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The "Weekday Effect" on Enhanced Recovery after Surgery Protocol for Gastrectomy

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Abstract
Introduction: While enhanced recovery after surgery (ERAS) protocol demonstrated to improve outcomes after gastrectomy, some papers evidenced a detrimental effect on postoperative morbidity related to the "weekday effect." We aimed to understand whether the day of gastrectomy could affect postoperative outcomes and compliance with ERAS items. ***Methods:*** We included all patients that underwent gastrectomy for cancer between January 2017 and September 2021. Cohort was divided considering the day of surgery: Early group (Monday–Wednesday) and Late group (Thursday–Friday). Compliance with protocol and postoperative outcomes were compared. ***Results:*** Two hundred twenty-seven patients were included in Early group, while 154 were in Late group. The groups were comparable in preoperative characteristics. No significant difference in pre/intraoperative and postoperative ERAS items' compliance was apparent between Early and Late groups, with most items exceeding the 70% threshold. Median length of stay was 6.5 days and 6 days in Early and Late groups ($p = 0.616$), respectively. Morbidity was 50% in both groups, with severe complications that occurred in 13% of Early patients and 15% of Late patients. Ninety-day mortality was 2%, and it was similar between the two groups. ***Conclusions:*** In a center with a standardized ERAS protocol, the weekday of gastrectomy has no significant impact on the success of each ERAS item and on postoperative surgical and oncological outcomes.

Introduction

Enhanced recovery after surgery (ERAS) in gastrectomy demonstrated to improve surgical outcomes by reducing postoperative complications, length of hospital stay (LoS), and costs [1–4]. ERAS guidelines for gastrectomy [1] highlighted the importance of overall compliance in improving postoperative outcomes. While ERAS requires a strong multidisciplinary approach,

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during the weekend, hospitals' staff is reduced. This could lead to a delay in ERAS postoperative pathway, thus possibly leading to a worsening in items' compliance and postoperative outcomes.

Few studies analyzed this "weekday effect" in major abdominal surgery [5–12], and none of them was conducted within a unit with an established ERAS protocol for gastrectomy. A large single-center experience on patients who underwent abdominal surgery did not find any significant difference in mortality and LoS between patients operated early or late during the week [13]. Other studies highlighted how major surgery performed during the second half of the week was burdened by higher postoperative mortality [14–16]. Similar outcomes were reported in a study from Sweden on esophagectomy, with the addition of improved long-term survival for patients operated on Monday or Tuesday [8]. On the other hand, a large Dutch population-based study [6] failed to find any significant influence of the weekday of gastrectomy on postoperative mortality, radicality, and overall survival. To date, no study has examined the "weekday effect" on the application of an ERAS pathway for gastrectomy. Aim of this study was to assess whether the day of gastrectomy could have an impact on postoperative outcomes and compliance with ERAS items in a unit with an established ERAS pathway.

Patients and Methods

We conducted a retrospective study on a prospectively maintained database. We included all patients who underwent elective gastrectomy for cancer from January 2017 to September 2021. Exclusion criteria were emergency surgery, palliative resection, and concomitant HIPEC. All patients were discussed at the tumor board, and the planned strategy was shared with oncologist and radiotherapist. Lymphadenectomy was performed according with the Japanese guidelines for gastric cancer [17]. During the study period, laparoscopic surgery was reserved for patients with early gastric cancer according to the current Italian guidelines on gastric cancer [18].

The cohort was divided into two groups according to the day of surgery: Monday–Wednesday (Early group) and Thursday–Friday (Late group). As the early postoperative period is crucial for ERAS application, when a holiday occurred during the week, patients operated within 2 days before the holiday were considered to be in Late group.

ERAS Pathway and Ward Organization

Elective surgery in our unit is planned between Monday and Friday, and all the operations are performed or attended by an expert upper-GI surgeon. Surgeons do not have a fixed operating day, and each surgeon performs elective surgery from Monday to Friday. The surgical ward has a 24-h/7 consultant on duty and an experienced surgeon on call for gastroesophageal emergencies. Physiotherapy service is active from Monday to Saturday morning, while the dieticians are available from Monday to Friday.

Since January 2017, a 12-item ERAS pathway for gastrectomy has been applied in our ward (Table 1), and clinical results have already been published [4, 19]. Discharge is planned on postoperative day 6, based on the assessment of the following criteria: independently mobile and able to eat a soft diet, pain controlled with oral analgesia, no need for intravenous therapy, no abnormal physical signs or laboratory tests. Patient's ERAS pathway is described in Figure 1.

