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Patients' refusal as major limitation of early discharge after colorectal resection in an enhanced recovery program.

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Abstract:	<p>Purpose</p> <p>The reduction of length of hospitalization without compromising the patient's safety constitutes the challenge of the enhanced recovery after surgery (ERAS) programs. Our aim was to evaluate the feasibility and safety of a 3-day hospitalization after colectomy and 5-day hospitalization after proctectomy in the setting of an ERAS program.</p> <p>Methods</p> <p>An ERAS program was prospectively proposed to all patients who required a colorectal resection (January 2014-December 2018) with a 3 or 5-day discharge objective. The success of the program was defined by a 3-day/5-day hospitalization without complications and without readmissions.</p> <p>Results</p> <p>Among 283 patients included, 232 patients had a colectomy (82%) and 51 (18%)</p>

patients a proctectomy. Eighty-six patients experienced complications (30%) including fifteen severe complications (5%). Mean hospital stay was 5.1 ± 3.7 (2-33) days. 136 patients (48%) were discharged at 3-day/5-day, within 9 were readmitted (3%). Discharge was delayed after 3-day/5-day for complications (n=65, 23%), CRP>120 (n=45, 16%) or refusal without medical reason (n=37, 13%). The success rate of the program was 45% (n=127). This success rate was similar between colectomy and proctectomy (p=0.277) and between right and left colectomy (p=0.450). In multivariate analysis, predictive factors associated with the program success were intra-operative use of lidocaine (OR:2.1[1.1-4.1], p=0.022), time to remove perfusion ≤ 2 days (OR:10.3[5.4-19.6], p=0.001), time to recover bowel movement ≤ 2 days (OR:4.0[1.7-9.6], p=0.002) and time to walk out of the room ≤ 2 days (OR:2.6 [1.1-6.0], p=0.022).

Conclusion

Integrating a realistic hospitalization duration objective into an ERAS program guarantees its safety, feasibility and effectiveness in reducing hospitalization duration.

RESPONSE TO EDITOR/REVIEWER COMMENTS:

We would like to thank the Editor and the Reviewers for their comments contributing to improving our manuscript. We have answered all the comments point-by-point. In the manuscript, all changes are highlighted in yellow. We hope that this revised manuscript fulfils all expectations and is now acceptable for publication in *Langenbeck's Archives of Surgery*.

Editorial comments:

1. *The title should be shortened. The title suggestion of reviewer #2 is just one suggestion; an alternative would be: "Patients' refusal as major limitation of early discharge in an enhanced recovery program". But the authors should feel free to change but shorten the title in their own way.*

We entirely agree with this proposed amendment. Indeed, a title highlighting the high refusal rate of patients is very relevant. This change has been applied.

Reviewer #1:

The authors present their data on the feasibility of the ERAS program in colorectal cancer with focus on discharge at day 3 or 5. 283 patients were included, receiving colectomies (n=232) or rectal resections (n=51). It was proposed, that patients could leave hospital safely 3 days after colectomies and 5 days after proctectomies.

The paper is well written and might be interesting for the readers of LAS.

We would like to thank the reviewer for this very nice comment.

1. *Results: "As related in table 1, they were 121 (43%) female with a mean age of 61.6 ± 13.1 (17-90) years" is not precise as the mean age was 61.6 for female and male patients together.*

We thank you for this remark since the formulation of the sentence was unclear. This sentence has been reformulated to remove any confusion.

Results - Population and procedures: **"Two hundred and eighty-three patients with a mean age of 61.6 ± 13.1 (17-90) years were included in the program between January 2014 and December 2018. As related in table 1, there were 121 (43%) female."**

2. *It would be interesting to know, how often (at what days) the authors measured the CRP value. Was it only intended to be measured at day 3 or 5, respectively? Was a $CRP > 120$ a contraindication for discharge? Or was the enhanced CRP only a contraindication for discharge, when a CT scan showed signs of a pathology to be treated? Did it make any difference if the CRP dropped to a lower value postoperatively, and increased again, e.g. at day 5 after rectal resection, but stayed below 120?*

All these questions raise an important issue: should we consider the kinetics of the CRP or only a threshold value on a given postoperative day? Here are our answers point by point to your remarks.

- In our center, CRP is routinely measured on postoperative day 1 and every 2 days thereafter until discharge. This information has been incorporated in the manuscript (Methods- Post-operative cares: "***CRP was routinely measured on postoperative day 1 and every 2 days thereafter until discharge.***")
- Yes, CRP>120 was always a contraindication for early discharge (J3 after colectomy and J5 after proctectomy). If the CT scan performed was normal, the patient was discharged the next day if still clinically symptomatic. Thus, a CRP>120 at D3/D5 was always associated with a program failure. This consideration has been added in the manuscript (Methods- Post-operative cares: "***In case of CRP>120 in an asymptomatic patient on day 3 after colonic resection and on day 5 after rectal resection, discharge was systematically delayed for at least 24 hours for clinical observation and eventually associated with a CT-scan.***")
- In this program that we had developed, if the CRP dropped to a lower value postoperatively, and increased again, but stayed below 120, the patient was discharge if totally asymptomatic. Surely, this cut-off is arbitrary. In the literature, several options have been validated with different thresholds and different kinetics of CRP with comparable results in terms of patient safety. Of course, we paid particular attention to the clinical examination of patients in this situation of CRP re-ascension but always below 120 and discharge was delayed if we had the slightest doubt.

