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Implementation of Enhanced Recovery After Surgery Protocol in a Second-level Hospital

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Abstract

Background: Enhanced recovery after surgery (ERAS) became standard perioperative care in the western world. However, little is known about the implementation of fast-track pathways (FTP) in developing countries. The objectives of the study were to assess the feasibility of the FTP program and adherence to the ERAS protocol in general surgery patients implemented in low-resource setting. *Methods*: In this retrospective, observational study, we evaluated perioperative care for elective and emergency surgical population changed in accordance with the ERAS program in a second-level hospital in Zambia. Ninety-eight patients aged two weeks to 87 years (median 32 years) with a male to female ratio of 2.3:1 and categorised by the American Society of Anaesthesiologists (ASA) in classes I to IV were included. Outcomes of interest were functional recovery, postoperative complications, length of hospital stay, and compliance with the protocol. *Results*: All elements of the ERAS protocol, including minimal access surgery (through mini-laparotomy incisions) and accelerated postoperative care, were employed. A successful recovery with discharge home by day 4 after the operation and the absence of complications and readmissions was achieved in 45.5% of patients. The postoperative period was complicated in 18.8% of cases, with a total mortality rate of 6.3%. The overall adherence level to the protocol was 72.2%. The highest levels of adaptation (≥95%) were reported for preoperative stratification, antimicrobial prophylaxis, modification of preanaesthetic medications, and prevention of intraoperative hypothermia. The poor compliance to the program was recorded for fasting and carbohydrate loading before surgery and postoperative thromboprophylaxis (17.9% and 21.4%, respectively). *Conclusion*: The study indicates that the employment of the ERAS program for the general surgery population at a second-level hospital is feasible and safe. It is possible to achieve a high level of adherence to the ERAS pathway in a resource-limited environment. A reasonable modification of the protocol can bring additional clinical benefits. Integrating elements of FTP into perioperative care and including the ERAS program in postgraduate education in developing nations is recommended. Further studies are needed, first, to frame ERAS pathways for application in emergency general surgery, and second, to present the local initiatives and identify barriers to the implementation of FTP in low-income countries.

Keywords: Enhanced Recovery After Surgery (ERAS); General Surgery; Fast-track Pathways (FTP).

1. Introduction

Due to the fast development of medical science and technology, Enhanced Recovery After Surgery (ERAS) has become an integral part of perioperative care in many countries [1, 2]. Initially created for elective colorectal procedures, this program was further developed for different specialized surgical populations [3–6]. The program includes targeted analgesia, goal-directed fluid therapy, minimally invasive techniques, and early postoperative mobilization [7]. The benefits and cost-effectiveness of fast-track pathways (FTP) were validated in multiple studies, including randomized controlled trials [8–10]. However, in spite of its many successes, ERAS still has a number of

