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Good compliance to enhanced recovery program improves outcome after colorectal surgery

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Abstract

Aim of the study The fast-track (FT) protocol consists of several measures to optimize physiologic response to the surgical stress and improve postoperative outcome. Our goal was to evaluate the compliance to our protocol and to analyze the effect of compliance to the FT protocol on postoperative outcome and postoperative hospital stay. We also aimed to identify isolated FT measures able to influence outcome.

Methods This retrospective study involves a cohort of consecutive patients who underwent colorectal surgery within a FT protocol between 2007 and 2013. Beside basic demographics, adherence to protocol, postoperative complications, and postoperative hospital stay (POHS) were recorded. Both univariate and multivariate analyses were performed to determine the predictive value of the FT protocol compliance and of specific FT items on surgical outcome and POHS.

Results There were 284 patients with a mean age of 58 years. Compliance to the FT protocol reached a median of 18 out of 19 items. The median hospital stay was 3 days (2–49). Overall complications rate was 34.9% and 7,4% when Dindo–Clavien classification > 2 was considered. Higher compliance to the FT protocol reduces the complication rate ($p = 0.00004$), severity of complication ($p = 0.002$), and POHS ($p = < 0.00001$). We have not been able to identify any specific isolated FT measure able to influence post-operative outcome.

Conclusions Greater adherence to the FT protocol decreases postoperative complications and POHS. Our data support a holistic effect of the FT protocol rather than specific isolated measures to improve the patient's postoperative outcome.

Keywords Enhanced recovery after surgery (ERAS) · Fast-track · Colorectal surgery · Compliance

Enhanced recovery program (ERP) after surgery or fast-track, a concept initiated by Henrik Kehlet during the nineties, is a multimodal pathway with several measures which aim to reduce surgical stress through an optimized patient care in the pre-, intra-, and postoperative periods [1].

An increasing number of studies have confirmed that ERP after colorectal surgery reduces the incidence of postoperative complications as well as the length of postoperative hospital stay without compromising patient's safety [1–3].

Currently, the ERP, which was implemented in 2007 in our colorectal surgery unit, consists of a total of 19 pre-, intra-, and postoperative measures according to published guidelines [4, 5].

However, each element of the FT protocol is probably not equally important, and their individual influence on outcome remains unknown. The same is true concerning the precise number of items, a FT program should include [2, 3, 6–9].

This retrospective study aimed to evaluate the compliance to the ERP after colorectal surgery and evaluate the influence of isolated FT elements on the outcome.

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Patients and methods

A cohort of 284 consecutive patients managed according to our ERP after colorectal surgery between 2007 and 2014 were included in this retrospective study. Patients with a stoma, neuropsychiatric history, or an unfavorable family or social condition were excluded from the protocol.

It was not necessary to have the institutional review board approval and written consent.

Fast-track protocol

Our ERP consists of 19 pre-, intra-, and postoperative measures based on the recommendations of the French GRACE association (Groupe francophone de Réhabilitation Améliorée après Chirurgie) [5]. Briefly, it includes the following elements: inform the patient, optimized preoperative fasting with preoperative carbohydrate intake, no preoperative bowel preparation, no premedication, minimal invasive surgical access, epidural anesthesia, short-acting anesthetic agents, optimized intraoperative fluid administration, prevention of intraoperative hypothermia, multimodal management of postoperative pain, prevention of postoperative nausea and vomiting, absence of nasogastric tube, no postoperative abdominal drainage, day 0 removal of the urinary catheter and day 1 IV infusion interruption, early mobilization, early oral intake, and prevention of deep venous thrombosis.

Details of our ERP are reported in Table 1.

