were retained for the present analysis if drawn within 30 days of surgery. All types of colorectal resection were included: rectal resections (within 12 cm of the anal verge); left, right and transverse resections (as a common entity); and total colectomies. Ostomy procedures, including loop ileostomy reversals and Hartmann reversals, and reconstructive surgeries without resection were excluded. Perioperative wound contamination was assessed and classified as: grade II, clean contaminated; grade III, contaminated; and grade IV, infectious. Blood loss was estimated by the main operating surgeon.

Discharge criteria and assessment of length of stay

Predefined, standardized discharge criteria were the same in both institutions and included, by the time of discharge: tolerance of a normal oral diet; ambulation (at least 6 h/day or back to baseline ambulation status); adequate pain control with oral medications; and no evidence of complications[5]. Length of hospital stay (LOS) was assessed from administrative data (time from index surgery until discharge to home or skilled nursing facility). Short LOS was defined as discharge within 48 h of surgery. Patients with a short stay (less than 48 h) were compared with those discharged at 48 h or more.

Functional recovery parameters included postoperative mobilization on the day of surgery and tolerance of a normal diet within 48 h. Postoperative weight gain (postoperative day (POD) 1–3) and ingestion of oral fluids (POD 0–2) were assessed.

Fig. 1 Distribution of length of hospital stay for the whole cohort



*Denotes median stay.

Outcomes

The primary study outcome of interest was the rate of any complication according to the Clavien–Dindo classification[17] (grade I–V) as opposed to severe complications (grade IIIb or above).

Secondary study aims included assessment of unplanned readmission within 30 days of discharge from the index hospital stay, to either the index or an independent facility, and reoperation rate (under general anaesthesia) within 30 days of the index operation. All outcomes were compared between the two study groups of short (less than 48 h) or longer (48 h or more) stay.

Statistical analysis

Descriptive statistics for categorical variables are reported as frequencies, and continuous variables as mean(s.d.) or median (i.q.r.) values, according to normal or skewed distributions. The χ^2 test was used for categorical variables, and Student's t test for continuous variables. All statistical tests were two-sided; a level of 0·050 was used to indicate statistical significance. Multinominal logistic regression was performed to determine adjusted estimations of the odds ratio (OR) based on a probit regression model of significant factors associated with short hospital stay (less than 48 h).

Data analysis was performed with SPSS® Advanced Statistics 22 (IBM, Armonk, New York, USA).

Results

The study cohort consisted of 5122 unselected patients (Mayo Clinic, 4186 patients; Lausanne University

