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ORIGINAL ARTICLE

Large-scale implementation of enhanced recovery programs after surgery. A francophone experience

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KEYWORDS
Enhanced recovery after surgery;
Colorectal surgery;
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Orthopedic surgery

Summary
Introduction: Enhanced recovery after surgery program (ERP) has now surpassed the stage of clinical research in certain specialties and currently poses the problematic of large-scale implementation. The goal of this study was to report the experience during the first year of implementation in three French-speaking countries.
Material and methods: This is a prospective study in which 67 healthcare centers, all registered in the Grace-Audit databank, participated. Included were patients undergoing colorectal (CRS), bariatric (BS) and orthopedic hip and knee surgery (OS), performed within an ERP. The main endpoints were duration of hospital stay, postoperative morbidity, the degree of compliance with the elements of the ERP, the relation between the extent of application of the elements and postoperative hospital stay, and finally the completeness of data inclusions in the databank.
Results: A total of 1904 patients were included in the Grace-Audit databank between January 1, 2015 and January 31, 2016, undergoing CRS ($n = 490$), BS ($n = 431$), and OS ($n = 983$). The mean implementation rate was $83.7 \pm 10.0\%$ for CRS, $75.0 \pm 23.7\%$ for BS, and $83.5 \pm 14.9\%$ for OS. The duration of hospital stay was 6.5 days for CRS, 2.6 days for BS and 3.4 days for OS. Overall postoperative morbidity (onset of postoperative undesirable event), surgical morbidity (superficial or deep organ space surgical site complications such as bleeding, infection or defective healing) and readmission rates were 20.6%, 7.5%, and 5.7% for CRS; 2.5%, 1.4%, and 1.6% for BS and 2.9%, 0.2%, and 2% for OS, respectively. A statistically significant relationship was found between the degree of compliance of the elements of ERP and the duration of hospital stay for CRS and BS; hospital stay was reduced when at least 15 of the 22 elements of the program were applied ($P < 0.001$). The patients included in the Grace-Audit databank represented less than 20% of the patients undergoing operation in the same establishments during the study period for all three specialties.

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Conclusions: This study shows that large-scale ERPs are feasible and safe in French-speaking countries. Nonetheless, although encouraging, these preliminary results highlight that implementation must be improved in specialties such as bariatric surgery and that more complete data collection is needed.

Introduction

Enhanced recovery in surgery is a multimodal approach that aims to optimize perioperative management. Enhanced recovery programs (ERP) group together a cluster of perioperative management elements to reduce the degree of surgical aggression [1]. The result is an improved postoperative course with, in the majority of cases, a reduction in the risk of postoperative complications and hospital stay, as well as enhanced physiologic recovery [2,3]. ERP have been adapted to all types of surgery [4]. Having shown that ERP is harmless and effective, the current ongoing challenge is to enhance ERP implementation in everyday practice. The Francophone Group for Enhanced Recovery after Surgery (*Groupe francophone de réhabilitation améliorée après chirurgie* [GRACE]) is a multidisciplinary group created in early 2014 with the goal of enhancing the development and diffusion of ERP on a large-scale basis. The goal of this study was to report our experience during the first year of development for three widespread specialties: colorectal (CRS), bariatric (BS) and orthopedic surgery of the hip and knee (OS).

Material and methods

Type of study

Sixty-seven centers registered in the Grace-Audit databank agreed to participate in this multicenter prospective study. Patients who underwent CRS, BS, or OS with an ERP between January 1, 2015 and January 31, 2016 were included. Specific ERPs were established for each specialty by the GRACE group (www.grace-asso.fr/espace-membre) according to the numerous existing international recommendations.

