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ORIGINAL ARTICLE

Enhancing surgical recovery in Central-West Brazil: The ACERTO protocol results

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Summary

Background & aims: Multimodal strategies enhance postoperative recovery. The aim of this study was to evaluate the results of an ERAS-based protocol named ACERTO project in elective patients in a University Hospital in Central-West Brazil.

Methods: A total of 308 patients (M/F = 160/148; median age = 47 (18–85) years old) entered the study. Patients received either traditional ($n = 78$) or a multidisciplinary protocol of peri-operative care (ACERTO project; $n = 230$).

Results: The implantation of the ACERTO protocol was followed by a decrease in both pre- (16 [8–27] vs. 4 [2–20] h, $p < 0.001$) and postoperative fasting time (0 [0–20] vs. 1 [0–14] day; $p < 0.01$), and in the volume of intravenous fluids (8 [1–101] vs. 2.0 [0–100] L, $p < 0.001$). The changing of protocols reduced hospital stay by 2 days (5 [2–104] vs. 3 [1–64] days, $p = 0.002$) and surgical site infection rate by 66% (11.5%; 9/78 vs. 3.9%; 9/230, $p = 0.01$; odds ratio = 3.2, 95%CI: 1.2–8.4). Per-protocol analysis showed that both postoperative stay and morbidity diminished, and in the subset of major operations both infectious and non-infectious complications decreased only in patients who completed the protocol ($p < 0.01$).

Conclusion: The implantation of multidisciplinary routines such as the ACERTO protocol diminishes both hospitalization and morbidity in general surgery.

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Introduction

Traditional peri-operative care is based on old concepts and most of the current management of surgical patients is

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grounded in empirism.¹ The new paradigm of evidence-based medicine has been showing in recent years that some routines and protocols in peri-operative care are useless and in some cases harmful.² Preoperative fasting of 6–8 h, postoperative re-feeding only after ileus resolution (2nd–4th PO day), routine use of nasogastric tube and abdominal drains, and preoperative bowel preparation for colorectal surgery are some of the conventional prescriptions followed by surgeons in many countries.^{1–3} Moreover, preoperative nutritional status evaluation and peri-operative nutritional support are sometimes neglected.⁴

The results reported by the ERAS (Enhanced Recovery After Surgery) group, which is a multicentric European project aiming at accelerating postoperative recovery of patients by multimodal strategies, showed that the changes of some protocols were associated with both faster postoperative hospitalization and decrease of infectious morbidity.⁵ Various studies using this multimodal protocol have consistently shown a faster recovery by the patients.^{3,5–8}

In 2005, the Department of Surgery of Julio Muller University Hospital initiated the ACERTO project based on the various new routines advocated by the ERAS group.⁵ This multidisciplinary project was implanted after a day-long seminar involving residents, surgeons, dietitians, physiotherapists, nurses, and anesthetists. We named the project ACERTO (Aceleração da Recuperação Total) because it is a Portuguese word meaning “hit the target”, “get it right” or “rightness” and at the same time a Portuguese acronym for ERAS (Enhanced Recovery After Surgery). This study aimed at comparing the clinical outcome before and after the implementation of this multimodal peri-operative protocol in general surgery.

Material and methods

We prospectively studied all patients admitted at the Department of Surgery infirmary of the Julio Muller University Hospital, and candidates to elective operations from January 2005 to September 2006. The study design was approved by the Ethical Research Committee of the hospital.

The study had two distinct phases: before (January–June 2005), and after the implementation of the ACERTO protocol (July 2005–July 2006). In the first period (before the implementation of the ACERTO protocol) data were prospectively collected without previous knowledge of either the medical (surgeons, anesthetists, and residents) and non-medical staff (nurses, dietitians, and physiotherapists) of the surgical ward (phase 1). After six months, the data were presented to the entire staff in a whole-day seminar previously planned to introduce the ACERTO project. The seminar included the following issues: (1) Peri-operative nutrition; (2) Peri-operative intravenous fluids; (3) Anesthesia and postoperative analgesia to reduce the organic response to trauma; (4) Peri-operative care (pre-operative information and counseling, use of drains and nasogastric tubes, and early mobilization); (5) Mechanical bowel preparation; and (6) Anti-microbial prophylaxis. These topics were arranged in a booklet and distributed to all personnel. The staff was not obligated to follow the

various routines of the entire project. Instead, adherence to the new protocol was let be in a free-willing basis. Data collection resumed the next day following the seminar (phase 2 – after the ACERTO protocol). Audits were conducted every three months and comparisons between before and after the initiation of the ACERTO protocol were showed to all staff. Table 1 shows the conventional policies adopted by the Department of Surgery before the project and those proposed by the ACERTO protocol.