Reviewer #2:

This interesting article entitled "Feasibility and safety of a discharge at day 3 after colectomy or day 5 after proctectomy: a prospective cohort of 283 patients included in an enhanced recovery program" describes the attempt for early hospital discharge after colorectal surgery. Collard and co-workers present the results of a study with 283 consecutive patients who underwent (preferably) laparoscopic colon or rectal resection. This paper underlines the necessity of enhanced recovery programs in (colorectal) surgery. Hence, this paper is interesting for all readers of LAOS.

However, the authors conclude that their proposed program is feasible. Indeed, the re-admission rate is low and the complication rate among all patients is acceptable. Unfortunately, not even half of the patients were discharged at day 3 or day 5, respectively.

Interestingly, one major cause was denial by the patient. This observation underlines the problem regarding early recovery and early discharge after major surgery: the patients do not want to leave the hospital that early. This might be motivated by the fact that, at least in Europe, they do not have to pay the hospital bill by themselves. This issue was discussed in the manuscript.

1. *However, I recommend changing the article, i.e. "Failure of an innovative enhanced recovery program: how can we convince our patients?". Another reason for failure of the program was the onset of early complications; this might reflect the vulnerability of this kind of surgery.*

Your opinion converges with that of the editor. Thus, we have modified the title in the sense you suggest.

2. *Some very few spelling errors should be corrected.*

On your advice, we have revised the entire manuscript to correct spelling errors.

3. *Additionally, the limitations of the study should be mentioned, such as the single-center character.*

In line with your proposal, we have added a paragraph in the discussion relating to the limits of our work.

Discussion: ***“Of course, this study has some limitations such as its single-center character. This limitation is even more important in the evaluation of an ERAS program since the application of this type of program depends directly on the capacities and means of each center. Furthermore, the status of Saint-Antoine Hospital as a tertiary care center is a limitation to be considered. The distance of patients from the center, the pre-operative medical condition of patients and the expertise of the surgeons in colorectal surgery are factors that influence considerably the success of an early discharge program after colorectal surgery.”***

The Authors

Patients' refusal as major limitation of early discharge after colorectal resection in an enhanced recovery program.

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Original article.

Running head: Colectomy in 3 days, proctectomy in 5 days

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No conflict of interest to report.

Abstract

Purpose: The reduction of length of hospitalization without compromising the patient's safety constitutes the challenge of the enhanced recovery after surgery (ERAS) programs. Our aim was to evaluate the feasibility and safety of a 3-day hospitalization after colectomy and 5-day hospitalization after proctectomy in the setting of an ERAS program.

Methods: An ERAS program was prospectively proposed to all patients who required a colorectal resection (January 2014-December 2018) with a 3 or 5-day discharge objective. The success of the program was defined by a 3-day/5-day hospitalization without complications and without readmissions.

Results: Among 283 patients included, 232 patients had a colectomy (82%) and 51 (18%) patients a proctectomy. Eighty-six patients experienced complications (30%) including fifteen severe complications (5%). Mean hospital stay was 5.1 ± 3.7 (2-33) days. 136 patients (48%) were discharged at 3-day/5-day, within 9 were readmitted (3%). Discharge was delayed after 3-day/5-day for complications (n=65, 23%), CRP>120 (n=45, 16%) or refusal without medical reason (n=37, 13%). The success rate of the program was 45% (n=127). This success rate was similar between colectomy and proctectomy (p=0.277) and between right and left colectomy (p=0.450). In multivariate analysis, predictive factors associated with the program success were intra-operative use of lidocaine (OR:2.1[1.1-4.1], p=0.022), time to remove perfusion ≤ 2 days (OR:10.3[5.4-19.6], p=0.001), time to recover bowel movement ≤ 2 days (OR:4.0[1.7-9.6], p=0.002) and time to walk out of the room ≤ 2 days (OR:2.6 [1.1-6.0], p=0.022).

Conclusion: Integrating a realistic hospitalization duration objective into an ERAS program guarantees its safety, feasibility and effectiveness in reducing hospitalization duration.

Keywords: colorectal surgery; enhanced recovery; morbidity; discharge; readmission

Authors' contribution:

- Study conception and design: JHL, YP, TL
- Acquisition of data: MKC, MA, AL, CG
- Analysis and interpretation of data: MKC, MA, JHL,
- Drafting of manuscript: MKC, MA, JHL, CS, TL, YP
- Critical revision of manuscript: all authors

INTRODUCTION

Since the mid-1990s and Kehlet works, [1] early rehabilitation programs, also known as enhanced recovery after surgery (ERAS) or fast-track, have become popular for colorectal surgery. [2] Insertion of nasogastric tube, preoperative and postoperative fasting or multiple intra-abdominal drains that were commonly proposed previously, progressively, disappeared of perioperative cares. Eventually, numerous randomized controlled trials have shown that the implementation of detailed perioperative care protocols is useful for recovery of patients after colorectal resection. [3-7] Standardization of ERAS is underway and more and more programs are proposed with the aim of shortening the hospital stay.

Shortening the hospital stay is, once the safety of ERAS has been confirmed, the main objective. Four days of hospitalization have been easily reached but two days of hospitalization have been tested with some drawbacks. [8] In a recent randomized, multicentre trial comparing two modalities of ERAS after colorectal resection, the mean hospital stay was 9 days after colectomy and 12 days after proctectomy. [9] In our institution, we designed an ERAS program with the aim of a three days post-operative stay after colon resection and five days post-operative stay after rectal resection. This type of ERAS program for the treatment of cancer

risks some issues and more information is needed to convince patients to accept this tremendous change of view on hospital and surgery safety. In fact, patients may be afraid of possible complications occurring after discharge and possible delay to rescue with possible life-threatening consequences.