We included all the operations since the beginning of the application of the ERAS protocol, considering our team is already proficient in ERAS for upper-GI surgery. Indeed, a pilot study on an ERAS protocol for esophagectomy has been active since December 2013 [20, 21].

Data on ERAS protocol completion were collected on a daily basis by the ward staff (independently from the day of the week) in a formalized datasheet for each patient. All the collected data were then included in an anonymized database.

Outcomes

Postoperative complications were registered until postoperative day 30 or in-hospital (whichever was longer) and graded according to the Clavien Dindo Classification [22], considering them severe complications graded above 2. If more than one complication occurred, the most severe was considered in the overall morbidity analysis. Complications were also analyzed by type (medical or surgical) and separately, considering anastomotic leak, pulmonary, and cardiac complications. Differences in 90-day or in-hospital mortality (whichever was greater), LoS, and 30-day readmission rate were analyzed. Compliance was analyzed for each of the 12 ERAS items, and the cause of failure was recorded (physician's decision, complication, mistake, or patient's refusal).

Statistical Analysis

Descriptive statistics was accomplished using percentages for categorical variables and medians with I and III quartiles for quantitative variables. The significance of differences between week groups was evaluated using Fisher's exact test and non-parametric Kruskal-Wallis test when appropriate. Analysis was performed using Stata software 17 (StataCorp, USA), and statistical significance was set at $p < 0.05$.

Results

Patients' Characteristics

Patients' characteristics are fully reported in Table 2. From January 2017 to September 2021, 427 patients underwent gastrectomy for cancer in our unit. After excluding patients who were not eligible, 381 patients were included. Two hundred and twenty-seven (60%) patients were included in Early group, while 154 (40%) were in Late group. Forty percent of the patients underwent neoadjuvant chemotherapy and were equally distributed between the study groups ($p = 0.396$). Both groups presented a median age of 67 ($p = 0.400$) with a slight prevalence of men (Early 65% vs. Late 56.5%,

Table 1. ERAS protocols for gastrectomy

	Enhanced recovery after surgery protocol
Preoperative	
Counseling	Pathway explanation and informative booklet. Nutritional counseling and physiotherapy prehab
Preoperative fasting	Carbohydrate load (Preop, Nutricia) 12 and 2 h before surgery
Intraoperative	
Analgesia	Multimodal: TEA for open surgery or RSB and/or subcostal TAP Block for laparoscopic surgery + CNS-targeted drugs
Prophylaxis	Antibiotic prophylaxis, VTE (pharmacological and mechanical), PONV prophylaxis
Fluids	Goal-directed fluid management
Extubation	Immediate extubation
Hospital acuity	Immediate ward transfer; PCU for close monitoring/respiratory need
NGT	Remove at the end of surgery
Postoperative	
Analgesia	Multimodal: TEA; fixed time interval-opioid sparing analgesia + rescue therapy with NSAIDs or codeine
Fluid	Zero balance goal; stop iv fluids within POD 4
Abdominal drain	Placed only after TG[a]. No routine anastomotic leak test. Remove on POD 3
Line management	Remove urinary catheter on POD 2. Remove peridural catheter on POD 4
Diet	POD 1 clear fluids; POD 2–5 nutritional counseling; POD 3 soft diet
Rehabilitation	POD 1–3 pulmonary physiotherapy; POD 1 chair and bedside exercise; POD 2–3 assisted ambulation
Length of stay	POD 6 if discharge criteria are met[b] (timed discharge)

CNS, central nervous system; TEA, thoracic epidural anesthesia; PONV, postoperative nausea and vomiting; RSB, rectus sheath block; subcostal TAP block, subcostal transversus abdominis plane block; VTE, venous thromboembolism; PCU, progressive care unit; NGT, nasogastric/jejunal tube; POD, postoperative day; TG, total gastrectomy. [a]Placed only after TG and removed on POD 3. Since December 2019 drain was placed according to the randomization plan of ADiGe Trial and eventually removed on POD 4. [b]Discharge criteria: patient self-sufficient for daily activities and able to eat a soft diet; pain well controlled with oral analgesia; no need for iv therapy; and no abnormal physical signs or laboratory tests.