The surgical procedures were divided as major and minor operations. Major operations included open laparotomies lasting for more than 3 h, and procedures with at least one anastomosis performed at either the gastrointestinal tract or biliary tree. As minor operations were included video- or open cholecystectomies, herniographies, videolaparoscopies for diagnosis and biopsy, and laparotomies lasting less than 3 h. Nutritional status was assessed by subjective global assessment.⁹ Patients were categorized as malnourished or normal.

In all phases the preoperative fasting time, indication and utilization of preoperative nutritional support, volume of peri-operative intravenous fluids, peri-operative use of abdominal drains and nasogastric intubation, and the post-operative day of return of feeding were collected. The mean endpoints in the two periods were the postoperative

Table 1 Conventional and the ACERTO routines of peri-operative care

Conventional care	ACERTO project care
Preoperative counseling at surgeon's discretion	Oral preoperative counseling
Preoperative fasting of 8 h	Preoperative fasting of 2 h. Six and 2 h before operation the patient drank 400 and 200 mL of a beverage containing 12.5% of maltodextrine
Postoperative feeding after ileus resolution	Early oral or enteral postoperative feeding (6–24 h)
Preoperative nutritional support if malnourished and candidate to major operation	Preoperative nutritional support if malnourished and candidate to major operation
Mechanical bowel preparation for colorectal operations	No mechanical bowel preparation
Intravenous fluids at a rate of 30–50 mL/kg/day usually until the 3–4th PO day	Avoid excessive intravenous fluid (no more than 30 mL/kg/day). No IV fluids for minor operations postoperatively. Discontinuation of IV fluids, if possible, on the 1st PO day
Abdominal drainage and nasogastric tube at surgeon's discretion	Avoid drains and nasogastric tubes
Mobilization on the 1st PO day	Early mobilization (if possible on the same day of the operation)

morbidity, mortality, and the length of hospital stay (LOS). As adherence to the ACERTO protocol was not compulsory the intention to treat analysis was complemented with per-protocol analysis (including patients who completed or did not complete the ACERTO protocol). Chi-square test or Fisher's test was used to compare categorical data. Kruskal–Wallis test (complemented with Bonferroni test as needed) or Mann–Whitney test was used to compare continuous data. A 5% ($p < 0.05$) level was established for significance.

Results

A total of 308 patients (M = 160, 51.9% and F = 148; 48.1%) with a median age of 47 (18–85) years entered the study. Seventy eight (25.3%) patients were operated on before (phase 1) and 230 (74.7%) after the implementation of the new ACERTO protocol (phase 2). All patients included in phase 2 had at least two of the main new routines (abbreviation of preoperative fasting, early postoperative feeding, intravenous fluids restriction, and no mechanical bowel preparation) of Table 1. However, the ACERTO protocol was fulfilled in only 120 patients (52.2%). One hundred sixteen (37.7%) patients underwent major and 192 (62.3%) minor procedures. Table 2 shows the distribution of the operations performed in the two periods. Demographics of patients included in the two periods can be seen in Table 3.

Peri-operative nutritional support

Preoperatively, 61 patients (21.1%) were considered malnourished with a similar distribution in both periods (Table 3). Malnutrition was 3-fold greater in major operation subjects (43/116; 37.1% vs. 22/192; 11.5%; $p < 0.001$). All malnourished patient candidates for major operations received either oral supplements or specialized nutritional support

Table 2 Distribution of the operations before and after the ACERTO protocol

Operation	Before ACERTO	After ACERTO
Pancreatectomy	1	2
Esophagectomy	3	7
Total gastrectomy	2	4
Subtotal gastrectomy	5	6
Biliary tree exploration	5	7
Bilio-digestive anastomosis	1	7
Laparotomy	4	15
Bariatric operation (Fobi–Capella)	3	9
Colorrectal ^a	10	16
Small bowel operations	1	10
Herniography	18	73
Cholecystectomy ^b	25	74
Total	78	230

^a Segmental colectomy, abdomino-perineal resection of the rectum, colorectal pull-through, and colostomy closure.

^b Fourteen operations before ACERTO and 51 after ACERTO were laparoscopic.