The aim of this study was to evaluate the feasibility and safety of a 3-day hospitalization after colectomy and 5-day hospitalization after proctectomy in patients enrolled in an enhanced recovery program.

METHODS

Patients and protocol

A surgeon-anesthesiologist binomial evaluated the 35 points proposed by the French Expert Recommendations including both Surgeon Society and Anesthesiologist Society on a rehabilitation program in colorectal surgery, [10] to propose our rehabilitation program. A simplified information sheet was written to be given to the patient before accepting this program. After selection, excluding patients pregnant, having an emergency procedure, with high co-morbidities, invalid or living too far from the institution, patients requiring elective colectomy or proctectomy whatever the indication were included in this enhanced rehabilitation program.

Information given orally focused on the objective of an early discharge at day 3 after colonic resection or day 5 after rectal resection. After informed consent, their participation was decided during the pre-operative consultation. All care workers (surgeons, anesthesiologists, physiotherapists and nurses) were involved in a standardized multidisciplinary protocol. During the weeks before surgery, the patient had the possibility to contact the service, to ask any questions. An oral immunonutrition was given the week before surgery in case of colorectal cancer as recommended by guidelines. [11, 12]

Operative procedures

Patients were admitted the day before or early in the morning before surgery. According to guidelines, only patients planned for rectal resection received bowel preparation. [13, 14] Patients received a last meal until midnight. Then the fast was reduced to drinks until two hours before surgery. A soft drink was proposed two hours before surgery.

During surgery, the patient received besides a standard anaesthesia, a unique bolus of corticosteroid (dexamethasone 8 mg), a continue injection of lidocaine (1mg/kg/h), an adapted antibioprophylaxis and a strong prevention of nausea and vomiting. Furthermore, volemic expansion was optimised to fight against too strong expansion. If necessary, an oesophageal Doppler was used. The patient rewarming began as soon as the patient entered in operating room, before induction, with a forced-air system.

A laparoscopic approach was systematically attempted. Surgical procedures consisted in either laparoscopic right colectomy, with a short periombilical incision to complete lymph node dissection, bowel section and extraction and anastomosis; or laparoscopic left colectomy or transversus with short median incision for specimen extraction, and anastomosis. For rectal resection, a short median incision was done after laparoscopic dissection for specimen extraction and anastomosis. Defunctioning loop ileostomy was performed for low anastomosis. [15] No drain was systematically placed after colonic or rectal resection. A supra-pubic urinary catheter was placed in men in case of pelvic dissection.

Post-operative cares

A multimodal analgesia was done to prevent strong morphine dosage, and it was associated to a parietal infiltration done by the surgeon. If possible, a multiperforated catheter was inserted in the abdominal wall, in pre-peritoneal space, to have a wound continue infusion of local anaesthetic for 48 hours as already described. [16] A Patient-Control-Analgesia (PCA), administering intravenous morphine, was more often set up than Patient-Control-Epidural-

Analgesia. At day 1 or 2, PCA was replaced by oral analgesic medications, and parenteral morphine only if necessary.

Nasogastric tube was removed at the end of the operative procedure. Oral diet was reintroduced in a stepwise and accelerated manner: oral fluids were given few hours after surgery, light diet on day 1 and complete meals on day 2. Therefore, perfusion was removed at day 1 or 2.

Patients received post-operative physiotherapy focused on early mobilization. With daily persuasive coaching, they can walk few steps during the first evening after surgery, and walk around the ward the days after.

CRP was routinely measured on postoperative day 1 and every 2 days thereafter until discharge.

In the absence of complications, patients were planned to be discharged at day 3 or 5 if they can tolerate normal diet, oral analgesic medication, have bowel movement, a $CRP \leq 120$ mg/L, no fever, and walk easily around the ward. In case of $CRP > 120$ mg/L in an asymptomatic patient on day 3 after colonic resection and on day 5 after rectal resection, discharge was systematically delayed for at least 24 hours for clinical observation and eventually associated with a CT-scan.

Outcome measures

Data were prospectively collected. Pre and per-operative anaesthetic informations, surgical procedures, complications (classified according to Dindo-Clavien's classification[17]), physiotherapy evaluation with daily mobilization results were recorded. Hospital stay, time to discharge and readmission rate were also recorded.

The enhanced recovery program was considered as a success if the patient had no complication and was discharged before or on day 3 after colonic resection and day 5 after rectal resection and without any readmission.

Statistical analysis

Quantitative variables were expressed as mean \pm standard deviation (minimum-maximum). Qualitative data were reported as frequency and percentage. The t-student test or Mann-Whitney U test was used for comparisons of quantitative variables as appropriate, whereas χ^2 test or Fisher exact test was used to compare categorical data. A univariate analysis was performed to assess the factors associated with the success of the enhanced recovery program. All factors related to patient characteristics, surgery, anaesthesia and post-operative rehabilitation were evaluated. Variables that reached a P-value ≤ 0.10 in univariate analysis were entered into a multivariate analysis conducted by a multiple logistic regression with forward stepwise selection. All of the tests were 2 sided. A p-value of <0.05 was considered statistically significant. These statistical analyses were performed using SPSS (version 23, IBM Corp, Armonk, NY).