Study aim and outcome

We analyzed the impact of compliance of our ERP on different postoperative outcomes. Compliance to the protocol was defined as the ratio of the number of fulfilled ERP items

Table 1 ERP applied in the study

Information to the patient	At the first surgical consultation, information is given to the patient. These explanations are repeated ones by the anesthesiologists and a second time by the coordinating nurse with an explanatory brochure
Absence of preoperative fasting	To reduce hunger, thirst, anxiety, postoperative resistance to insulin and to help maintain anabolic state [31]
Carbohydrate intake	400 cc of a 12% non-carbonated sweet drink is given two hours before surgery
No oral preoperative bowel preparation	Oral bowel preparation is only administered for protectomy [10, 25, 26]. In case of left sided colectomy, an enema is administered just prior to the procedure to empty the rectal ampulla
No premedication	The premedication is limited to anxiolytic and b-blocker treatment if part of the patient's daily treatment
Surgical access	Favors laparoscopy and short incisions in the case of laparotomy
Epidural	Emphasize is placed on multimodal anesthetic techniques. Epidural anesthesia is systematically used
Intraoperative fluid restriction	Intraoperatively restrictive fluid administration to reduce intestinal edema and check preoperatively the hydro-electrolytic balance with the variation index of the pletysmograph [31]
Prevention of intraoperative hypothermia	Increased temperature in the operating room, warm perfusions, heating blanket, continuous intraoperative monitoring and warming of laparoscopic gases
Prevention of postoperative nausea and vomiting	Prophylactic treatment such as the administration of ondansetron, dexamethasone, dehydrobenzperidol and avoiding any emetic treatment (opioids, neostigmine, certain anesthetic gases) [31]
Short-acting anesthetic agents	Total IV anesthesia, and avoid benzodiazepine
No nasogastric intubation	Intraoperative NGT removed immediately after the procedure
Absence of drainage	No postoperative abdominal drainage is placed
Day 0 removal of the urinary catheter	The urinary catheter is removed at the end of the procedure. We were able to show that the risks associated with this early withdrawal are acceptable (20% risk of urinary retention without increasing the risk of urinary infection) [31]
Day 1 IV infusion cessation	IV infusion is suspended at day 1 with the catheter left in place until day 2
Early mobilization	Two hours after the procedure: the patient invited to sit in a chair. At day 0 patients are invited to walk few meters and more each day
Early oral intake	Two hours after discharge from the recovery room, the patient receives 200 cc of clear fluid and a normal meal the same evening
Multimodal management of postoperative pain	NSAIDs may be associated with analgesia to decrease the intake of morphine derivatives
Prevention of deep vein thrombosis	Prophylactic low molecular weight heparin is administered to 10 days postoperatively and one month in case of oncological resection [31]

on a total of 19 anticipated measures. The outcomes tested for were the postoperative complication rate, the severity of complications (Dindo–Clavien ≥ 3), the reintervention rate, the length of hospitalization stay (LOS), and the need for readmission within 30 postoperative days. To assess the value of isolated ERP measures, the association of certain ERP measures was tested separately for their impact on the outcomes.

Statistical analysis

Demographic, surgical, anesthesiological, and nursing data on the perioperative period were retrospectively collected from medical files.

Continuous variables are expressed as either averages and standard deviations, or medians and range. Qualitative variables are expressed as absolute values and as percentages.

A univariate and multivariate statistical analysis was performed. For the univariate analysis, we applied the χ^2 and the Fisher test for the discrete variables, the Student test, or the Mann–Whitney test depending on whether the normality of the population. For dichotomous outcomes, a logistic regression was applied.

For multivariate analysis, we performed a linear regression using the least squares method. Results with a p value of less than 0.05 were considered statistically significant.

We have voluntarily and arbitrarily limited the number of ERP items tested separately in multivariable models to avoid generating unstable multivariate models resulting from too many variables. The items included in the multivariable analysis were therefore early mobilization, no nasogastric intubation, early removal of the urinary catheter, early removal perfusion, early oral intake (liquid and solid feeding), administration of non-steroids anti-inflammatory drugs, and absence of epidural and surgical access.

Results

Demographic data

The total cohort includes 284 patients, 157 men (55.3%) and 127 women (44.7%), with a mean age of 58.8 ± 12.7 years and a mean body mass index (BMI) of 25.9 ± 4.4 kg/m^2.

The two main surgical indications were colon cancer (56%) and diverticular disease (31.7%). All demographic data are listed in Table 2.