Table 3 Demographics of patients before and after the ACERTO protocol

Variable	Period of the study		P
	Before ACERTO (n = 78)	After ACERTO (n = 230)	
Gender (M/F)	48/30	112/118	0.07
Age (years) ^a	44 (18–85)	47 (18–84)	0.95
Operative time (min) ^a	160 (42–450)	130 (30–570)	0.22
Malnutrition (n; %)	21 (26.9)	44 (19.1)	0.14
Malignancies (n; %)	13 (16.7)	29 (12.6)	0.37
Major operations (n; %)	35 (44.9)	81 (35.2)	0.14

^a Median and range.

preoperatively. Preoperative specialized nutritional support with either parenteral or enteral nutrition was similarly prescribed for malnourished patients in both periods (47.7% [21/44] vs. 33.3% [7/21]; $p = 0.30$).

Preoperative fasting

Before the implementation of the project (8 h fasting routine), patients remained a median of 16 [8–27] h fasting preoperatively, and thus 2-fold longer than the recommended 8 h. In the second period there was a significant fall ($p < 0.001$) in preoperative fasting time. Patients were operated on after a median of 4 [2–20] h of preoperative fasting.

Early postoperative feeding

Patients were fed earlier after the implementation of the ACERTO project. Diet was introduced 1 day earlier when compared to phase 1 (0 [0–20] vs. 1 [0–14] day; $p < 0.01$). Re-introduction of diet was earlier in both minor (0 [0–1] day vs. 1 [0–3] day; $p < 0.001$) and major operations (1 [0–20] vs. 2 [1–14] vs. days; $p < 0.001$).

Peri-operative intravenous fluids

Preoperative intravenous fluids were most prescribed before (39/78; 50.0%) than after the new protocol (31/230; 13.5%; $p < 0.001$). This difference between the two periods occurred in both minor (17/43; 39.5% vs. 10/149; 6.7%; $p < 0.001$) and major operations (22/35; 62.9% vs. 21/81; 25.9%; $p < 0.01$).

All patients submitted to major operations received postoperative intravenous fluids. As for minor procedures however, while all 43 patients of phase 1 received postoperative intravenous fluids, this routine was less frequent prescribed in phase 2 (133/149; 89.3%; $p = 0.03$). The median total volume of fluids received per patient was approximately 4-fold greater ($p < 0.001$) before (8 [1–101] L) than after the ACERTO project (2.0 [0–100] L). In minor operations, not only the total volume of fluids in those undergoing intravenous therapy was greater (4.5 [1–29.5] vs. 1.5 [0–10] L; $p < 0.001$) but also the length of intravenous therapy was longer before the new protocol than after

(3 [2–16] vs. 2 [2–16] days; $p < 0.01$). Patients submitted to major operations after the ACERTO protocol received a median of 15 L of fluids less than those operated on the first period (15 [5–101] vs. 10 [1–121] L; $p = 0.008$).

Abdominal drains and nasogastric tubes

After the implementation of the ACERTO protocol the use of abdominal drains significantly fell (36/78; 46.2% vs. 70/230; 30.4%; $p = 0.01$). Although the difference was not significant drains were less used in both minor (7/43; 16.3% vs. 17/149; 11.4%; $p = 0.39$) and major operations (29/35; 82.9% vs. 53/81; 65.4%; $p = 0.06$) in the second period of the study. In both phases, nasogastric tubes were seldom used (7/78; 9.0% vs. 12/230; 5.2%; $p = 0.13$).

Length of hospital stay

Fig. 1 shows the median LOS in the two phases. Both LOS (5 [2–104] vs. 3 [1–64] days; $p = 0.002$) and postoperative stay (4 [1–94] vs. 2 [1–62] days; $p = 0.004$) were shortened by 2 days after the implementation of the ACERTO project. Per-protocol analysis showed that the shortening of postoperative stay reached the significance level only in patients who completed the entire protocol (Table 4).

Both LOS (3 [2–19] vs. 2 [1–14] days; $p < 0.01$) and postoperative stay (2 [1–15] vs. 1 [0–8] day; $p < 0.01$) shortened by 1 day after minor procedures. However, this effect was not found in patients who underwent major operations for both LOS (10 [4–104] vs. 11 [3–64] days; $p = 0.37$) and postoperative stay (7 [3–94] vs. 8 [2–62]; $p = 0.30$) even when per-protocol analysis was carried out (Table 5).