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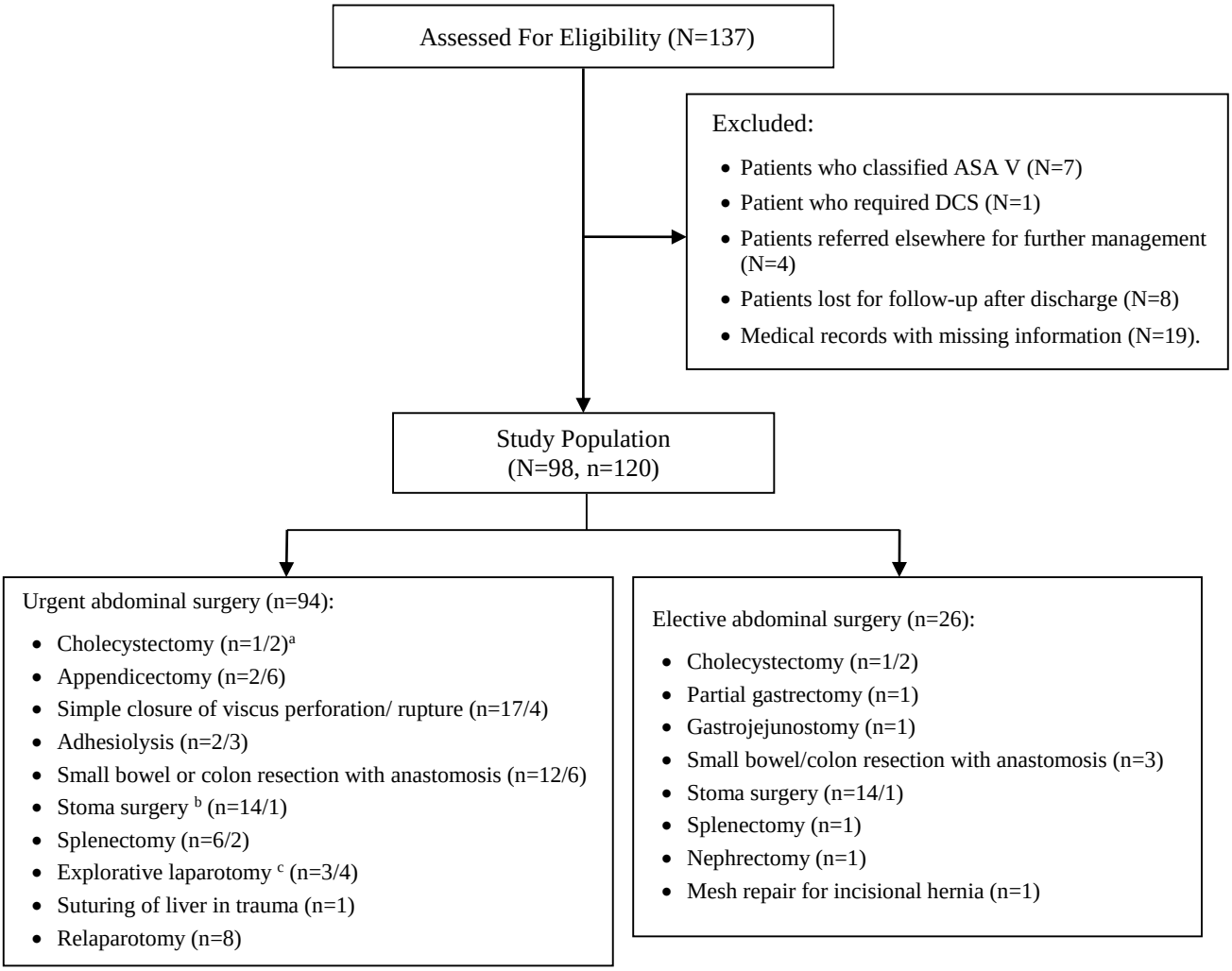
issues, and the implementation of accelerated stay programs remains challenging [11]. The reasons are manifold, including internal barriers (lack of awareness of current evidence-based literature, poor communication, particularly across disciplines, a belief that a particular hospital cannot support fast-track surgery protocols, etc.) and external barriers (insufficient number of support staff, lack of expertise in FTPs, and limited hospital resources) [3, 12].

This is particularly true for hospitals operating in low-resource environments having a reduced surgical workforce density and an urgent need to increase access to safe and timely surgical care [13]. The delay in the implementation of fast recovery protocols in the developing world is further magnified by the lack of research in this area. This study set out to address the 'implementation gap' between accumulated evidence of the effectiveness of the ERAS program (in western healthcare systems) and its adoption into clinical practice (in a resource-constrained environment). In particular, we were interested in how safe and feasible the FTP is for patients with elective and urgent abdominal conditions at a second-level community-based hospital in Zambia. Besides, we aimed to assess the level of compliance with elements of the ERAS protocol in our setting.

2. Materials and Methods

This study was designed as a retrospective review of the surgical database, and was carried out at Roan General Hospital, Zambia. Our community-based hospital is a second-level referral institution having a capacity of 164 beds and operates as the main medical center in the area with a population of 200,000. Participants were identified through operative case logs, and perioperative variables were obtained by the review of inpatient and ambulatory medical records. To minimize the time effect in interventions and reduce the risk of chronology bias (according to Kooistra et al. [14]), we employed a short inclusion period (of 18 months) and conducted the study without a historical control group. All consecutive patients operated on for elective and urgent abdominal conditions from March 2021 to September 2022 were assessed to enter the study; no age restrictions applied. Exclusion criteria are depicted in Figure 1.



N, number of patients; n, number of operations; ASA, American Society of Anaesthesiologists; DCS, damage control surgery

[a] Numerator defines procedures performed through a standard laparotomy incision; a denominator indicates a mini-laparotomy approach

[b] Defined as closure or creation of an end/diverting ileo- or colostomy performed with or without resection of the intestine

[c] Performed for acute pancreatitis (n=5), blunt abdominal trauma (n=1), and complicated pelvic inflammatory disease (n=1).