Surgical data

Left (57.4%) and right (20.8%) colectomies were the most frequent procedures managed according ERP. The vast majority of patients underwent minimally invasive

Table 2 Demographic and surgical data

Variables	Number	%
Sex		
Female	127	44.7
Male	157	55.3
Age (y)	58.8 ± 12.7	
Body mass index (Kg/m^2)	25.9 ± 4.4	
ASA		
1	22	7.8
2	242	85.2
3	20	7
Tobacco use	56	19.7
Alcohol abuse	76	26.8
Dyslipidemia	72	25.4
Associated comorbidity	111	39.1
Pulmonary	7	2.5
Cardiovascular	6	2.1
Nephropathy	7	2.5
HBP	99	34.9
Diabetes Mellitus	24	8.5
Previous abdominal surgery	111	39.1
Indication for surgery		
Neoplasia	159	56
Diverticulitis	90	31.7
Crohn disease	16	5.6
Volvulus	6	2.1
Stenosis	6	2.1
Polyposis	5	1.8
Rectal prolapse	1	0.4
Colonic perforation	1	0.4
Surgical intervention		
Right colectomy	59	20.8
Left colectomy	163	57.4
Transverse colectomy	4	1.4
Subtotal colectomy	3	1.1
Anterior resection of rectum	32	11.3
Ileo-colic resection	18	6.3
Polypectomy	1	0.4
Rectopexy	1	0.4
Ileal resection	1	0.4
Hartmann's reversal	2	0.7
Laparoscopy	266	93.7
Conversion	19/266	7.14
Laparotomy	18	6.3
Intraoperative complication	4	1.4
Bladder trauma	1/4	25
Hemorrhage	2/4	50
Colonic perforation	1/4	25

ASA score of American Society of Anesthesiologists, *HBP* High blood pressure

laparoscopic surgery (93.7%). Of these, 6.7% required conversion. The rate of intraoperative complications was 1.4%, including bleeding, bowel perforation, and bladder perforation. Intraoperative data are summarized in Table 2.

During the 30 days following surgery, the complication rate was 34.9%, of which 77.4% were minor according to Dindo–Clavien classification (scores 1 and 2).

The most frequent medical complications were urinary retention (9.9%) and ileus (5.3%) (Table 3). Eighteen patients (6.3%) had to be readmitted and 6.3% required reintervention mainly for anastomotic dehiscence (72.2%).

The most surgical complication was anastomotic leakage with a rate of 4,6% in our 284 patients series. This surgical complication was followed by wound infection (3,2%) and peritonitis (3,2%).

The median interval before reoperation was 12 days. It should be noted that 32 patients visited the emergency room within 30 days of surgery. However, 6 of these 32 patients showed no specific complications. No patient died within 30 days of the operation.

Table 3 Surgical data: postoperative complication within 30 days of the operation

Variables	Number	%
Admission in emergency < 30 days	32	11.3
Patients without complication	6/32	18.8
Complications < 30 days	99	34.9
Surgical complications		
Anastomotic leakage	13	4.6
Wound infection	9	3.2
Peritonitis	9	3.2
Rectal bleeding	6	2.1
Intraabdominal collection	4	1.4
Occlusion	3	1.1
Perforation	1	0.4
Rectal stenosis	1	0.4
Medical complications		
Vomiting (NGT)	4	1.4
Urinary retention	28	9.9
Ileus	15	5.3
Respiratory complication	10	3.5
Gastroenteritis	7	2.5
Urinary infection	5	1.8
Arrhythmia	4	1.4
Anemia treated by blood transfusion	4	1.4
	3	1.1
Inflammatory syndrome	1	0.4
Cardiac decompensation	1	0.4
Ileitis		
Rehospitalization < 30 days	18	6.3
Reintervention < 30 days	18	6.3
Dindo–Clavien classification		
0	191	67.3
1	50	17.6
2	22	7.7
3	21	7.4
Postoperative mortality < 30 days	0	0

NGT nasogastric tube

Influence of compliance to ERP

Patients remained an average of 4 days in hospital, with a median of 3 days. Compliance to the ERP reached a median of 18 items among the 19 of the full protocol.

Patients ($n = 217$, 76.41%) with more than 17 ERP items had fewer postoperative complications. Among them, 76% did not develop any complications and 19.8% only minor ones (Dindo–Clavien 1–2). In contrast, 61,2% of the patients with a compliance lower than 17 items presented complications, of which twelve patients (17.9%) developed major complications (Dindo–Clavien > 3) ($p < 0.0001$).