Data collection

The Grace-Audit software has the dual function of being a database and audit tool at the same time and is accessible online (www.grace-audit.fr); it was provided to all participating GRACE centers. This study included three modules: colorectal surgery (CRS), bariatric surgery (BS) and hip and knee orthopedic surgery (OS), with all three specialties incorporated into the original software program. Collected information concerned patient demographics, comorbidities, the type of surgical procedure, the postoperative course (postoperative mobility and pain, overall hospital stay, complications and 30-day mortality), mean postoperative hospital stay (MPHS), theoretical (discharge criteria met) and actual duration of hospital stay, morbidity, application (or not) of the different elements of the ERP as well as the relationship between the MPHS and the number of elements applied. Exclusion criteria included emergency surgery, pregnancy, patient refusal to participate in the program, and impossibility to contact the patient after discharge. For safety reasons, data were entered anonymously. Data were stored in a web-based host approved for healthcare data handling (according to the French ministerial decree of Jan 4, 2006). Data collection was declared to the National Commission of Informatics and Liberties (CNIL) according the terms of the modified law of Jan 6, 1978, and CNIL authorization was obtained on December 8, 2014 (n° 1817711).

Analysis of the completeness of data inclusion

In order to analyze the completeness of the Grace-Audit tool, collected data were compared to the overall activity of participating centers. Non French-speaking GRACE centers (difficulty in accessing data) and centers exploring the outcome of only one patient (''just to see'') were not included in this analysis. The *Agence technique sur l'information hospitalière* (ATIH) database (http://www.scansante.fr/applications/casemix_ghm_cmd) was consulted, choosing the Diagnostic Related Groups (DRG) roots (irrespective of levels 1,2,3,4) corresponding to the French Codification system for medical acts (*Classification commune des actes médicaux*) and listed in the Grace-Audit. After this analysis, an inquiry was sent to all participants to ask why patients were not included in the Grace-Audit. The inquiry questionnaire was sent via surveymonkey (https://fr.surveymonkey.com).

Statistical analysis

All analyses were two-sided with an alpha error set at 5% using the Stata® software (version 13, StataCorp, College Station US). Populations were described as number and percentage for categorical variables and as means ± standard deviation or median and interquartile intervals for quantitative variables, in view of the statistical distribution (statistical normality analyzed by the Shapiro-Wilk test). Sensitivity analysis was proposed to study the threshold below which the number of applied elements was associated with a statistically significant decrease in MPHS. Comparisons between independent groups were performed using the *t* test of Student or the Mann-Whitney test as appropriate [(1) normality and (2) homogeneity of variance, according to the Fisher-Snedecor test].

Results

In all, 1904 patients were included in the Grace-Audit between January 1, 2015 and January 31, 2016 in 67

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Table 1 Types of procedures performed according to surgical specialty.

Specialty	Procedures	Total (%)
Colorectal		*n* = 490
	APR	11 (2.2)
	Total protectomy	88 (17.9)
	Colectomy	352 (71.8)
	Right	150
	Left, transverse	202
	Colorectal (other)	39 (7.9)
	Malignancy	302 (61.6)
	Laparoscopic approach	373 (76.1)
	Mechanical anastomosis	355 (72.4)
Bariatric		*n* = 431
	Sleeve gastrectomy	236 (54.7)
	Roux-en Y GBP	86 (19.9)
	Mini GBP	108 (25)
	Bariatric (NA)	1 (0.2)
	Laparoscopic approach	429 (99.5)
Orthopedic		*n* = 983
	Hip replacement	604 (61.4)
	Knee replacement	351 (37.7)
	Orthopedic (other)	28 (2.8)

APR: Abdomino-perineal resection; GBP: gastric bypass; NA: not available.

centers (CR = 490, BS = 431, OS = 983) in Belgium, France, and Switzerland.

Descriptive analysis

Colorectal procedures were mainly colectomies and rectal resections. Bariatric procedures included sleeve or longitudinal gastrectomies (SG) and gastric bypass operations (GBP). Procedures in OS were mainly hip and knee replacements. The complete and detailed list of procedures for each specialty is presented in Table 1. Patient characteristics included by specialty are presented in Table 2.