Figure 1. Flow diagram of the study population

ERAS was systematically introduced for general surgery as a quality improvement initiative at our hospital in March 2021. A new protocol of surgical care was presented to the hospital staff, and a multidisciplinary team consisting of three surgeons (one consultant and two senior registrars), two anaesthetists, trainees, nurses, physiotherapists, and a nutritionist was trained regarding FTP elements prior to the start of the project. Awareness of the change in perioperative management was checked through interpersonal communication. In study participants, corresponding components of ERAS were used in accordance with an interdisciplinary consensus review [7], starting from preoperative assessment and including final recommendations to the patients at the time of discharge from clinical care (Table 1). The preoperative management of patients and the timing of surgery depended on their clinical needs. Evaluation of patients scheduled for an elective procedure comprised of revealing and correcting coexistent medical morbidity, while management of patients admitted as urgent cases focuses on the immediate optimization of their conditions. The physical status of patients was classified using the American Society of Anaesthesiologists (ASA) scale [15]. To reveal accompanying physiological derangement, patients preparing for emergency laparotomy were screened using a validated quick Sepsis-related Organ Failure Assessment (qSOFA), as it was recommended in Guidelines for Perioperative Care for Emergency Laparotomy [2]. Patients and their relatives were routinely involved in the decision-making process, and discussion of fast-track surgery components was part of the informed consent procedure.

Table 1. Application of ERAS program in our hospital

ERAS item	Comments
1. Preoperative counseling and patient education on ERAS components	For elective patients performed routinely in the outpatient clinic, for urgent patients – on admission if time permitted
2. Preoperative stratification	ASA Physical Status Classification and qSOFA (in emergency patients) used
3. Optimization of pre-existing health conditions	Medical optimization performed pre-operatively. Routine preoperative HIV testing No routine bowel preparation for elective colonic surgery.
4. Preoperative fasting and carbohydrate loading	All patients fasted before the procedure. No carbohydrate loading used preoperatively
5. Antimicrobial prophylaxis and skin preparation	Single-dose antibiotic given at induction. Chlorhexidine-alcohol-based skin preparation. No routine skin shaving, no adhesive incise sheets available
6. Preanaesthetic medication	Long-acting anxiolytic and opioids avoided
7. Nasogastric intubation	Used in emergency patients. Nasogastric tube removed on POD1-2 when ≤300 ml/day. No routine use in elective surgery
8. Anaesthetic Protocol	Individualized depending on the ASA grade. Short-acting anesthetic agents
9. Preventing intraoperative hypothermia	Blankets used to cover the patient before procedure started. Ambient temperature in theatre is regulated by air-conditioner IV fluid therapy monitored using haemodynamic parameters and urine output
10. Minimally invasive surgery including laparoscopic/robotic approaches	Mini-laparotomy used when possible. Laparoscopic technique still not available
11. Intraoperative fluid and electrolyte therapy	Balanced crystalloids used as routine. Colloid solutions and inotropes considered in haemodynamically unstable patients
12. Drainage of the peritoneal cavity	Abdominal drains placed in cases belonging to the contaminated/dirty surgical wound classes [16]; removed when output ≤100 ml/day. No drains used to prevent or detect anastomotic leakage
13. Post-operative analgesia	NSAIDs alone or in combination with opioids used. Spinal/epidural analgesia not used postoperatively
14. Urinary catheter postoperatively	Removed in conscious and haemodynamically stable patients
15. Postoperative fluid management	Balanced crystalloid solutions were preferred. Monitoring of IV fluids aimed to achieve state of zero fluid balance
16. Thromboprophylaxis	Unfractionated heparin/LMWH started 8-12 hourly on POD 1 and continued till patient discharge
17. Early mobilisation	Physiotherapy started on POD 1. Out of bed on POD 2-3
18. Post-operative nutritional care	Clear liquids on POD 1as tolerated. Soft diet commenced as soon as possible
19. Discharge criteria	Afebrile Tolerance of meals without nausea or vomiting Passage of stool Adequately controlled pain Patient ambulating independently Adequate support at home