RESULTS

Population and procedures

Two hundred and eighty-three patients with a mean age of 61.6 ± 13.1 (17-90) years were included in the program between January 2014 and December 2018. As related in table 1, there were 121 (43%) female. Surgery was proposed mainly for colorectal cancer (n=249, 88%).

A laparoscopic approach without unplanned conversion was achieved in 248 (88%) patients. Procedure was a colectomy in 232 (82%) patients and a proctectomy in 51 (18%) patients. The two most frequently performed procedures were segmental right colectomy in 119 (42%) patients and segmental left colectomy in 109 (39%) patients. The average operating time was 198 ± 77 (52-465) minutes. An associated surgical procedure was performed in 56 patients (20%): defunctioning ileostomy for patients who had a rectal resection (n=39), hernia repair

(n=3), intravenous catheter for chemotherapy (n=2), intestinal resection for Crohn's disease fistulae (n=2), small bladder resection (n=2), peritoneal biopsy (n=2), cholecystectomy (n=2), partial cystectomy (n=2), omentoplasty (n=1) or hepatic biopsy (n=1).

During operative procedure, lidocaine continuous infusion was used for 196 (69%) patients and the median inflow was 24.0 ± 10.8 (5.9-105.2) mL/kg. Body temperature at the end of procedure was never below 35.4 °C, with an average of 36.6 ± 0.4 (35.4-38.4) °C. PCA were used in 155 patients (55%). One hundred and twelve patients had a wound catheter (40%), whereas only 12 (4%) had a peridural anaesthesia.

Post-operative complications

Eighty-six patients experienced complications (30%). Severity of these complications is detailed in **table 2**. Fifteen patients experienced major complication (5%) defined by Dindo-Clavien's classification ≥ 3 . An anastomotic leakage was observed in 21 patients (7%). A readmission was necessary for 21 patients (7%): post-operative ileus (n=10), pelvic or intra-abdominal abscess (n=6) and anastomotic leakage (n=5). One patient of the study died. He was discharged at home on day 4 after a right colectomy for a cancer. CRP was 174 on day 3, the reason for he was kept longer under medical supervision. The patient was admitted in another hospital at day 9 for confusion and abdominal pain. He had a major elevation of CRP at 500 mg/L. The patient finally returned in our institution at postoperative day 10 when we immediately proceeded to surgery. He had a postoperative peritonitis from an anastomotic leakage and unfortunately died.

Results of the enhanced recovery program

Median hospital stay after surgery was 5.1 ± 3.7 (2-33) days. Perfusion was removed before or on day 2 for 169 patients (60%). Between day 0 and day 2, 231 patients (82%) had recovered bowel movement, and the mean delay before first bowel movement was 1.8 ± 1.4 (0-14) days.

Walking out of the hospital room was possible at day 2 for 223 patients (73%). The details of post-operative mobilization in patients after colectomy and proctectomy are depicted in **figure 1**. One hundred and thirty-six patients (48%) were discharged at day 3 or 5. Discharge was delayed after day 3 or 5 for complications (n=65, 23%), CRP > 120 mg/L (n=45, 16%) or refusal without medical reason (n=37, 13%). Considering these results and the readmitted patients this program was successful for 127 patients (45%) (**figure 2**).

After proctectomy, the success rate of the enhanced recovery program did not differ statistically from the success rate after colectomy (respectively 37% (19/51) and 47% (108/232), p=0.277). Among colonic resections, the success rate between right and left colectomies was similar (respectively 45% (53/119) and 50% (54/109), p=0.450). Details of the outcomes after enhanced recovery program between colectomy and proctectomy and between right and left colectomy are exposed in **table 3**.

Predictive factors of the program success

The univariate and multivariate analysis of pre-operative, intra-operative and post-operative factors associated with the success of the enhanced recovery program are provided in **table 4**. The factors independently associated with program success were intra-operative use of lidocaine (OR 2.1 [1.1-4.1], p=0.022), time to remove perfusion \leq 2 days (OR 10.3 [5.4-19.6], p=0.001), time to recover bowel movement \leq 2 days (OR 4.0 [1.7-9.6], p=0.002) and time to walk out of the room \leq 2 days (OR 2.6 [1.1-6.0], p=0.022). Of the 85 patients (30%) in whom these four factors were respected, the success rate of the program was 78% (66/85).

DISCUSSION

Enhanced recovery program has been developed for multiple types of surgery and especially for colorectal surgery. A great number of publications on the subject are available in the

literature. [18, 19] The main objectives of these early recovery program are to reduce morbidity and as a consequence the length of hospitalization without compromising patient safety. However, a recent multicentric randomized trial showed a median hospitalization stay of 9 days after colonic resection and 12 days after rectal resection in expert colorectal surgery centers and in the setting of an enhanced recovery program. [9] Our study highlighted the benefit of integrating a hospitalization duration objective into an ERAS program in order to guarantee its safety, feasibility and effectiveness.

The complication rate was 30% in this study with a severe complication rate of 5%. The patient who died had many comorbidities such as diabetes and was ASA score 3. He was readmitted late in our institution at postoperative day 10 with an undiagnosed peritonitis, which highlights the absolute necessity of a readmission in the referential centre in case of complications. Since then, we are used to do a CT-scan for patients who have a CRP > 120 mg/L at the expected day of the discharge. The post-operative morbidity observed in this study is quite comparable to the morbidity described in the literature after colectomy or proctectomy. [3-7, 20-22] As such, these results support the safety of the program proposed in this study for patients.