Postoperative morbidity

Surgical site infection rate was significantly lower after the implementation of the ACERTO protocol (3.9%; 9/230) than before (11.5%; 9/78; $p = 0.01$; odds ratio = 3.2; 95%CI = 1.2–8.4) especially in the subset of major operations (6.2%, 5/81 vs. 22.8%, 8/35; $p < 0.01$; odds ratio = 4.5; 95%CI = 1.4–14.9). The number of infections per infected patient was greater in the 1st phase when compared to the 2nd phase (2

Table 4 Clinical outcome according to the phase and completion of the ACERTO protocol

Outcome	ACERTO protocol		
	Before (n = 78)	Complete (n = 120)	Incomplete (n = 110)
Total LOS*	5 (2–104)	3 (2–64) [†]	4 (1–57) [†]
Postoperative LOS*	4 (1–94)	2 (1–62) [†]	3 (1–33)
SSI (n,%)	9 (11.5)	3 (2.5) [†]	6 (5.4)
Non-infectious complications (n,%)	12 (15.4)	5 (4.1) [†]	10 (9.1)
Anastomotic dehiscence (n,%)	2 (2.6)	1 (0.8)	2 (1.8)
Mortality (n,%)	1 (1.3)	1 (0.8)	1 (0.9)

LOS: length of stay; SSI: surgical site infection.

*Median and range. †: $p < 0.01$ vs. before ACERTO.

[1–3] vs. 1 [1–3]; $p = 0.05$). Non-infectious complications also diminished ($p = 0.02$) after the ACERTO protocol (6.5%; 15/230 vs. 15.4%; 12/78, odds ratio = 3.1; 95%CI = 1.4–6.9). However, at per-protocol analysis both surgical site infection and non-infectious complications were significantly lower only in those patients who completed the ACERTO protocol (Table 4), mainly in the subset of patients submitted to major operations (Table 5). There was no difference in the number of anastomotic dehiscence between the two periods.

Discussion

The findings showed that the implementation of the ACERTO project promoted clear benefits for patients in various postoperative parameters. The overall data showed that not only LOS and postoperative stay were shortened but also both surgical site infection rate and non-infectious complications decreased. Moreover, the severity of the septic complications also diminished. This was most evident when per-protocol analysis was carried out. The benefits of the ACERTO protocol described above were most seen in patients who completed the whole protocol. These results are

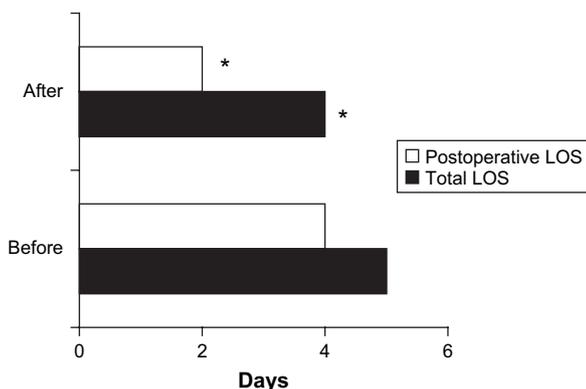


Figure 1 Total and postoperative length of hospital stay (LOS) before and after the ACERTO project. *, $p < 0.05$ vs. before ACERTO.

Table 5 Clinical outcome after major operations (n = 116) according to the phase and completion of the ACERTO protocol

Outcome	ACERTO protocol		
	Before (n = 35)	Complete (n = 30)	Incomplete (n = 51)
Total LOS*	10 (4–104)	11 (4–64)	11 (3–57)
Postoperative LOS*	7 (3–94)	7 (3–62)	8 (2–60)
SSI (n,%)	8 (22.8)	1 (3.3) [†]	4 (7.8)
Non-infectious complications (n,%)	11 (31.4)	2 (6.7) [†]	8 (15.7)
Anastomotic dehiscence (n,%)	2 (5.7)	1 (3.3)	2 (3.9)
Mortality (n,%)	1 (2.9)	1 (3.3)	1 (2.0)

LOS: length of stay; SSI: surgical site infection.

*Median and range. †: $p < 0.01$ vs. before ACERTO.

significant and indirectly suggest that an important institutional endpoint as hospital costs was probably cut down.

Both Infectious and non-infectious morbidity rate reduced most significantly after major operations. This result is consistent with previous studies with multimodal strategies after major operations.^{3,5,7,8} However, hospital stay has not decreased as morbidity in this subset of patients. In fact, LOS and postoperative stay significantly diminished only after minor procedures. We believe that the main cause for that is the social condition of those patients that are often referred to this tertiary hospital from distant cities. Finding appropriate conditions to discharge them home is frequently a difficult task.

Beyond the good results observed after the ACERTO protocol the experience of changing minds and traditional peri-operative routines of the hospital staff was most relevant. Conveying the concepts of multimodal approach followed a strategy that was possible in a day seminar. We believe that many surgical and nutritional societies could efficiently promote actions as that aiming for changing attitudes in peri-operative care. In an international perspective, this may result in sensible benefits for many patients.