ERAS, Enhanced Recovery After Surgery; ASA, American Society of Anaesthesiologists; qSOFA, quick Sepsis-related Organ Failure Assessment; HIV, Human Immunodeficiency Virus; NSAIDs, Non-Steroidal Anti-Inflammatory Drugs; POD, post-operative day(s); LMWH, low molecular weight heparin

The plan for the intervention was discussed in detail with anaesthesiologist and we reached consensus in every case. Standard general anaesthesia protocol with full ventilator support was used in the majority of the patients. Local infiltration of the abdominal wall with lignocaine 0.5% (200–250 mg), moderate sedation with spontaneous ventilation, and oxygen support by mask, was employed in four patients with limited physiological reserve (chronic obstructive pulmonary disease or pulmonary tuberculosis, recent history of stroke, poorly controlled hypertension and diabetes, advanced Acquired Immunodeficiency Syndrome, and a combination of the above) and an estimated high risk of general anaesthesia.

In a selective group of patients, to reduce surgical stress, we practiced a mini-laparotomy (ML) approach to the abdominal cavity. ML was defined as a skin incision of less than or equal to 12 cm in length performed using traditional surgical techniques and instruments. A decision to use ML was taken after a critical assessment of possible risks and expected benefits for every particular patient. We did not attempt small incisions in obese patients with a body mass index of above 30, in cases of generalised peritonitis, abdominal malignancy, and for relaparotomy procedures. After the operation, patients were managed in the Intensive Care Unit or surgical ward, depending on their clinical condition. We mobilized the patients with the help of specially trained hospital staff. Mobilization started on postoperative day (POD) 1 with in-bed exercises and chest physiotherapy and continued thereafter with encouraging ambulation as tolerated.

The primary outcomes were functional recovery, the occurrence of intra- and postoperative complications, and hospital length of stay (LOS). Functional recovery was assessed by a resumption of oral intake, a return of bowel function, and sufficient mobilization. Successful patient recovery was defined as an uneventful postoperative period associated with return to normal physiological functions, discharge by POD 4, and absence of hospital readmission within 30 days of operation [17]. Morbidity was estimated according to Clavien-Dindo (C-D) classification [18] and was calculated as per operations when they represent a separate case or admission; a patient could undergo several procedures, both urgent and elective, different in their risk of postoperative complications and performed at various stages of surgical management with intervals ranging from seven days to eleven months. For example, morbidity for intestinal resection with stoma placement, stoma reversal, and repair of an incisional ventral hernia done in the same patient with repeated admissions is calculated separately. Likewise, the reversal of the stoma was considered a different case from the index procedure even if the patient underwent these two operations during the same hospital admission (as suggested by Alves et al. [19] and was done in three of our patients).

In cases of reoperations performed because of complications developed within 30 days of the postoperative period, even if it happened after discharge (in one of our patients), the morbidity rate has been adjusted so morbidity/mortality are attributed to the last procedure, and thus patients rather than operations were counted in the denominator. As a result of this calculation, the figures for elective and urgent cases exceed the number of patients enrolled in the study (see Figure 1). On the other hand, an admission- or case-related outcome report allows more sensitive mortality analysis, as, for example, a patient involved in staged operative management can approach different stages in different physical states, varying from ASA I to ASA IV class (depending on the developed systemic complications like Acute Respiratory Distress Syndrome, sepsis, or shock). A similar computation was produced by Timan et al. [20] in a study on emergency surgery and suggested in other reports [21, 22] to standardize the approach to evaluating the quality of surgical and anaesthetic services as a whole. Mortality was defined as death following surgery and before discharge from the hospital, or within 30 days of surgery, whichever is sooner [23]. LOS was counted from the day of surgery until the day of discharge. The discharge criteria were clearly outlined and standardized (Table 1). The pillars for decision-making included optimal pain control, appropriate bowel function, and adequate care support at home. If any of these factors seemed questionable, the patients remained in the hospital until a safe discharge was guaranteed. Readmissions were documented from the day of going home until 30 days postoperatively.

Apart from assessing clinical outcomes, we were particularly interested in a detailed evaluation of the ERAS program's implementation in the hospital. To perform such an analysis was recommended in a Joint Statement by the ERAS and ERAS USA Societies [24], and assessment of the adherence to the protocol was one of the principal aims of this study. We analyzed protocol compliance by calculating percentages of successful application of the individual interventions within the program. Eighteen components presented in Table 1 are assessed for adherence to the protocol except for the last one, discharge criteria, as delayed discharge could likely be a consequence of adverse postoperative events rather than the cause. The level of compliance for elective and urgent subgroups of the population was computed separately.