Compliance to the different elements of the ERP

Colorectal surgery

In CRS, the mean rate of application was 83.7 ± 10.0%. The mean number of elements applied was 18.5 ± 3.6 (of a total of 22 elements). Preoperatively, just over half of the patients (52.8%) did not have immune-enhancing nutritional support whereas (according to the protocol) this was required for malignant disease. Overall, 15 elements were applied in more than 80% of cases: patient information, tobacco consumption cessation, colonic prep (or not), intraoperative antibiotic prophylaxis, prevention of hypothermia, prevention of nausea and vomiting, surgical approach, absence of nasogastric tube and routine drainage, multimodal analgesia, prescription of NSAID ≤ 48 h, thromboembolic prophylaxis, early mobilization and early feeding (< 24 h). Aside from immune-enhancing nutrition, the least applied colorectal ERP element was appropriate intraoperative intravenous (IV) fluids at 69% (Fig. 1a).

Bariatric surgery

In BS, the mean application rate of ERP elements was 75.0 ± 23.7%. The mean number of elements applied was 15.8 ± 2.5 (of a total of 21 elements). Preoperatively, 50% of patients had not stopped smoking. Intraoperatively, only 22% of patients had intermittent pneumatic compression stockings. Postoperatively, one patient out of two still had a nasogastric tube after operation, and multimodal analgesia was applied in 40% of patients. Only 11 out of 21 elements had an application rate over 80% (Fig. 1b).

Orthopedic surgery

In OS, the mean application rate of the ERP elements was 83.5% ± 14.9%. The mean number of elements applied was 18.5 ± 3.0 (of a total of 21 elements). Among the least applied elements, preoperative carbohydrate loading, appropriate intraoperative IV fluids, and postoperative prevention of nausea and vomiting rates were 56, 47.5 and 55.7%, respectively. Overall, one out of two patients did

Table 2 Patient characteristics.

Specialty	CRS	BS	OS	Missing data (%)
N	490	431	983	
Mean age (SD)	64.8 (± 13.97)	40.4 (± 11.83)	67.05 (± 11.19)	62 (3.2)
Male gender (%)	273 (55.7)	74 (17.1)	498 (50.6)	7 (0.36)
BMI (SD)	26.9 (± 9.17)	41.8 (± 7.36)	25.91 (± 4.15)	31 (1.6)
ASA 1-2 (%)	381 (77.8)	260 (60.3)	705 (71.8)	–
ASA 3-4 (%)	102 (20.8)	169 (39.2)	272 (27.6)	15 (0.7)
Preoperative radiation (%)	47 (9.59)	na	na	8 (0.4)

CRS: colorectal surgery; BS: bariatric surgery; OS: orthopedic surgery; SD: standard deviation; BMI: body-mass index; ASA: American Society of Anesthesiologists; na: non applicable.