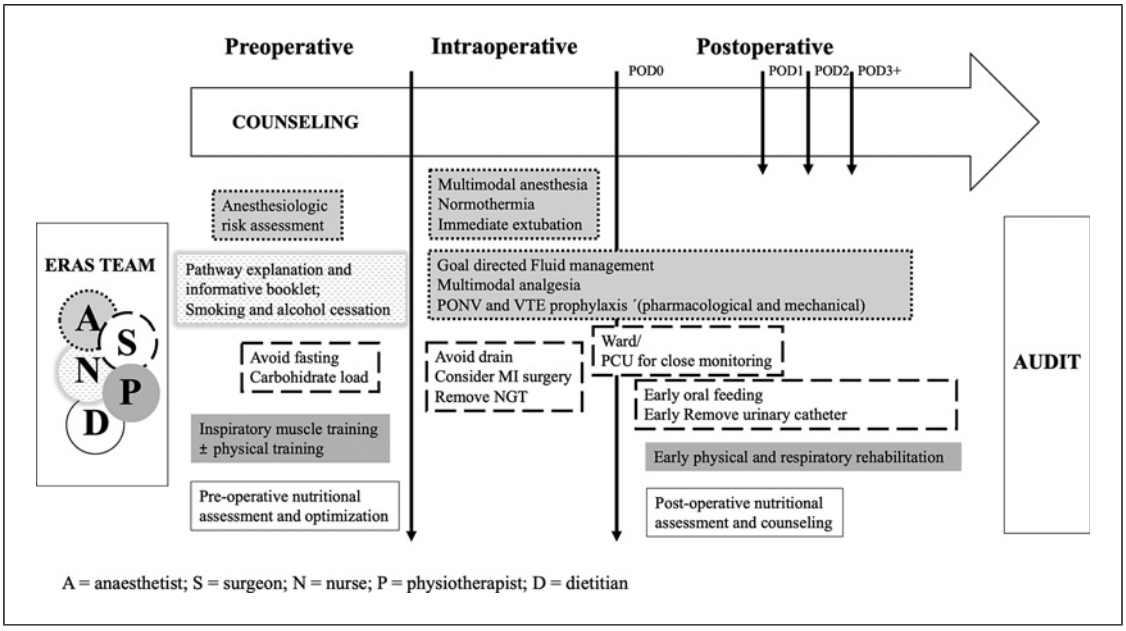

Fig. 1. ERAS pathway in gastrectomy.

Table 2. Patients' characteristics and oncological and surgical features

	Total (n = 381), n (%)	Early (n = 227), n (%)	Late (n = 154), n (%)	p value
Sex, female	147 (39)	80 (35)	67 (43.5)	0.109
Age, median (p25-p75)	67 (59–75)	67 (59–76)	67 (58–74)	0.400
BMI				0.368
<20	15 (4)	10 (4)	5 (3)	
20–25	188 (49)	114 (50)	74 (48)	
26–30	132 (35)	81 (36)	51 (33)	
>30	46 (12)	22 (10)	24 (16)	
Smoking history				0.059
Active	50 (13)	22 (10)	28 (18)	
Former	119 (31)	74 (32)	45 (29)	
Alcohol abuse				0.348
Active	6 (1.5)	5 (2)	1 (1)	
Former	2 (0.5)	2 (1)	0	
Albumin, median (p25-p75)	38 (35–41)	38 (33–41)	39 (35–41)	0.238
Comorbidities				
Cardiovascular disease	224 (59)	140 (62)	84 (55)	0.170
Respiratory disease	49 (13)	22 (10)	27 (17.5)	0.029*
Metabolic disease	111 (29)	71 (31)	40 (26)	0.301
Kidney disease	29 (8)	20 (9)	9 (6)	0.329
Previous major surgery	80 (21)	48 (21)	32 (21)	1
ASA, III-IV	124 (32.5)	83 (37)	41 (27)	0.045*
Histology, adenocarcinoma	368 (97)	218 (96)	150 (97)	0.778
Tumor location				0.846
Proximal	112 (29)	68 (30)	44 (29)	
Body	126 (33)	76 (33.5)	50 (32)	
Antrum	133 (35)	76 (33.5)	57 (37)	
Gastric stump	10 (3)	7 (3)	3 (2)	
Pathological stage				
I	111 (29)	64 (28)	47 (30.5)	0.409
II	97 (26)	54 (24)	43 (28)	
III	137 (36)	89 (39)	48 (31)	
IV	35 (9)	19 (9)	16 (10.5)	
Neoadjuvant therapy, yes	154 (40)	96 (42)	58 (38)	0.396
Type of surgery				0.311
TG	200 (52)	126 (55)	74 (48)	
STG	144 (38)	79 (35)	65 (42)	
TG + DE	37 (10)	22 (10)	15 (10)	
Lymphadenectomy				0.701
D1+	58 (15.5)	32 (14)	26 (17)	
D2	197 (52)	116 (52)	81 (53)	
D2+	123 (32.5)	76 (34)	47 (30)	
Nodal harvesting, median (p25-p75)	44 (32–56)	44 (31–59)	45 (34–54)	0.784
Other resections				
Cholecystectomy	69 (18)	42 (18.5)	27 (17.5)	
Other organ	61 (16)	38 (17)	23 (15)	
Minimally invasive surgery	51 (13)	29 (13)	22 (14)	0.759
Jejunostomy	27 (7)	13 (6)	14 (9)	0.227
Radicality, R0	359 (94)	212 (93)	147 (95)	0.504