Table 1 Demographic and surgical characteristics

	All patients ($n = 5122$)	Duration of hospital stay (h)		P‡
		< 48 ($n = 686$)	≥ 48 ($n = 4436$)	
Age (years)*	59 (45–71)	55 (41–65)	60 (46–71)	< 0·001§
≥ 70	1398 (27·3)	114 (16·6)	1284 (28·9)	< 0·001
< 60	2600 (50·8)	415 (60·5)	2185 (49·3)	< 0·001
Sex ratio (M : F)	2636 : 2486	355 : 331	2281 : 2155	0·902
BMI (kg/m^2)†	27·1(6·2)	27·1(5·4)	27·1(6·4)	0·990§
≥ 30	1332 (26·1)	164 (23·9)	1168 (26·3)	0·190
< 18	157 (3·1)	11 (1·6)	146 (3·3)	0·017
ASA grade ≥ III	1443 (28·2)	123 (17·9)	1320 (29·8)	< 0·001
Diabetes mellitus	555 (10·8)	45 (6·6)	510 (11·5)	< 0·001
Preoperative albumin (g/dl)†	4·1(0·6)	4·1(0·5)	4·1(0·6)	0·045§
< 35	335 of 1676 (20·0)	31 of 229 (13·5)	304 of 1447 (21·0)	0·008
Preoperative haemoglobin (g/dl)†	12·2(2·2)	12·7(2·1)	12·1(2·2)	0·002§
Preoperative WBC (× 10^3/μl)†	7·6(4·3)	7·5(2·9)	7·6(4·5)	0·219§
Preoperative platelet count (× 10^9/l)†	279(114)	277(96)	279(115)	0·706§
Procedure				
Left colectomy	1345 (26·3)	194 (28·3)	1151 (25·9)	0·208
Right/transverse colectomy	1406 (27·5)	205 (29·9)	1201 (27·1)	0·125
Total colectomy	602 (11·8)	103 (15)	499 (11·2)	0·006
Rectal resection	1731 (33·8)	182 (26·5)	1549 (34·9)	< 0·001
Other	38 (0·7)	2 (0·3)	36 (0·8)	0·140
Malignancy	3071 (60·0)	274 (39·9)	2797 (63·1)	< 0·001
Minimally invasive approach	3019 (58·9)	511 (74·5)	2508 (56·5)	< 0·001
Duration of surgery (incision to closure) (min)†	200(100)	170(70)	210(100)	< 0·001§
≥ 180	2608 (50·9)	242 (35·3)	2366 (53·3)	< 0·001
New stoma	1641 (32·0)	218 (31·8)	1423 (32·1)	0·895
Wound contamination grade ≥ III	288 (5·6)	6 (0·9)	282 (6·4)	< 0·001
EBL (ml)†	190(320)	100(120)	200(340)	0·001§
Total i.v. fluids on POD 0 (ml)†	3180(1800)	2660(1250)	3260(1850)	< 0·001§
> 3000	2302 (44·9)	212 (30·9)	2090 (47·1)	< 0·001

Values in parentheses are percentages unless indicated otherwise; values are *median (i.q.r.) and †mean(s.d.). WBC, white blood cell count; EBL, estimated blood loss; i.v., intravenous; POD, postoperative day. ‡χ^2 test, except §Student's t test.

Hospital, 936). Of these, 686 patients (13·4 per cent) (Mayo, 14·0 per cent; Lausanne, 10·1 per cent) were discharged within 48 h; 17 patients (0·3 per cent of the entire cohort) were discharged within 24 h (*Fig. 1*). Median hospital stay for all patients was 4 (i.q.r. 3–7) days. Demographic, surgical and perioperative details are shown in *Table 1*.