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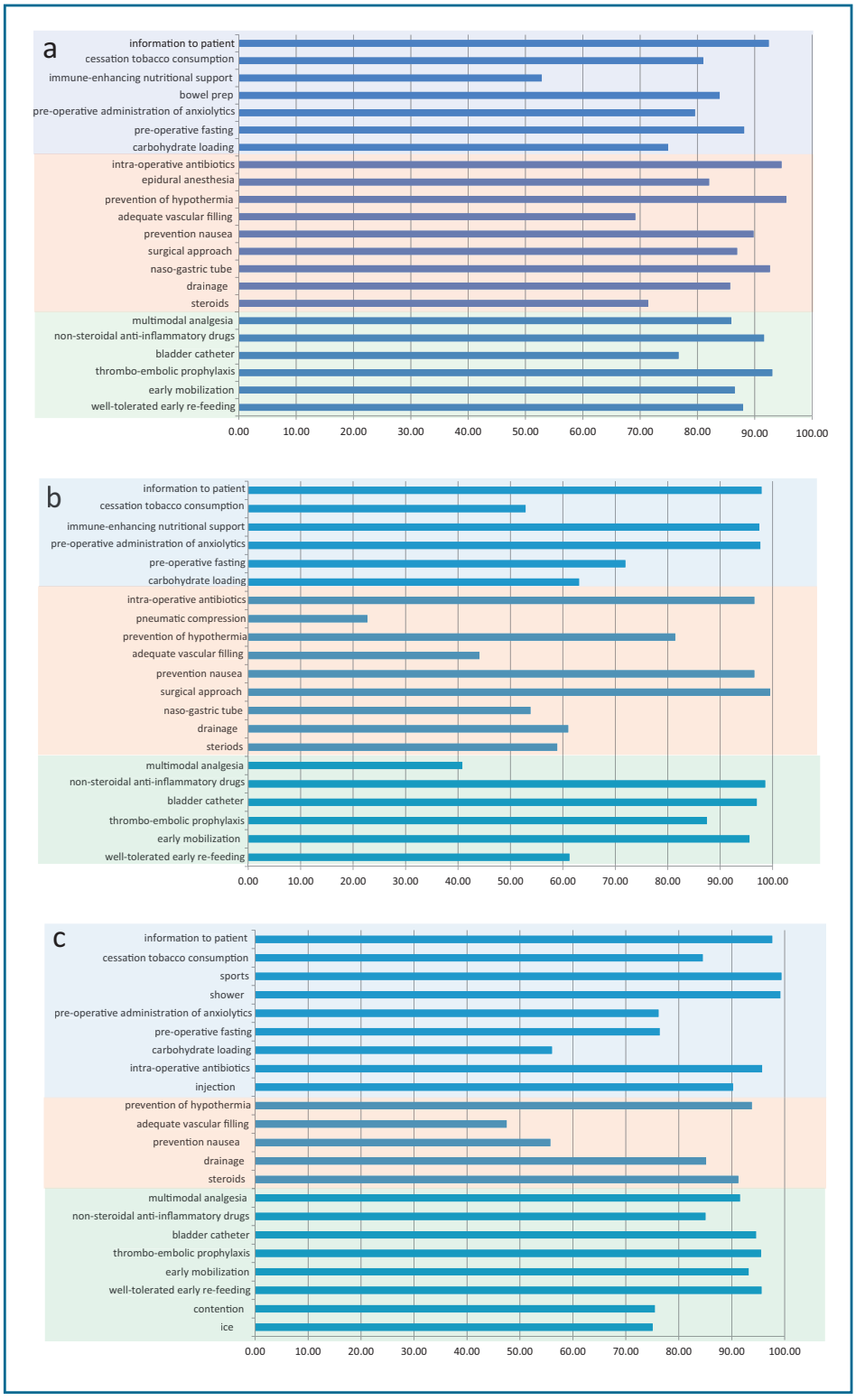

Figure 1. Application of the different pre-, intra-, and postoperative elements in the ERP for colorectal surgery (a), bariatric surgery (b) and orthopedic surgery (c).

not have these measures. For the other elements of the protocol, the implementation rate was over 75% (Fig. 1c).

Duration of theoretical and actual hospital stay

The theoretical hospital stay corresponded to the postoperative period in hospital before the predetermined discharge criteria were met (Table 3). MPHS as well as the difference between theoretical and actual MPHS for each specialty are presented in Table 4. For all patients included in each specialty, the difference between the theoretical and actual MPHS was mainly related to patient refusal to participate, lack of space in the involved health-care structures, or a problem with material or organization (Table 4).

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Table 3 Discharge criteria for patients according to GRACE (all are needed) [www.grace-asso.fr].

Pain controlled by oral analgesics (VAS $\leq$ 3)
Tolerance of solid food
No IV lines
Independent mobilization (or same as before operation)
Passing flatus
No signs of infection: fever < 38 °C, leukocytosis < 10 000 WBC/ml, CRP < 12.0 mg/dl
Patient willing to be discharged
Rehospitalization possible (from organizational aspect) in case of complication

VAS: Visual analogue scale; IV: intravenous; WBC: white blood cells; CRP: C-reactive protein.

Postoperative morbidity

Colorectal surgery

In CRS, overall morbidity was 20.6% and surgical morbidity was 7.5%. The anastomotic fistula rate was 2.86%. The readmission rate was 5.7%. Half of readmissions were for management of postoperative surgical complications (requiring an unplanned surgical, interventional radiological, or endoscopic reoperation in two-thirds of cases).

Bariatric surgery

In BS, overall and surgical morbidity were 2.55 and 1.4%, respectively. The readmission rate was 1.6%. Most readmissions were related to management of medical complications (thromboembolic or urinary tract event). One fistula after SG was treated surgically.