Most of the previous studies on ERAS report the results of such program with a reduced length of stay. [18] They give a mean time but there is no objective in terms of the number of days that should be respected. With the present ERAS program, we aimed to limit the hospital to three days after a colonic resection and five days after a rectal resection. This is a more challenging situation and we considered that if the patient had to stay longer, it was a failure. Per se, our failure rate (lengthening of the hospital stay or readmission) was quite high, with 147 patients (52%) who were not discharged at day 3 or 5. The first reason of failure was the diagnosis of a post-operative complication in 23% of patients. The surveillance period of 3 days for the colectomy and 5 days for the proctectomy aims to detect these early complications in order to offer an effective treatment. Only 6% of the 136 patients discharged on day-3 or day-

5 without complications had to be readmitted for the occurrence of a complication at home. Although incompletely perfect, the post-operative hospitalization of 3 days for colectomy and 5 days for proctectomy ensures the safety for the patient.

The second reason of failure was a CRP >120mg/L in 16% of cases. This cut-off of CRP is a reliable indicator to allow an early discharge of patients without fear of a readmission. In a meta-analysis published in 2013, Singh and al. showed that CRP is a useful negative predictive test for the development of anastomotic leakage following colorectal surgery. [23, 24] The derived CRP cut-off values were 172 mg/L on postoperative day (POD) 3, 124 mg/L on POD 4 and 144 mg/L on POD 5 and corresponded to a negative predictive value of 97 per cent. We chose initially to use a lower CRP value to be safe, because most of patients included in this meta-analysis had an open approach. We recently studied the CRP values from a consecutive cohort of 522 colorectal resection from our center and found that a 140 value at day 3 is safe to allow discharge. [24]

The last reason of failure was the refusal of the patient to leave the hospital on day 3 or day 5 despite the absence of complications and a CRP <120mg/L. This result shows how difficult it is to convince the patients that they can leave precociously the hospital after a major surgical procedure. The main concern of these patients was “what will happen if I develop a complication while I am at home far from doctors and nurses?”. Moreover, patients also consider that there is not benefit for them to leave earlier the hospital. The differences between the health care system between each country might influence the refusal of patients to leave the hospital in a short delay despite the absence of complications. In France, the patients don't pay his hospital stay and the social security pay directly the hospital. This point is probably responsible for the relatively high percentage of patients refusing to leave within an early period in the absence of complications. Furthermore, the surgeon who is willing to make them leave

the hospital might expose himself to reprimand, if the patient develops any kind of complication, even minor, if he left the hospital after being convinced by the surgeons.

With a target hospital stay of 2 days longer for patients undergoing rectal surgery, the success rate was similar to that of patients undergoing colectomy ($p=0.277$). Proctectomy including patients with an ileostomy, is therefore not a limit to the fast-track. The low readmission rate among patients after proctectomy (6%) supports the safety of the protocol in this situation. Concerning the comparison between left and right colectomy, this study found no difference in the risk of failure ($p=0.450$). While the risk of post-operative ileus is often considered as increased after right colectomy [25], our results show that in a well-managed ERAS program, the risk of prolonged hospitalization is well controlled and does not compromise the success of the program in patients with right colectomy. This result is in line with the literature. [26]

Four factors that predict independently the success of the program were identified in this study: intra-operative use of lidocaine, time to remove perfusion ≤ 2 days, time to recover bowel movement ≤ 2 days and time to walk out of the room ≤ 2 days. These factors are very simple to identify and promote. The benefit of lidocaine use was already demonstrated in a prospective randomized trial, with a faster recovery of transit and a significantly shorter hospitalization time. [27] Time to recover bowel movement ≤ 2 days is an observational but not an interventional factor. At the opposite, the other two factors (time to remove perfusion ≤ 2 days and time to walk out of the room ≤ 2 days) can be observed and encouraged in order to potentiate the success of the program. However, it is difficult to figure out whether a given patient had better recovery because he was ambulating early or whether he tolerated walked early thanks to the absence of complications. This egg-and-chicken situation has already been described in the literature and must be considered. [28]

Of course, this study has some limitations such as its single-center character. This limitation is even more important in the evaluation of an ERAS program since the application of this type of program depends directly on the capacities and means of each center. Furthermore, the status of Saint-Antoine Hospital as a tertiary care center is a limitation to be considered. The distance of patients from the center, the pre-operative medical condition of patients and the expertise of the surgeons in colorectal surgery are factors that influence considerably the success of an early discharge program after colorectal surgery.

To conclude, this study validates the feasibility and safety of a 3-day hospitalization after colectomy and 5-day hospitalization after proctectomy in patients enrolled in an enhanced recovery program. The quality of the information given to the patient and the optimization of the ERAS programs are the two major factors that contribute to the highest rate of successful early discharge without readmission.

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Compliance with Ethical Standard:

- No funding to report
- Conflict of interest: the authors have no conflict of interest to report.
- All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.
- Informed consent was obtained from all individual participants included in the study.

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Table 1. Patients characteristics and surgical procedures.