We used descriptive statistics to report the data obtained. Due to the skew distribution of the variables, continuous parameters were expressed as medians and ranges and analyzed with the Mann-Whitney test. Categorical data were presented as absolute figures and percentages and compared using a chi-squared test. Statistical significance was assigned at a 2-sided $p < 0.05$.

3. Results

Out of 137 patients operated on for elective and urgent abdominal conditions, 98 patients aged two weeks to eighty-seven years with a male to female ratio of 2.3:1 were included in the study (Table 1). Demographics and clinical variables are presented in Table 2. As our patients were generally young, medical comorbidities were uncommon (N = 9, 9.2%), and 74% of patients were classified as ASA scores I-II. However, one-fourth of emergency admissions were in complicated conditions of sepsis or/and shock, as reflected in the ASA score of IV. The patients were likely hospitalized as an urgent case rather than following an elective admission (Table 3), and these groups contrasted in their physical status (p=0.04). However, they were not significantly different in sex (p=0.2) and age (p=0.4).

Operations performed are presented in Figure 1. To reduce surgical stress, an ML with a median length of incision of 10.5 cm (range 6–12 cm) was used as a surgical approach in 33 operations performed in 32 patients. Incisions applied were midline (upper n=12, lower n=10), oblique in the right (n=4) and left (n=1) hypochondrium, and oblique in the right (n=4) and left (n=2) iliac fossae, and were used in both elective and emergency cases.

Table 2. Sociodemographic and clinical variables

Variables	N=98
Gender: Male	68 (69.4)
Female	30 (30.6)
Age: years, median; IQR	32; 22-48
Aetiology:	
Intestinal obstruction	33 (31.7)
Perforation peritonitis	20 (20.4)
Abdominal trauma	18 (17.3)
Acute appendicitis	11 (10.6)
Acute pancreatitis	6 (5.8)
Gastrointestinal tumour[a]	6 (5.8)
Acute/chronic cholecystitis	5 (4.8)
Other[b]	5 (4.8)
Co-morbidities:	
Hypertension	4
Acquired Immunodeficiency Syndrome	4
Chronic Obstructive Pulmonary Disease	2
Pulmonary Tuberculosis	2
Diabetes Mellitus	1
ASA grade:	
I	37 (33.0)
II	35 (31.3)
III	15 (13.4)
IV	25 (23.3)
ML: Elective	3 (12)
Urgent	28 (32.6)
Multiple surgery[c]	10 (10.2)
Length of stay, days, median; IQR	4.0; 3-7
Postoperative morbidity:	
Surgical site infection (C-D I, III)	8
Paralytic ileus (C-D I)	3
Dermatitis around the stoma (C-D I)	1
Enterocutaneous fistula (C-D II)	3
Postoperative wound dehiscence (C-D III)	3
Anastomotic leakage (C-D III)	2
Ongoing peritonitis (C-D III)	1
Total	21 (18.8[d])
Postoperative mortality:	
After elective surgery	0
After urgent surgery	7 (8.1[e])
Total	7 (6.3[d])

Values are number of patients with percentage given in brackets, unless indicated otherwise. N, number of patients; IQR, interquartile range; ML, mini-laparotomy, C-D, Clavien-Dindo grade.

[a] Except those caused intestinal obstruction.

[b] Included splenomegaly, hydronephrosis, complicated pelvic inflammatory disease.

[c] 4 patients had 3 operations and 7 patients had 2 operations as separate cases, these 10 patients therefore represent 24 operations. [d] calculated per total 112 cases

[e] Calculated per 86 emergency operations as separate cases.

Table 3. Elective and urgent admissions

		Elective, N=26	Urgent, N=86	*p*
Gender	Male	15 (58)	60 (70)	0.2[a]
	Female	11 (42)	26 (30)	
Age: years, median; IQR		32.0; 24.0-57.5	31.0; 21.0-43.0	0.4[b]
ASA I and II		21 (81)	50 (58)	0.04[a]
ASA III and IV		5 (19)	36 (42)	0.04[a]

Values are number of patients with percentage given in brackets, otherwise noted. N, number of patients; IQR, interquartile range; ASA, American Society of Anaesthesiologists; [a] Chi-squared test; [b] Mann-Whitney test.