Orthopedic surgery

Overall and surgical morbidity was 2.9 and 0.2%, respectively. Three patients had surgical site infections (all requiring remedial surgery) while 10 patients had postoperative hematoma (three requiring surgery). The readmission rate was 2%. Two-thirds of readmissions were related to medical morbidity.

Relation between ERP compliance and hospital stay

For each specialty, good compliance with the different ERP elements was associated with decreased hospital stay (Figs. 2a, b, c). For CRS, there was a statistically significant inversely proportional relationship found between the number of elements observed and the MPHS (Fig. 2a). For CRS and BS, the threshold number of elements associated with a statistically significantly decreased MPHS was 15 ($P < 0.001$). Thus, for CRS, median hospital stay was 11 [6; 15] days for fewer than 15-implemented elements and 5 [4; 7] days for $\geq$ 15 elements ($P = 0.004$). In BS, the median hospital stay was 3 [3; 5] days for < 15-implemented elements and 1 [1; 2] days for $\geq$ 15 elements ($P < 0.001$). It was not possible to calculate the threshold value for OS because the median reduction of hospital stay was not found to be statistically significant.

Completeness of data acquisition

During the study period, 14,156 procedures (CRS, BS, and OS) were performed in the participating structures. The overall inclusion rate in Grace-Audit with regard to all acts performed in these structures was 10.2% (466/4574) for CRS, 18% (427/2372) for BS and 13.6% (978/7210) for OS. When involved surgeons and anesthesiologists were queried (response rate = 65%), the reasons behind this low ERP participation rate were predominantly that the other physicians working with the participants did not adhere to the ERP (56%) or failed to take the time to include their patients (31%), or more rarely, included patients selectively (11%).

Discussion

This prospective, multicenter center showed that ERPs are feasible on a large-scale basis (67 centers in three French-speaking countries), for colorectal, bariatric and orthopedic surgery. The study underscores the innocuousness and the efficacy of progress in surgical care according to ERP with low readmission and morbidity rates for each specialty studied, and therefore confirms the findings of the literature [5–7], especially in accordance to the UK study that included several specialties, similarly to ours [7].

In colorectal and bariatric surgery, the anastomotic fistula and surgical morbidity rates were relatively low and in general, lower than those reported outside of ERPs [8–10]. Notwithstanding, these results are to be taken with caution because our study (not a true registry) has several limitations that will be discussed later.

Our study also confirms the importance of optimal implementation of the ERP, beyond the value of providing evidence-based healthcare. A statistically significant

Table 4 Reason for discrepancy between actual and theoretical mean postoperative hospital stay $\geq$ 1 days.

	CRS	BS	OS
Actual MPHS (days)	6.51	2.66	3.4
Theoretical MPHS (days)	5.75	2.56	2.93
Number of patients for whom the MPHS are different (%)	197 (40.2)	25 (5.8)	202 (20.5)
Difference between actual and theoretical MPHS (days)	0.77	0.08	0.39
Cause of discrepancy between actual and theoretical MPHS (*n*)			
Patient refusal	93	20	64
Lack of receiving structure	34	1	93
Material or organizational problem	69	3	45
Non transmission of discharge prescriptions	1	1	0

MPHS: mean postoperative hospital stay; CRS: colorectal surgery; BS: bariatric surgery; OS: orthopedic surgery; *n*: number of patients.