BMI, body mass index; TG, total gastrectomy; STG, subtotal gastrectomy; DE, distal esophagectomy. *Significant variables.

p = 0.109) and almost half of overweight or obese patients (Early 46% vs. Late 49%, p = 0.368). Tumor location and stage were also homogeneous, with 9% of the patients affected by stage IV disease. Late group had a significantly lower predicted operative risk (p = 0.045) according to the ASA risk score, though they presented a higher

Fig. 2. Compliance to ERAS items.

percentage of patients that suffered from respiratory diseases (Early 10% vs. Late 17.5%, p = 0.029). No differences were found between groups by type of gastrectomy, with more than 50% of patients that required a total gastrectomy with or without a distal esophagectomy (p = 0.311). Multiple organ resection was necessary in 17% and 15% of patients belonging to Early and Late groups, respectively. Laparoscopy was seldom used, while open procedure was the preferred approach (Early 87% vs. Late 86%, p = 0.759). Oncological results were adequate irrespective of the day of surgery, with a median nodal harvesting of 44 in Early and 45 in Late group (p = 0.784) and a radical resection rate higher than 90% in both groups (p = 0.504).

Compliance with ERAS

Compliance exceeded the threshold of 70% for most ERAS items in both groups (Fig. 2, online suppl. Table S1; for all online suppl. material, see https://doi.org/10.1159/000531022). No significant difference in pre/intraoperative and postoperative ERAS items' compliance was apparent between Early and Late groups (online suppl. Table S1). Of note, also the compliance to items that occurred during the weekend in patients belonging to the Late group, such as resume of a soft diet (Early 76% vs. Late 71%, p = 0.284) or ambulation (Early 82 vs. Late 75%, p = 0.120), were not impaired by the weekend.

When the cause of failure was analyzed (online suppl. Table S2), no significant difference between Early and Late groups was found. Physician's decision was predominant in pre- (carbohydrate load) and intraoperative (multimodal analgesia, intraoperative goal-directed therapy, immediate extubation, avoid intensive care unit) items. Still, complication was the leading cause of failure in postoperative items (no nasogastric/jejunal tube, drain removal, urinary catheter removal, liquid and soft diet, and physiotherapy). Interestingly, failure due to a mistake of the team was higher in preoperative fasting (32% Early, 44% Late) and nasogastric/jejunal tube removal (55% Early, 54% Late).

Postoperative Outcomes

LoS was similar between the two groups, with a median of 6.5 days and 6 days in Early and Late groups, respectively (p = 0.616). Overall morbidity was 50% in both groups, with severe complications that occurred in 13% of Early patients and 15% of Late patients (p = 0.745). No significant differences were found between the two groups when complications were analyzed by type (surgical/medical) or when pulmonary (Early 9% vs. Late 10%, p = 0.598), cardiac (Early 5% vs. Late 6.5%, p = 0.501), and anastomotic leak (Early 1% vs. Late 2%, p = 0.398) were considered separately. Readmission rate increased slightly in Early group (11.5%) compared with Late group (6%), but this finding did not reach statistical significance (p = 0.071). A possible explanation could be the higher operative risk (ASA score) of the early group that could have led to a higher number of patients that required a hospital readmission for non-surgical problems. Ninety-day mortality of the entire cohort was 2%, and it was similar between the two groups (p = 0.249). Postoperative outcomes are fully reported in Table 3.