The reintervention rate was also higher (14.9%) in the group with fewer than 17 items than the group with more than 17 items (3.7%) ($p = 0.025$).

The average LOS is lower in the group with better compliance (> 17 items). The data on complication and LOS are shown in Table 4.

Compliance is also the only factor, with laparoscopy, to have a significant effect on the LOS, the severity of complication and the rate of reintervention in univariate analysis (Table 5). Furthermore, the only independent risk factor systematically found to worsen the outcomes in multivariate analysis is the lack of compliance with the ERP (Table 6).

Table 4 Results on compliance

Variables	Number	%
Median hospital stay (days)	3 (2–49)	
Median compliance (on 19 items)	18 (12–19)	
Compliance to ≥ 17 items	217 patients	76.41
Hospital stay	3 +—1j	
Dindo–Clavien 0	165	76
Dindo–Clavien I–II	43	19.8
Dindo–Clavien III	9	4.1
Reintervention < 30 days	8	3.7
Compliance to < 17 items	67 patients	23.59
Hospital stay	6 +—6j	
Dindo–Clavien 0	26	38.8
Dindo–Clavien I–II	29	43.3
Dindo–Clavien III	12	17.9
Reintervention < 30 days	10	14.9

Table 5 Univariate analyses of risk factors

	Length of hospitalization (*p* value)	Complications within 30 days postoperative	Severity of complication (Dindo–Clavien ≥ 3)	Reintervention	Rehospitalization within 30 days postoperative
Demographic data					
Age	NS	NS	NS	NS	NS
Male	NS	NS	NS	NS	NS
BMI	NS	NS	NS	NS	NS
Score ASA	0.0075	NS	NS	NS	NS
Tobacco	NS	NS	NS	0.0202	NS
Comorbidities	NS	NS	0.0025	NS	NS
Laparotomy	0.038	0.0328	0.0064	0.0043	NS
Neoplasia	NS	NS	NS	NS	NS
Intraoperative complication	NS	NS	NS	NS	NS
Poor compliance to FT protocol	0.0001	NS	0.0001	0.0001	NS

ASA score of American Society of Anesthesiologists, *FT* fast-track protocol, *NS* non-significate value ($p > 0.05$)

Table 6 Multivariate analyses of risk factors

	Length of hospitalization	Complication	Severity of complication (Dindo–Clavien ≥ 3)		Reintervention		Rehospitalization within 30 days postoperative
	p value	*p* value	CI (95%)	*p* value	CI (95%)	*p* value	*p* value
Demographic data							
Age	NS	NS	NS	NS	NS	NS	NS
Male	NS	NS	NS	NS	NS	NS	NS
BMI	NS	NS	NS	NS	1.19 (1.01—1.44)	0.03154	NS
Score ASA	NS	NS	NS	0.0075	NS	NS	NS
Tobacco	NS	NS	4.25 (1.33–13.94)	NS	4.48 (1.28–16.15)	0.01822	NS
Comorbidities	NS	0.001734	NS	NS	NS	NS	NS
Laparotomy	NS	NS	5.23 (1.17–21.83)	0.038	NS	NS	NS
Neoplasia	NS	NS	NS	NS	NS	NS	NS
Intraoperative complication	NS	NS	NS	NS	NS	NS	NS
Poor compliance to FT protocol	< 0.0000	0.00004	1.71 (1.22–2.46)	0.0001	1.78 (1.25–2.59)	0.00136	NS

NGT nasogastric tube, *NSAIDs* non-steroidal anti-inflammatory drugs, *CI* confidence interval, risk ratio (95% CI), *NS* non-significant value ($p > 0,05$)

Influence of isolated ERP items

The multivariate analysis shows that no single ERP measure has an impact on the rehospitalization rate at 30 days postoperatively. The rapid withdrawal of urinary catheter and IV infusion is significant on all other outcomes. In addition to these, mobilization and early refeeding are significant for decreasing hospital stay and complications (Table 7).

Furthermore, taking NSAIDs decreases the complication rate (Table 8).