In the study population, we did not encounter any life-threatening intraoperative events, and eight of the patients required blood transfusions during and/or immediately after the procedure. Successful patient recovery was achieved in 45.5% of patients (elective 46.2%, urgent 45.4%). Postoperative complications occurred in 18.8% of patients (Table 2), and most of them (N=17) were recognized during their stay in the hospital. Four patients were readmitted with complications developed within 30 days after discharge: postoperative wound infection (N=1), high-output colostomy (N=1), both managed medically, and adhesive intestinal obstruction (N=2) that required laparotomy and adhesiolysis in one patient and responded to conservative treatment in the other.

Seven patients died after surgery; all deaths occurred while patients were in the hospital after urgent procedures. The causes of death recorded were as follows: anastomotic leakage with peritonitis, sepsis, and multiple organ failure (N=1), septic shock without leakage (N=2), uncorrectable hypotension and respiratory failure in medically compromised patients (N=2), acute renal failure (N=1). One patient died on day 4 after an uncomplicated adhesiolysis procedure performed for intestinal obstruction, and the cause of death remains unknown as an autopsy was not performed. LOS for survived patients ranged from 1 to 47 days, with a median of 4.0 days. The reasons for a prolonged stay in the hospital were septic complications from the postoperative wound and abdominal cavity, paralytic ileus, and performing the stoma-reversal procedure during the same admission.

The overall rate of adherence to the ERAS protocol was 72.2% (Table 4). Compliance with individual ERAS components varied. The highest levels of adaptation (≥95%) related to preoperative stratification, antimicrobial prophylaxis, modification of pre-anaesthetic medications, and prevention of intraoperative hypothermia. Sufficiently high figures (91–92%) were recorded for balanced postoperative fluid management, timely removal of a urinary catheter, early mobilization, and nutrition.

Table 4. Compliance to ERAS components

ERAS item	Number of patient-cases			*p*[a]
	Total (N=112)	Elective (N=26)	Urgent (N=86)	
Preoperative				
Counseling and patient education	69 (61.6)	24 (92.3)	45 (52.3)	.0003
Stratification of operative risk	108 (96.4)	24 (92.3)	84 (97.7)	0.2
Optimization	96 (85.7)	23 (88.5)	73 (84.9)	0.7
Antimicrobial prophylaxis	109 (97.3)	24 (92.3)	85 (98.8)	0.08
Fasting and carbohydrate loading	20 (17.9)	13 (50)	7 (8.1)	<0.0001
Preanaesthetic medication	108 (96.4)	24 (92.3)	84 (97.7)	0.2
Intraoperative				
Nasogastric intubation	60 (53.6)	21 (80.8)	39 (45.4)	0.002
Anaesthetic protocol	98 (87.5)	20 (76.9)	78 (90.7)	0.06
Preventing intraoperative hypothermia	106 (94.6)	24 (92.3)	82 (95.4)	0.5
Minimally invasive surgical access	33 (29.5)	3 (11.5)	28 (32.6)	0.04
Balanced intravenous fluids	100 (89.3)	17 (65.4)	83 (96.5)	<0.0001
Drainage of the peritoneal cavity	66 (58.9)	19 (73.1)	47 (54.7)	0.1
Postoperative				
Opioid-sparing analgesia	46 (41.1)	13 (50.0)	33 (38.4)	0.3
Early removal of urinary catheter	102 (91.1)	23(88.5)	79 (91.9)	0.6
Balanced fluid management	103 (92.0)	19 (73.1)	84 (97.7)	0.0001
Thromboprophylaxis	24 (21.4)	8 (30.8)	16 (18.6)	0.2
Early mobilisation	102 (91.1)	24 (92.3)	78 (90.7)	0.8
Early nutrition	103 (92.0)	24 (92.3)	79 (91.9)	0.9
% Overall compliance, median; IQR	72.2; 66.7-83.3	83.3; 77.2-88.9	72.2; 61.1-77.2	0.00001

Values are number of patient-cases with percentage given in brackets, otherwise noted. IQR, interquartile range.

[a] represents the difference in compliance to ERAS protocol between elective and urgent patients; tested for individual ERAS items using chi-squared test, while percentage of overall compliance assessed by Mann-Whitney test.