Peri-operative multimodal approaches as the ERAS project have significantly impacted the outcome in general surgery.^{3,5} Various traditional surgical routines when examined by the sight of the evidence-based medicine paradigm have failed to demonstrate its usefulness.² In the last decades, for example, the use of nasogastric intubation,^{10,11} and abdominal drains¹² as routine has been proved to be useless and probably harmful. Other traditional peri-operative prescriptions such as 6–8 h of preoperative fasting and postoperative re-feeding only after the resolution of ileus have also been investigated. There is now good evidence to affirm that the abbreviation of preoperative fasting not only is safe but also decreases insulin resistance^{13,14} and preserves skeletal muscle mass after surgery.¹⁵ Intake of carbohydrate beverage 2 h before operation may diminish discomfort¹⁶ and reduce episodes of postoperative nausea/vomiting.¹⁷ Many national societies of anesthesia have changed their fasting guidelines and now recommend clear fluids up to 2 h before elective surgery.^{18,19} An interesting observation of this study was that the prescribed fasting time was frequently enlarged. This profile occurred in both phases and as a consequence the median time of preoperative fasting was doubled. Supposed reasons for this increasing time were rescheduling of operations from morning to afternoon, delay of the first operation of the day pushing back all operations of the day, and other different causes. Anyway this delay may enhance the organic response to trauma and may contribute to increasing the risk of postoperative complications.

On the other hand, various randomized trials,^{20,21} and meta-analysis²² conclude that early feeding after intestinal anastomosis is safe and may reduce both postoperative ileus and LOS. In addition, early postoperative feeding does not cause impairment of healing of gastrointestinal anastomosis.¹¹ We were able to implement a rapid re-introduction of the diet in patients who underwent both minor and major operations. Patients tolerate diet on either the same day after minor procedures or the next day of a major operation.

There were no modifications in peri-operative nutritional support data before and after the new protocol. This finding is mainly due to the previous concept in the former protocol that remained in the ACERTO protocol: undernourished patients should receive preoperative nutritional support for 7–10 days.

In elective operations, the concept of peri-operative restriction of intravenous fluids is increasing in the recent literature.²³ Regimens of restricted use of fluids are associated with less postoperative complications and shorten postoperative stay.²⁴ Generous intravenous fluids therapy increases body weight and may cause edema, pulmonary complications, and prolonged ileus.^{23–26} The implementation of the ACERTO protocol was associated with a significant fall of intravenous fluid prescription at both pre- and postoperative periods. Not only had the volume of fluids fallen but also the number of days of intravenous therapy. In minor procedures even the number of patients receiving intravenous therapy decreased. The new protocol reduced by 4-folds the total volume of fluids which represented in major operations a median reduction of 15 L of fluids per patient.

The ACERTO protocol abolished the use of preoperative mechanical preparation of the colon for elective colorectal operations. Mechanical bowel preparation is stressful for the patient and can result in both significant dehydration and electrolyte abnormalities.² Various recent meta-analyses have consistently documented that there is no benefit in cleansing the large bowel preoperatively and furthermore, this protocol may be harmful and increase the risk of colonic anastomotic dehiscence.^{27–29} The number of anastomotic dehiscences in this study was not increased after the new protocol.

Our findings are in complete agreement with other authors and guidelines that advocate the changing of the traditional routines.^{2,5,30} The principals of the ERAS protocol⁵ with a focus on stress reduction and promotion of return to function were confirmed by the present study. The adoption of the ACERTO protocol in our infirmary was followed by a significant fall of wound infection rate and faster recovery of the patients. In Latin America including Brazil, as far as we could find, there is no report of adoption of multimodal strategies of peri-operative care. The adopted strategy to change concepts and routines in our staff proved to be not only successful but also reproducible in other hospitals. The findings of this study may promote a significant change of concepts in other centers in this part of the world. Based on these results we conclude that the implementation of the ACERTO protocol based on the ERAS protocol reduced postoperative morbidity thus providing clear benefits for patients submitted to general operations, mainly on the digestive tract.

Conflict of interest disclosure statement

I and any of the other authors do not have an actual or potential conflict of interest relative to the manuscript "Enhancing surgical recovery in Central-West Brazil: The ACERTO protocol results" submitted to Clinical Nutrition.

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Statement of authorship: JEA-N conceived the study, carried out the data analyses, and drafted the manuscript.

AB-S participated in the study design, and coordinated the data collection. CC conceived the study, participated in the design of the study, and helped train the staff of the service. RMS, EAC, and TPS were in charge of whole data collection on a daily basis. All authors read and approved the final manuscript.

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