Discussion

The goal of this retrospective study was to evaluate the compliance to our FT protocol and to analyze the effect of this compliance on postoperative outcome and postoperative hospital stay. We note that higher compliance to the enhanced recovery program reduces the complication rate, the severity of complication, the reintervention rate, and it reduces the length of hospital stay. We thus confirm the relationship between good adherence to an enhanced recovery protocol after colorectal surgery and favorable postoperative

Table 7 Univariate analyses of fast-track items on postoperative period

	Length of hospitalization	Complication	Severity of complication (Dindo–Clavien ≥ 3)	Reintervention	Rehospitalization within 30 days postoperative
	p value	*p* value	*p* value	*p* value	*p* value
Mobilization > 6 h	0.0001	NS	NS	0.028	NS
NGT	0.0006	0.0007	0.0001	0.0001	NS
Urinary catheter ≥ day 1	NS	NS	0.0321	0.0076	NS
Liquid feeding > 2 h	0.0001	0.0009	0.0005	0.0001	NS
Solid feeding > 24 h	0.0001	0.0001	0.0019	0.0005	NS
IV infusion ≥ day 2	0.001	0.0001	0.0001	0.0001	NS
No NSAIDs	0.0455	NS	NS	NS	NS
No epidural	NS	NS	NS	NS	NS

NGT nasogastric tube, *NSAIDs* non-steroidal anti-inflammatory drugs, *CI* confidence interval, risk ratio (95% CI), *NS* non-significant value ($p > 0.05$)

Table 8 Multivariate analyses of fast-track items on postoperative period

	Length of hospitalization	Complication	Severity of complication (Dindo–Clavien ≥ 3)		Reintervention		Rehospitalization within 30 days postoperative
	p value	*p* value	CI (95%)	*p* value	CI (95%)	*p* value	*p* value
Mobilization > 6 h	0.00003	NS	NS	NS	NS	NS	NS
NGT	NS	NS	NS	NS	NS	NS	NS
Urinary catheter ≥ day 1	0.00526	0.03102	4.28 (1.21—15.39)	0.0246	6.45 (1.69–26.52)	0.0067	NS
Liquid feeding > 2 h	0.01777	0.03614	NS	NS	NS	NS	NS
Solid feeding > 24 h	NS	0.00087	NS	NS	NS	NS	NS
IV infusion ≥ day 2	0.00043	0.0001	13.4 (2.31–81.8)	0.0047	21.03 (3.28–160.01)	0.00163	NS
No NSAIDs	NS	0.03389	NS	NS	NS	NS	NS
No epidural	NS	NS	NS	NS	NS	NS	NS
Demographic data							
Age	NS	NS	0.95 (0.9–1)	0.0318	0.94 (0.9–1)	0.0379	NS
Male	NS	0.03766	3.79 (1.16–15.24)	0.0266	4.55 (1.21–22.73)	0.0242	NS
BMI	NS	NS	NS	NS	1.25 (1.02–1.6)	0.0268	NS
Tobacco	NS	NS	NS	0.0349	4.02 (1.01–16.69)	0.0477	NS
Comorbidities	NS	0.00877	NS	NS	NS	NS	NS
Neoplasia	NS	0.00693	NS	NS	NS	NS	NS
Laparotomy	NS	0.01455	8.12 (1.16–40.27)	0.0121	8.43 (1.27–55.77)	0.0283	NS

NGT nasal-gastric tube, *NSAIDs* non-steroids anti-inflammatory drugs, *CI* confidence interval risk

outcomes, which are similar to other studies [10–14]. In fact, the current literature clearly shows that the higher the adhesion to an enhanced recovery program (ERP), the easier the postoperative recovery, the lower the complications, and the shortened hospitalization [15, 16].

In addition, our data show an increase of complication Dindo–Clavien 3 when less than 17 items of the ERP is respected.

Among ERP measures able to influence outcome, some items seemed to have more impact than others on postoperative evolution.

Early mobilization and early oral intake are the two most used and reported postoperative elements in published ERPs [17]. Some authors considered that those postoperative elements are markers of both protocol compliance and recovery [18]. One can indeed consider that early mobilization and early (liquid or solid) oral intake, generally regarded as components of ERPs, could or should also be viewed as outcomes of ERP [18]. In the immediate postoperative period, it is difficult to say whether a patient had better recovery because he was eating and ambulating early or whether he tolerated early

eating and walked early thanks to rapid recovery without complication.