Table 3. Postoperative outcomes: complications, length of hospital stay, 30-day readmission, and 90-day mortality

	Total (n = 381), n (%)	Early (n = 227), n (%)	Late (n = 154), n (%)	p value
Overall morbidity	197 (52)	114 (50)	83 (54)	0.742
Severity				0.745
Mild (CD 1–2)	145 (38)	85 (37)	60 (39)	
Severe (CD 3a-5)	52 (14)	29 (13)	23 (15)	
Surgical				
Yes	133 (35)	79 (35)	54 (35)	1
Severe	36 (9)	19 (8)	17 (11)	0.427
Medical				
Yes	77 (20)	44 (19)	33 (21)	0.697
Severe	19 (5)	11 (5)	8 (5)	1
Pulmonary				
Yes	36 (9.5)	20 (9)	16 (10)	0.598
Severe	20 (5)	10 (4)	10 (6.5)	0.515
Anastomotic leak				
Yes	5 (1)	2 (0.9)	3 (2)	0.398
Severe	4 (1)	2 (0.9)	2 (1)	1
Cardiac				
Yes	21 (5.5)	11 (5)	10 (6.5)	0.501
Severe	1 (0.3)	1 (0.4)	0 (0)	1
Other				
Yes	166 (44)	99 (44)	67 (43.5)	1
Severe	37 (10)	19 (8)	18 (12)	0.259
Discharge, median (p25-p75)	6 (6–8)	6.5 (6–8)	6 (6–9)	0.616
30-day readmission	35 (9)	26 (11.5)	9 (6)	0.071
90-day mortality	7 (2)	6 (3)	1 (0.7)	0.249

CD, Clavien Dindo Score.

Discussion

Our study evidenced that in a center with a standardized ERAS protocol, the weekday of gastrectomy has an impact neither on the success of each item nor on surgical and postoperative outcomes. With the introduction of ERAS programs for major surgical procedures, the attention to preoperative optimization and multimodal postoperative care increased significantly. Nevertheless, as ERAS relies on the cooperation of many specialists [23], to assume that compliance with ERAS could be impaired during the weekend, when hospital staff is reduced, is legitimate.

Weekday effect on major upper gastrointestinal surgery has been investigated with discordant results. Two nationwide studies from the Netherlands, analyzing, respectively, patients undergoing esophagectomy and gastrectomy, did not evidence any significant impact of the weekday of surgery on mortality for both operations [6, 7]. A retrospective study from Germany failed to recognize any significant weekday effect on short- and long-term outcomes of patients undergoing gastrectomy [5]. Meanwhile, a Sweden population-based study on 1,748 esophagectomies reported a 5-year mortality increase in patients operated on from Wednesday to Friday [8].

Moreover, one paper on general surgery [12] and one on colorectal surgery [24] reported an increased 30-day mortality when the operation was performed toward the end of the working week. Interestingly, none of the previous studies were conducted within an ERAS pathway, and to date, only two studies have assessed the weekday effect in this setting, both focusing on colorectal surgery [25, 26].

Ihedioha obtained comparable results in morbidity between early and late-week groups. Nevertheless, a 2-day hospital stay increase in Thursday-Friday group was apparent (p = 0.045), thus suggesting that an early-week operation could maximize the benefit of an ERAS protocol for colorectal surgery [26].

Conversely, Romain found no significant differences in complications and LoS between patients undergoing elective colorectal surgery early or late during the week, with compliance to the ERAS protocol that exceeded the 70% threshold in both groups [25]. Similarly to Romain's study, we didn't experience any significant difference in complications and LoS, and we exceeded the threshold of 70% compliance for most items. We applied continuous training of new staff on ERAS principles, and this could explain why, also during the weekend, the indication to proceed with the pathway is mainly attended. We expected a reduction in compliance on items that required a specialist not available during the weekend in our center, but probably with the assistance of the ward nurses and the medical staff, patients were still able to complete these steps. We also tried to analyze the cause of failure to detect a possible increase in flaws of the team during the weekend, but the rate of mistakes was comparable in Early and Late groups for all the items.

Concluding, the success of an ERAS pathway for gastrectomy as well as the short-term surgical and oncological outcomes, seem to be influenced by the degree of knowledge and competence of the personnel assigned to the program and not by the day of the surgery. To date, this is the first study investigating the "weekday effect" on ERAS protocol for gastrectomy. Despite the limitation due to the retrospective design, it supports the feasibility and safety of an ERAS protocol on the postoperative outcomes independently from the day of surgery.

Statement of Ethics

The data collection of patients who underwent surgery for gastric cancer was approved by Comitato etico per la Sperimentazione Clinica (CESC) delle Province di Verona e Rovigo (Number DBCES001). Written informed consent was obtained from all patients for use of clinical data in research.

Conflict of Interest Statement

There are no conflicts of interest to declare.

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Author Contributions

J.W., V.M., M.G., and S.G. designed the survey. M.G., S.H., D.S., and C.A.D.P. collected the results. L.T. took care of the statistical analysis. J.W., and V.M. contributed to the writing of the manuscript. All authors read and approved the final manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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