We had the least success with the adoption of two FTP components, namely fasting and carbohydrate loading before surgery and postoperative thromboprophylaxis (17.9% and 21.4%, respectively). When we compared elective and emergency patients, we found the first group to demonstrate better overall compliance and more faithful adherence to elements of preoperative counseling, fasting, and nasogastric intubation. On the other hand, when FTP was applied for emergency patients, perioperative fluid management was more likely to comply with the ERAS Society recommendations.

4. Discussion

In this study, we present our experience in employing ERAS methodology at a second-level surgical hospital. Despite the importance of research in the area of perioperative care, there remains a paucity of evidence on fast-track surgery pathways in the developing world. A recent systematic review by Patel et al. [25] identified twenty-seven eligible articles on perioperative care pathways conducted in Low- and Middle-Income Countries (LMIC) published since the year 2000, and only one of them (in obstetrics and gynaecology) [26] was performed in Sub-Saharan Africa. The search of the literature additionally revealed two citations. Both are one-center, small-size longitudinal studies from the Republic of South Africa on the application of the ERAS protocol. Moydien et al. [27], used six elements of the FTP in penetrating abdominal trauma, and obtained a decrease in LOS with similar postoperative complications comparing with a historical control group. The researchers, however, did not analyze the level of compliance with the ERAS protocol. Loots et al. [28] analyzed the impact of FTP on the outcomes of 62 patients undergoing bariatric surgery and found a positive clinical effect of adherence to the ERAS protocol in the study population.

In our work, among the different steps of the implementation process described [29], we were particularly interested in three principal aspects, namely 1) fidelity, or compliance, which shows how the innovation corresponds to the originally designed protocol; 2) dosage, which characterizes how much of the initial program has been delivered; and 3) adaptation, which refers to modifications made to the program during the performance. In other words, we aimed to investigate whether it is possible to reproduce and to what extent we can deliver the original protocol of ERAS for the general surgery population in a resource-scarce setting, and if we could prioritize certain items of the FTP and omit the others with the hope for a better outcome in a particular case.

It is well known that components of the ERAS pathway positively affect all elements of preoperative investigation, the decision-making process, intraoperative management, and postoperative care [1, 6]. Some alterations to perioperative management standards are minimal or not to be changed, like, for example, antibiotic- or thromboprophylaxis [8], and this alleviates the implementation of the FTP into everyday clinical practice. Other changes require more determined attempts, for instance, reducing pre-operative fasting, early postoperative nutrition, and restricted use of tubes [30], and need to be encouraged and controlled. Certain ERAS interventions represent a novel approach to perioperative care, like the use of minimally invasive surgery. Because of their ability to reduce surgical stress and enhance functional recovery, these procedures became an integral part of FTP [7, 10]. These techniques include, and should not be limited to, laparoscopic and robotic procedures [31]. At our hospital, we practice an ML approach in elective and urgent abdominal surgery. Naturally, the employment of small surgical access requires a sufficient level of surgical competence, and this technique has its contraindications and challenges [32]. However, this component of ERAS should not be eliminated in a resource-constrained environment in the absence of expensive special surgical instruments. Having comparable clinical benefits with laparoscopy [32], ML could be considered a viable alternative to the latter approach if modern equipment and/or special surgical training are not available. What is particularly important from the patient's perspective is that minimal access procedures make a vital contribution to the positive effects of the ERAS program [33].

With this in mind, there is a risk that the employment of a mini-invasive technique can be considered the sole decisive factor in improving morbidity in surgery, bypassing other elements of the ERAS protocol [31]. Opposing this notion, Wijk et al. [3] in an international multicentre study of more than 2000 patients concluded that it is the combination of all the different elements of the ERAS protocol that makes an effective regimen for improved outcomes after surgery. A detailed analysis of a multi-nation database (Europe and New Zealand) with over 2,300 patients [34] demonstrated that both the use of laparoscopic surgery and increased compliance with the FTP independently reduced postoperative complications and shortened LOS. Researchers suggest that ERAS, as a multimodal optimization program, brings the cumulative benefit of marginal gains from individual items [35], and the total 'holistic' effect of FTP exceeds the sum of each intervention provided there is good adherence to the protocol [36]. It is therefore crucial to realize that the clinical success of accelerated stay pathways depends first of all on the quality of multidisciplinary collaboration between the patient and all care providers involved [11], and different components of the FTP are in fact equally valuable for a faster return to baseline physiological function. On the other hand, because of the variety of disciplines in which ERAS protocols are used, the individuality of the patient, their clinical condition, and the type of procedure being performed should also be factors in determining whether FTP is utilized. These considerations led to modifications to the protocol, for example, in terms of the number of ERAS elements applied to the population, from 4 [37] to 28 [6].