The most common obstacles to ambulation seem to be urinary catheters, intravenous catheter, and pain [19]. These last factors appear in our study as elements of the ERP having a more important role than others. Rapid withdrawal of the urinary catheter, IV infusion, and pain management may have an impact on functional recovery that may be related to improved patient mobilization. There is a strong relationships between the maintenance of a urinary catheter, an infusion, and a good mobilization of the patient and a quick functional recovery [19–21].

Indeed, a patient who can mobilize himself quickly due to optimal pain management, lack of drains and tubes, etc., has a better quality of life and is actively participating in his care [20]. Mobilization also decreases the risk of complications associated with bed rest like thrombo-embolism, pneumonia, muscle wasting, and physical deconditioning [21].

Finally, functional recovery, as food tolerance without nausea, adequate pain control, and ability to mobilize, is considered the most crucial recovery target and actually defines full recovery. But all these postoperative factors are part of the ERP in itself, which incites some authors to qualify the situation as a chicken and egg dilemma [5, 18]. This attitudes highlights the importance of pre- and intraoperative elements, which become the real determinants of the success of the ERP [18]. Moreover, studies assessing the relationship between the adherence to ERP and the duration of hospital stay reported that the lower the adherence to pre- and intraoperative measures (carbohydrate loading, antiemetics, magnesium, and non-opioid analgesics), the longer the duration of stay [22].

Regarding our data, it is essentially the postoperative measures, in particular refeeding and mobilization, that are less followed in Dindo 3 patients. This leads to the hypothesis that it is in fact the complications that decrease the compliance rather than the reverse.

It should also beared in mind that a patient's deviation from the pathway is not necessarily caused by lesser compliance or a wrong selection of patients, but can also originate from the patient's familial and social environment [11, 23]. For example, the delay in hospital discharge for elderly patients may be due to social-care problems more than clinical complication [11]. As each patient and postoperative evolution are different, it is important to adapt the program to the variable local contexts [24]. It is essential to keep an ERP with flexible and individualized approach, rather than as a rigid protocol with more risk of failure if we don't listen to our patients [1, 2, 16].

Therefore, although we can isolate some independent predictive factors, the success of a FT program results, in our opinion, from its practice with good compliance and its holistic effect rather than the addition of the effects of each item of the program. This is also why the implementation of an ERP implies an upheaval of the usual practice and requires a cyclical and continuous training, maintained by evaluations and feedbacks to continually improve the effectiveness of the program [10, 16, 17, 22, 25, 26]. Good communication, collaboration, and coordination are also necessary to maintain the membership in the team [16, 24, 27, 28]. Indeed, regarding the literature and our experience, the most significant barriers to ERP implementation are time and staff restraints, resistance to change, opposition from colleagues, logistical reasons, opposition from the administration, money restraints, and patient-related factors [16, 27, 28].

Concerning staff lack of interest was reported particularly among nurses and anesthesiologists. One possible explanation is that unlike surgeons, the latter do not follow patients from the beginning to the end of perioperative management and therefore do not necessarily see the actual benefits of the ERP [16, 24, 29]. This should change with the current evolution of anesthesiology, which broadens the anesthesiologist's focus to the entire perioperative course [30]. In our experience, our anesthesiologists were part of the initiating and driving team of ERP. The dieticians, physiotherapists, and residents need also to take an active part in the program, as they are important pillars for the proper functioning of the perioperative team [16].

Conclusion

Our study confirms the association between good compliance to ERP and favorable postoperative evolution with a decrease of complications, complication severity, and LOS.

The elements of the protocol with the most significant impact on the patient and the postoperative course are rapid feeding, rapid removal of urinary catheters and IV infusion, and early mobilization. They can be discussed as being cause but also consequence of a good FT protocol. This is why it is essential to respect the pre- and intraoperative elements, to optimize the holistic effect of the protocol while constantly adapting to the patient needs.

Compliance with ethical standards

Disclosures Drs Hartman, Leonard, Trefois, Remue, Bachmann, Abbes Orabi, Lupu, Robu, Steyaert, and Kartheuser have no conflicts of interest or financial ties to disclose.

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