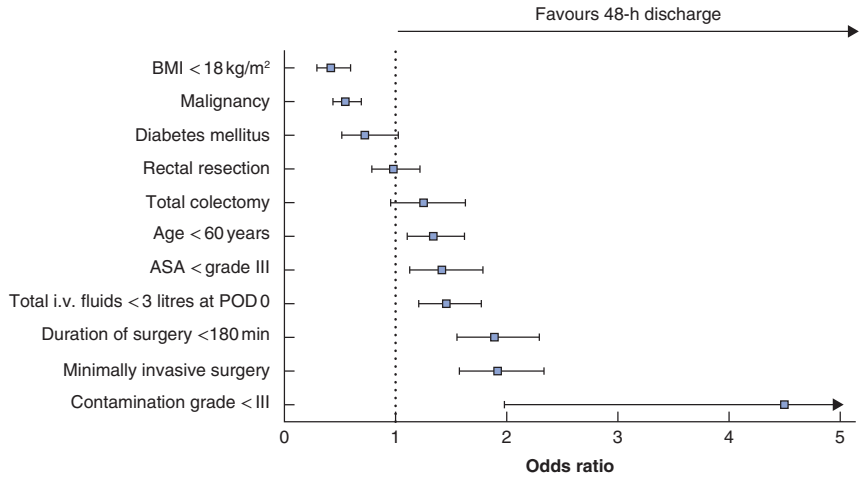
Multivariable analysis

Laboratory parameters and estimated blood loss (EBL) were not included in the multinominal regression analysis owing to inconsistency of available data. Independent factors favouring a short hospital stay were: age below 60 years (median age of the cohort) (OR 1·34; $P = 0·002$), ASA grade below III (OR 1·42; $P = 0·003$), restrictive fluid management (less than 3000 ml on day of surgery) (OR 1·46; $P < 0·001$), duration of surgery less than 180 min (OR 1·89; $P < 0·001$), minimally invasive approach (OR 1·92; $P < 0·001$) and perioperative contamination grade less than III (OR 4·50; $P < 0·001$) (*Fig. 2*). Cancer diagnosis (OR 0·55; $P < 0·001$) and malnutrition (BMI below 18 kg/m^2) (OR 0·42; $P = 0·008$) decreased the likelihood of early discharge. The 48-h discharge rate for patients with colonic cancer was 13·2 per cent, compared with 4·8 per cent for those with rectal cancer.

Postoperative outcomes

Differences in postoperative mobilization, diet tolerance and fluid ingestion were observed between the two groups (*Table 2*). Patients discharged within 48 h had fewer overall complications and a lower readmission rate (9·0 per cent *versus* 11·8 per cent in those with a longer stay; $P = 0·035$).

Fig. 2 Multivariable analysis of significant factors associated with discharge within 48 h of index surgery



Odds ratios are shown with 95 per cent confidence intervals. i.v., Intravenous; POD, postoperative day.

Table 2 Surgical outcomes and functional recovery

		LOS (h)		
	All patients (*n* = 5122)	**< 48 (*n* = 686)**	**≥ 48 (*n* = 4436)**	***P*§**
Any complication	1430 (27·9)	74 (10·8)	1356 (30·6)	< 0·001
Severe complication	469 (9·2)	18 (2·6)	451 (10·2)	< 0·001
Reoperation	356 (7·0)	15 (2·2)	341 (7·7)	< 0·001
Readmission	585 (11·4)	62 (9·0)	523 (11·8)	0·035
LOS (days)*	4 (3–7)	2 (2–2)	5 (3–7)	< 0·001¶
Discharge to home‡	4596 (89·7)	648 (94·5)	3948 (89·0)	< 0·001
Oral fluid intake (ml)†				
POD 0	510(430)	590(440)	500(430)	< 0·001¶
POD 1	1400(670)	1700(700)	1350(650)	< 0·001¶
POD 2	1360(640)	2000(440)	1310(670)	< 0·001¶
Change from preoperative bodyweight (kg)†				
POD 1	2·6(5·8)	2·4(5·0)	2·6(5·9)	0·472¶
POD 2	2·8(6·1)	2·4(5·0)	2·8(6·2)	0·229¶
> 2·5	1019 of 2045 (49·8)	105 of 217 (48·4)	914 of 1828 (50·0)	0·667
POD 3		–	2·4(5·1)	
Tolerance of normal diet within 48 h	3867 (75·5)	686 (100)	3181 (71·7)	< 0·001
Any mobilization on POD 0	3201 (62·5)	507 (73·9)	2694 (60·7)	< 0·001

Values in parentheses are percentages unless indicated otherwise; values are *median (i.q.r.) and †mean(s.d.). ‡As opposed to skilled nursing facility. LOS, length of hospital stay; POD, postoperative day. §χ^2 test, except ¶Student's *t* test.

Patients in the short-stay group were more often discharged to home rather than to a skilled nursing facility (94·5 *versus* 89·0 per cent respectively; $P < 0·001$). Severe complications (2·6 per cent) and reoperations (2·2 per cent) were uncommon in the short-stay group, and were all related to management of intra-abdominal abscesses or haematoma.

Discussion

This study revealed a 48-h stay rate of 13·4 per cent in an unselected cohort of patients undergoing colorectal resection within standardized enhanced recovery care pathways in two high-volume referral centres. Specific patient- and surgery-related criteria related to age, co-morbidity, extent of surgery and perioperative care were identified,

and may help in selecting patients for accelerated hospital stay and outpatient colorectal resection, provided there is compliance with predefined recovery goals and standardized discharge criteria, as well as optimal logistical management.