	N = 283
Gender: Female / Male	121 (43) ¹ / 162 (57)
BMI ² (m ² /Kg)	24.9 ± 4.1 (16-38) ³
Age	61.6 ± 13.1 (17-90)
ASA score: 1 / 2 / 3	107 (38) / 164 (58) / 12 (4)
Surgical indication	
<i>Cancer</i>	249 (88)
<i>Diverticulitis</i>	16 (6)
<i>Crohn's disease</i>	15 (5)
<i>Colonic volvulus: Caecum / Sigmoid</i>	3 (1): 1 / 2
Colectomy	
<i>Right colectomy</i>	232 (82)
<i>Transverse colectomy</i>	119 (42)
<i>Left colectomy</i>	4 (1)
<i>Left colectomy</i>	109 (39)
Proctectomy	51 (18)
Surgical approach : laparoscopy / conversion	
	248 (88) / 35 (12)
Anastomosis : manual / stapled	
	190 (67) / 93 (33)
Operative time (min)	
	198 ± 77 (52-465)
Lidocaine use	
	196 (69)
Inflow (mL)	
	1677 ± 695 (500-6000)
Inflow (mL/kg)	
	24.0 ± 10.8 (5.9-105.2)
Temperature at the end of procedure	
	36.6 ± 0.4 (35.4-38.4)
Wound catheter use	
	112 (40)
Peridural anaesthesia	
	12 (4)
PCA ⁴	
	155 (55)

¹ number of cases (percentage of cases); ² body mass index; ³ mean ± standard deviation (minimum-maximum); ⁴ patient-control-analgesia

Table 2. Postoperative outcomes after colorectal resection.

	N = 283
Duration of fasting without liquid (min)	466 ± 369 (120-1920) ¹
Time to remove urinary drainage (days)	1.5 ± 1.1 (0-8)
Time to remove urinary drainage ≤ 2 days	248 (88) ²
Time to remove perfusion (days)	3.1 ± 2.8 (0-16)
Time to remove perfusion ≤ 2 days	169 (60)
Time to recover bowel movement (days)	1.8 ± 1.4 (0-14)
Time to recover bowel movement ≤ 2 days	231 (82)
Wound catheter removal (days)	2.1 ± 0.6 (1-3)
Peridural anaesthesia removal (days)	2.5 ± 0.8 (1-3)
PCA removal (days)	1.6 ± 0.7 (0-4)
Morbidity	86 (30)
Morbidity during the same hospitalization as surgery	65 (23)
Morbidity diagnosed after readmission	21 (7)
Dindo-Clavien classification	
1	17 (6)
2	54 (19)
3	12 (4)
4	2 (0.7)
5	1 (0.3)
Postoperative ileus	30 (11)
Anastomotic leakage	21 (7)
Pelvic or abdominal fluid collection	18 (6)
Urinary dysfunction	10 (4)
Pulmonary embolism	3 (1)
Parietal abscess	1 (0.3)
Acute myocardial infarction	1 (0.3)
Confusion	1 (0.3)
Anastomotic bleeding	1 (0.3)
Hospital stay (days)	5.1 ± 3.7 (2-33)

¹ mean ± standard deviation (minimum-maximum); ² number of cases (percentage of cases).

Table 3. Comparison of outcomes after enhanced recovery program between colectomy and proctectomy and between right and left colectomy.

	Colectomy¹ n=232	Proctectomy n=51	<i>p-value</i>	Right colectomy n=119	Left colectomy n=109	<i>p-value</i>
<i>Operative time (min)</i>	186 ± 70 (52-465) ²	253 ± 86 (80-450)	0.001	157 ± 59 (52-465)	216 ± 68 (80-420)	0.001
<i>Laparoscopy without conversion</i>	204 (88) ³	44 (86)	0.745	106 (89)	95 (87)	0.654
<i>Morbidity</i>	63 (27)	23 (45)	0.012	35 (29)	28 (26)	0.530
<i>Serious morbidity</i>	11 (5)	4 (8)	0.486	4 (3)	7 (6)	0.281
<i>Hospital stay (days)</i>	4.5 ± 2.5 (2-19)	8.4 ± 6.0 (3-33)	0.001	4.4 ± 2.7 (2-19)	4.5 ± 2.3 (2-14)	0.683
<i>Discharge on time⁴</i>	115 (50)	21 (41)	0.277	57 (48)	57 (52)	0.200
<i>Readmission</i>	18 (8)	3 (6)	0.776	12 (10)	6 (6)	0.200
<i>Success of the program</i>	108 (47)	19 (37)	0.277	53 (45)	54 (50)	0.450

¹ including right, transverse and left colectomy; ² mean ± standard deviation (minimum-maximum); ³ number of cases (percentage of cases); ⁴ Day 3 for colectomy and Day 5 for proctectomy

Table 4. Univariate and multivariate analysis of factors associated with the success of the enhanced recovery program.