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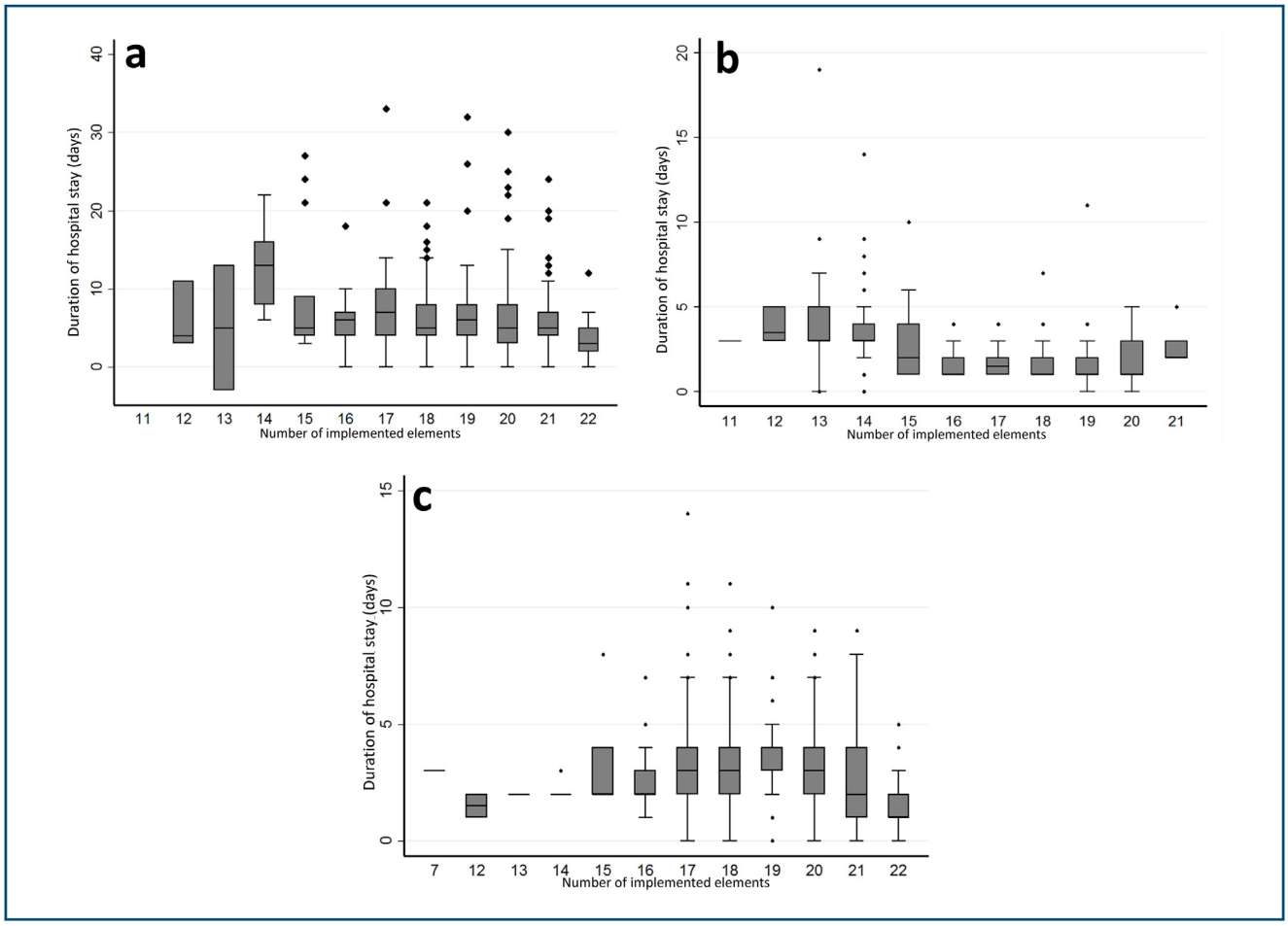

Figure 2. Relationship between the number of elements applied and postoperative hospital stay (medians and interquartiles) for colorectal surgery (a), bariatric surgery (b) and orthopedic surgery (c).

relationship between protocol compliance and hospital stay was found for CRS and BS, in accordance with other international large-scale studies [6,7]. The threshold value of 15 elements applied was associated with a statistically significant effect on hospital stay. The rareness of undesirable events (postoperative morbidity) did not allow analysis of the relation between the degree of compliance and morbidity.