Solid evidence[11,18] supports best possible compliance with the pathway, which ultimately leads to a decrease in hospital stay and treatment-related costs. Early identification and education of patients eligible for accelerated discharge is thus critical from both a patient perspective and logistical point of view, to anticipate and plan discharge. The present analysis of merged data deriving from two expert ERP centres with a similar implementation history, structure and organization allowed for critical evaluation of this specific subset of patients from a large data pool. Both teams had standardized discharge criteria (tolerance of a normal diet, independent ambulation, adequate pain control with oral medication and no evidence of complications), which further accounted for a homogeneous patient sample despite the bi-institutional design. The present study provides potential predictive factors for patient selection for early discharge.

Previous reports of early discharge did not reveal increased complication or readmission rates related to early discharge after colorectal procedures[7]. Rossi and colleagues[19] discharged 10·3 per cent of their patients from a heterogeneous cohort undergoing a wide variety of surgical procedures within 2 days, without increasing adverse outcomes. These results were confirmed by a more recent American College of Surgeons National Surgical Quality Improvement Program analysis[20] of 2277 patients, in which 305 patients (13·4 per cent) were discharged within 48 h. Similarly, the present study revealed an early discharge rate of 13·4 per cent in an unselected cohort, yielding a median LOS of 4 days. Patients with LOS of less than 48 h unsurprisingly achieved postoperative recovery goals related to ambulation, realimentation and early oral fluid intake, but several patient- and surgery-related factors favouring expedited discharge were also identified. These included younger age (less than 60 years), maintained general (ASA) and nutritional (BMI, albumin) status, and uncomplicated surgery (using the surrogate markers of duration of surgery, minimally invasive approach, wound contamination grade and perioperative fluids). The latter finding adds to growing evidence[21,22] supporting stringent fluid management in patients undergoing elective colorectal procedures. Consistent with previously published data[19], the presence of malignancy appeared to impede early discharge in the present cohort, potentially reflecting organizational and psychological challenges rather than complicated recovery in these patients. Taken together, these items may allow for early (upon completion of surgery), tailored discharge planning, provided there is uneventful recovery, logistical feasibility and patient willingness. A recent analysis[5] of patients in the Lausanne group revealed that only 30 per cent were discharged on the day that all recovery criteria were met. Interestingly, this was due to both patient- and surgeon-related reluctance and/or precaution. Enhanced preoperative education, timely organization of care after hospital discharge, close follow-up via a digital or virtual approach to non-face-to-face care (home hospital) will be critical for future effort to shorten LOS[23,24]. Alternatives to hospitalized care include the pilot 'patient hotel', situated next to Lausanne University Hospital, offering a rehabilitation structure outside the hospital setting.

This study has limitations beyond its retrospective design. Owing to inevitable inconsistencies in data assessment and definitions through data pooling of different (transatlantic) institutions, the available list of items in the merged data set was limited. Furthermore, laboratory analyses were performed inconsistently, and thus not retained for further analysis. Social, cultural and geographical (travel distance to home) discrepancies between the two patient populations may have further influenced discharge patterns. The particular setting of high-volume referral institutions with highly standardized surgical and perioperative care impedes uncritical extrapolation of the results. Accordingly, a clinical hands-on tool or nomogram based on the results was not provided. The list of available potential confounders in this large data set is not exhaustive, leaving a risk of residual confounding bias (potential causal relationship between variables). This has to be considered when interpreting the results. Finally, loss to follow-up remains an issue for referral institutions with nationwide accrual and may lead to underestimation of 30-day readmission rates.

Young patients with low co-morbidity undergoing minimally invasive, uncomplicated colorectal resection may represent a patient population for which outpatient colorectal surgery in high-volume institutions may be prescribed. More research is needed to find additional factors that may promote success for this potential cost-reduction innovation.

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