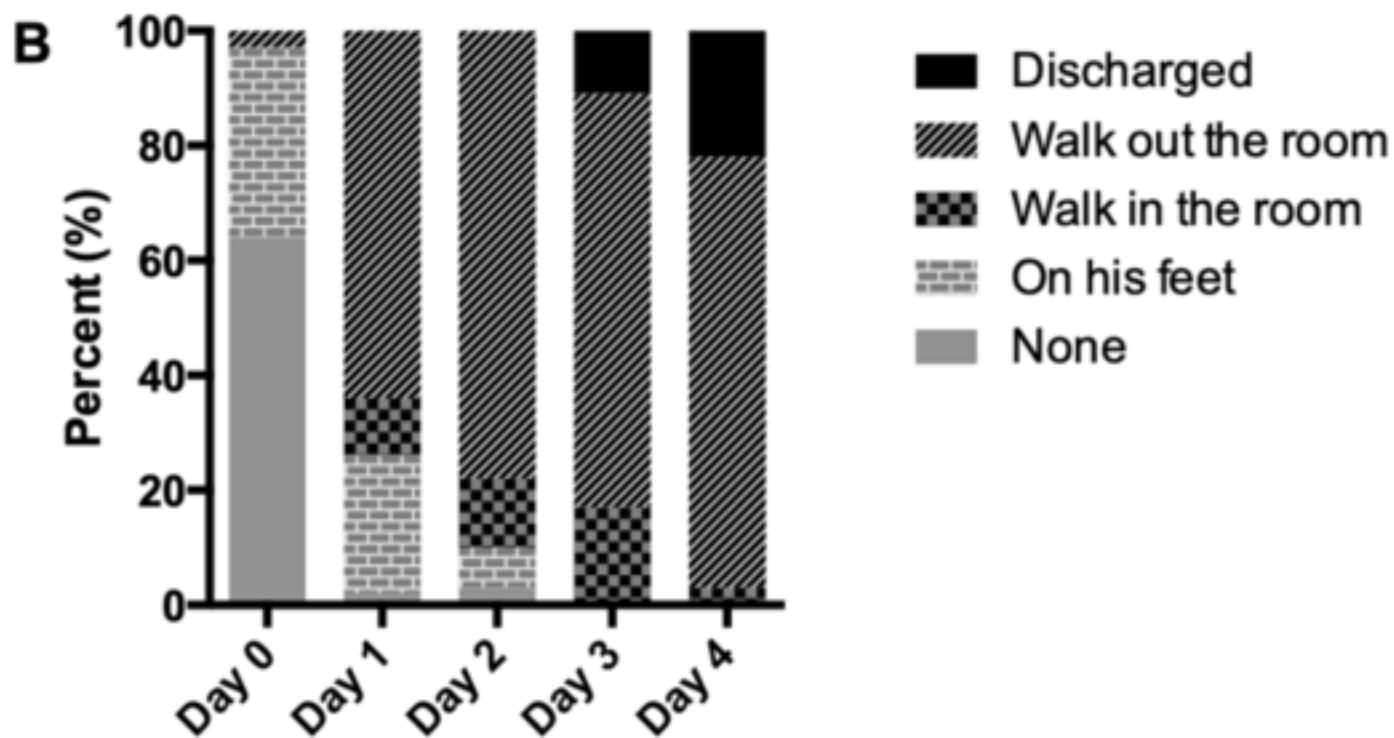
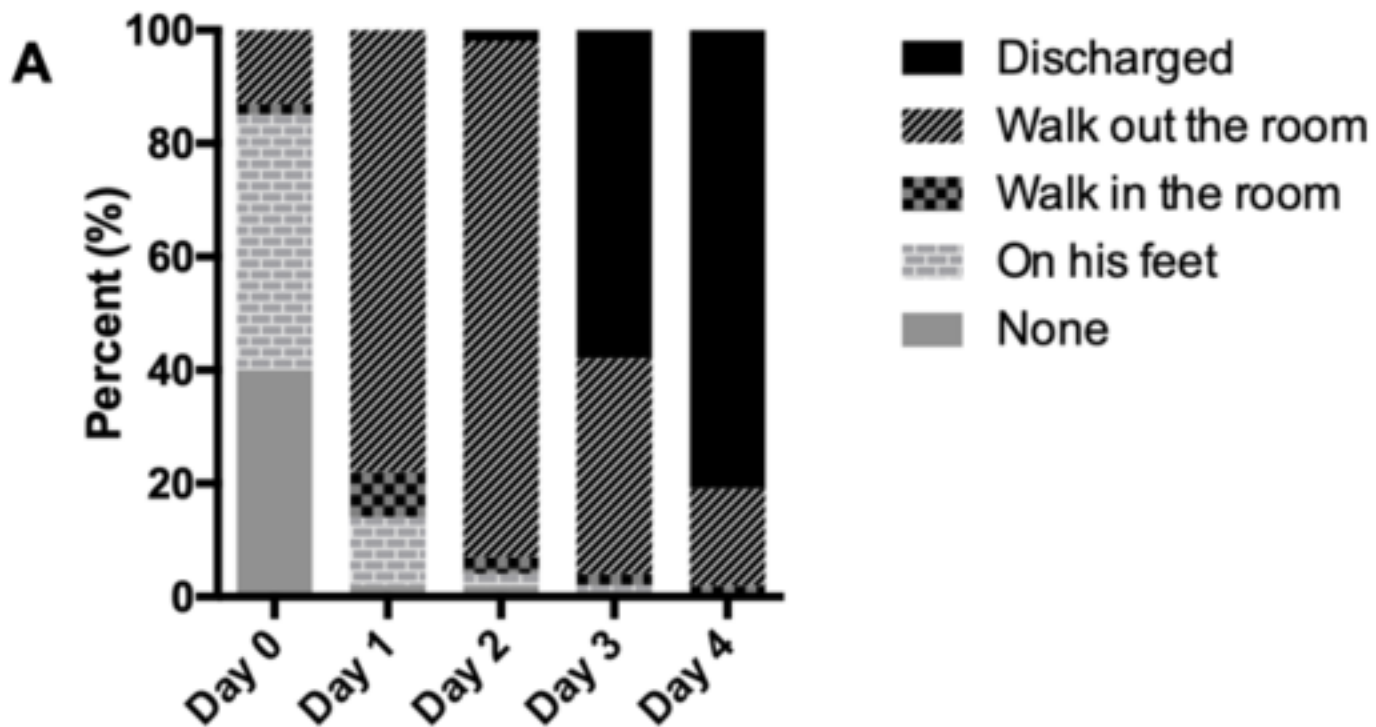
Outcomes	Univariate analysis	Multivariate analysis	
	<i>P-value</i>	<i>p-value</i>	<i>Odds ratio [IC95%]</i>
Clinical characteristics			
<i>Gender</i>	0.942		
<i>Age</i>	0.961		
<i>BMI¹</i>	0.381		
<i>ASA 1-2 vs 3-4</i>	0.157		
<i>Surgical indication: cancer vs others</i>	0.118		
Surgery			
<i>Operative time</i>	0.396		
<i>Laparoscopy without conversion</i>	0.002	NS	
<i>Colectomy versus Proctectomy</i>	0.277		
<i>Anastomosis : manual / stapled</i>	0.278		
<i>Defunctioning loop ileostomy</i>	0.009	NS	
Anesthesiology			
<i>Intra-operative lidocaine use</i>	0.068	0.022	2.1 [1.1-4 .1]
<i>Intra-operative Inflow (mL/kg)</i>	0.011	NS	
<i>Temperature at the end of procedure</i>	0.650		
<i>Wound catheter use</i>	0.100	NS	
<i>Peridural anaesthesia</i>	0.045	NS	
<i>PCA</i>	0.893		
Post-operative rehabilitation			
<i>duration of fasting without liquid</i>	0.411		
<i>Time to remove urinary drainage ≤ 2 days</i>	0.001	NS	
<i>Time to remove perfusion ≤ 2 days</i>	0.001	0.001	10.3 [5.4-19.6]
<i>Time to recover bowel movement ≤ 2 days</i>	0.001	0.002	4.0 [1.7-9.6]
<i>Time to walk out of the room ≤ 2 days</i>	0.001	0.022	2.6 [1.1-6.0]