Overall, the application of the different elements of the ERPs was optimal in CRS and OS (85%) but lower in BS (76%). As can be seen in Figs. 2 a, b, and c, the application of ERP elements varied with specific elements in the program: in carcinologic CRS (major gastrointestinal surgery), only 50% of patients actually had preoperative immune-enhancing nutrition, despite the fact that this is strongly recommended (grade A) to reduce infectious complications and duration of hospital stay [11]. Among the other elements that were not well applied are optimal and monitored vascular filling, multimodal analgesia and steroid therapy, despite recommendations by experts in the French Societies for Gastrointestinal Surgery (*Société française de chirurgie digestive* [SFCD]) and anesthesiology (*Société française d'anesthésie et de réanimation* [SFAR]) [12]. This was also the case for OS where optimized filling, carbohydrate loading and the prevention of nausea and vomiting were not well applied (Fig. 2c), probably because of the low level of evidence associated with these elements [13,14]. For BS, the ERP was associated with the least strict compliance (Fig. 2b). Among the elements that need to be improved are preoperative cessation of smoking (50%), despite recommendations for 8 weeks of smoking cessation to reduce the risk of major postoperative pulmonary, infective and thromboembolic complications [15]. Moreover, only 22% of the patients had lower limb intermittent pneumatic compression preoperatively despite the SFAR recommendation intermittent compression stockings and medicinal thromboembolic prophylaxis in the obese [16].

The relative importance of specific elements in ERPs is debated. In CRS, the LAFA study [17] suggested that certain elements (among the most applied) such as early mobilization and refeeding, laparoscopic approach, and female gender were independent success factors for ERP. The ERP Compliance Group [6] highlighted the value of optimal venous filling and carbohydrate loading. There is no consensus in the literature as concerns the most important element leading to a successful ERP. Faced with these discrepancies and the lack of scientific proof concerning the importance of specific elements, it seems more useful to insist on optimal implementation of the entire protocol rather than to highlight one or more of the ''essential'' elements of ERP. Our study confirms that at least three-quarters of the elements ($n = 15$) are necessary to observe a statistically significant effect on the MPHS.

Our study has limitations. This is not a registry, but rather an audit concerning the launching and implementation of ERPs in expert GRACE-certified centers for CRS, BS and OS. All centers were highly motivated. Nevertheless, our analysis of completeness showed that less than

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20% of patients treated in the GRACE centers were entered into the GRACE-Audit databank. A selection bias is therefore possible (selection of patients with positive effects of ERP or non-inclusion of patients sustaining a complication), but the inquiry conducted among the participating surgeons and anesthesiologists seemed to indicate that this bias could be minimized since the principal causes (subject to the declarations actually made) were non-adhesion to ERP principles by other coworkers on the service and the lack of time to enter the information into the GRACE-Audit database.

Therefore, even in expert centers, implementation was not optimal for all the elements included in the ERPs, and all treated patients were not included in the audit. However, let us underscore that this is only the launching stage of a very ambitious program. It may seem normal that all is not perfect at this gestational age. Further efforts are needed to improve the implementation of ERPs [18]. Just as other innovations, ERPs encounter multiple deterrents, especially in the beginning. Such brakes stress the need to motivate progressive implementation and continual communication between all stakeholders. With the aim of encouraging such progress, the GRACE group has recently published a series of recommendations to improve the implementation of the ERP [18]. Moreover, it seems important, to remove constraints, to designate leaders that are convinced, to develop team spirit, to convince stakeholders based on experience and to program team reunions. Again, within the spirit of implementation, the GRACE group has established a practical pamphlet (''Kit GRACE'' available on the website www.grace-asso.fr and on a free USB link). This kit can be likened to operating instructions conceived to help healthcare teams and structures to implement their ERPs. Once adequate experience is acquired in the domain of elective surgery by various specialties, it would be fitting to extend the indication of ERP to all forms of surgery. ERPs can be adapted and applied to all patients undergoing operation [18–20]. In the future, it would be appropriate to extend many of the principles of ERP to all patients, in particular to patients undergoing emergency surgery [21,22] and to the elderly [23,24].

Conclusion

This study shows that large-scale implementation of ERPs is feasible and effective in colorectal, bariatric and orthopedic surgery at expert centers of French-speaking countries. It confirms the importance of implementation of a maximum of perioperative elements. Further efforts are needed to include more patients in these ERPs and in the database, which would allow each team to evaluate their performances and improve their practice. There is also a need to extend the implementation outside of the GRACE centers and apply the ERPs to all types of patients. This is another role of GRACE.

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Disclosure of interest

The authors declare that they have no competing interest.

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