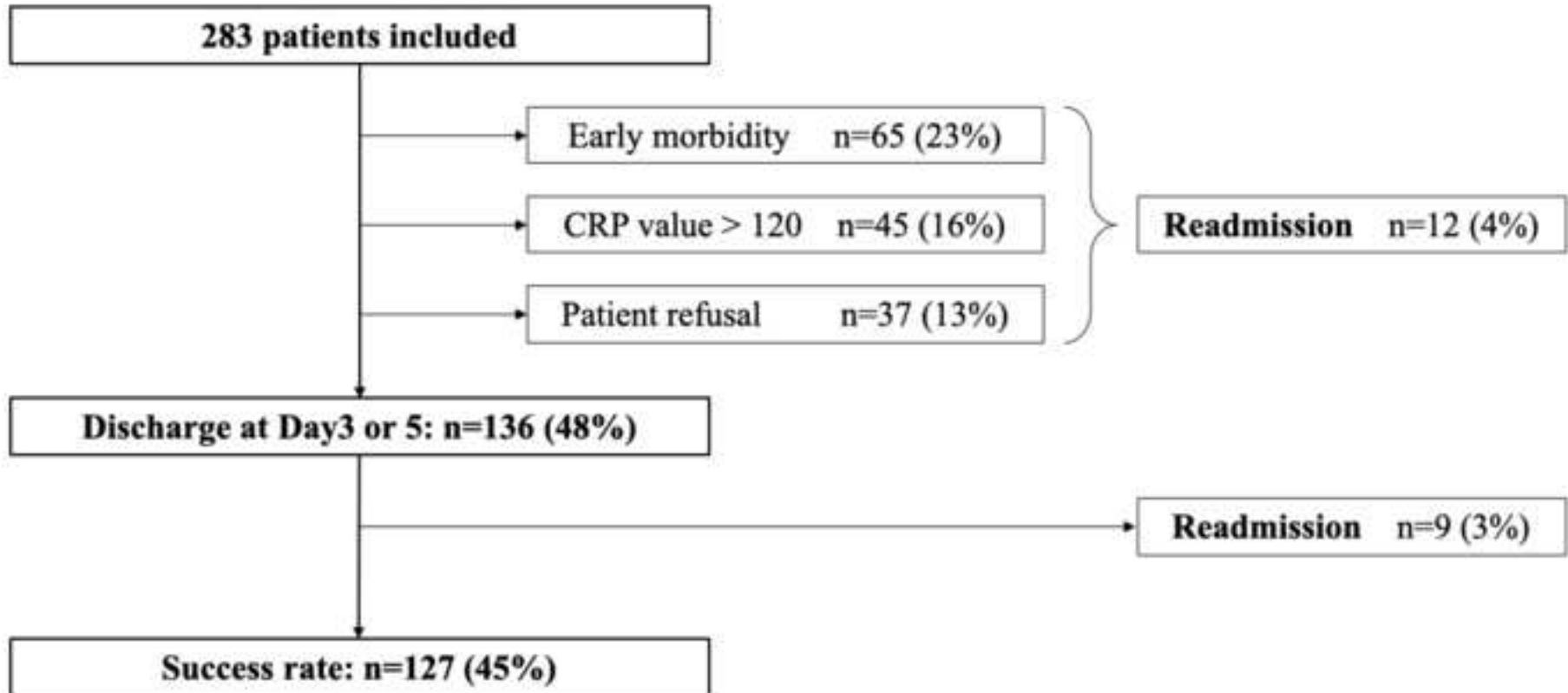
¹BMI: Body Mass Index; ² – Non-Significant after multivariate analysis.

FIGURE TITLES

Figure 1. Postoperative mobilization after colectomy (A) and proctectomy (B).

Figure 2. Results of the enhanced recovery program after colorectal resection.





Conflict of Interest: The authors declare that they have no conflict of interest.



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