Chestovich et al. [38] do not recommend the use of an enhanced recovery protocol in emergent abdominal procedures for obstruction, perforation, and ischaemia. Ugarte-Sierra et al. [30], while acknowledging the benefits of the accelerated stay program, mentioned certain clinical issues in emergency surgery that are not easily amenable to ERAS principles. Indeed, in patients presenting with acute surgical conditions, preoperative counseling and education, called otherwise prehabilitation [39], are generally limited or impossible because of a lack of time, and we met this challenge in our work. Similarly, preoperative fasting can hardly be fully controlled, and carbohydrate loading is not recommended [2] in emergency abdominal conditions. The same considerations concern nasogastric intubation and drainage of the peritoneal cavity. In the acute setting, these measures could be found crucial to ensuring uneventful intra- and postoperative periods, and this practice is very difficult to change. Therefore, decisions on these interventions should be made on an individual basis, taking into consideration the pathology and patient factors [2]. Definitely, routine use of NGT and abdominal drains should be avoided [40].

Despite the challenges seen with the application of the ERAS protocol in an acute setting, Bugada et al. [33] suggested that fast-track surgery strategies may be of even greater advantage in such situations because of the higher mortality rate for emergency operations in comparison with similar elective procedures. This is in accordance with our research question, and we started implementing ERAS components with a special focus given to the urgent surgical population. The burden of urgent surgical conditions in the developing world is well known [41], and the prevalence of urgent procedures over elective surgery (3.3:1) in our study reflected the real-life situation in low-resource healthcare systems [21]. This fact, in our opinion, could justify the practice and encourage attempts to implement the ERAS protocol for the emergency surgical population in the developing world. In line with these suggestions, Oodit et al. [42] advocated a wide application of the ERAS framework to all general surgery populations in LMIC, including urgent procedures. Interestingly, Vashistha et al. [43] developed a special perioperative protocol for emergency surgical care, described it in the retrospective review article, and suggested its use in low-resource countries. Deeper insight into this program reveals that at least two out of five points of the protocol actually represent fast-track interventions corresponding to the ERAS components.

By contrast to Ugarte-Sierra et al. [30] and Chestovich et al. [38], but in accordance with Nelson et al. [8], we offered elements of the ERAS program to patients with ASA scores III and IV on preoperative assessment. We rationalized the inclusion of these critical patients by the following. First, we presumed that flexible employment of fast-track surgery components can give the critically ill patient an additional chance to recover. For example, the use of a mini-laparotomy with local anaesthesia and conscious IV sedation allowed us to avoid intraoperative complications and achieve an uneventful recovery in four of our high-risk patients who were deemed to be poor candidates for a general anaesthetic. Second, the proportion of patients presented with severe systemic disease, including sepsis and shock, is quite high among the urgent admissions (in our population, it was 29.6%), and eliminating these patients from the study may distort the real results of the surgery. Nonetheless, I have to admit that we eliminated cases with ASA Class V, as these moribund patients routinely need postoperative intensive care, and the application of FTP elements to them can be difficult or even impossible. Third, apart from ASA score V, we did not see in our patients a strong association between the Physical Status score and postoperative mortality, as four out of eight deceased patients scored I and II, while mortality among the ASA class IV sub-cohort was as low as 12% (3/23). I acknowledge, however, that this study was not powered to make assumptions about correlational relationships. Of note, Horvath et al. [15] in a review article on the evolution of the ASA Physical Status System indicated that the ASA Classification was not intended to be used as a predictor of surgical risk in any particular patient, and I see a clear rationale behind this statement. In my opinion, challenges with predicting postoperative morbidity could serve as an additional argument in favour of the wider application of the ERAS program components to the management of high-risk patients.

The use of FTP elements after an emergency operation may also be challenging. Patients undergoing major abdominal surgery may require a period of prolonged ventilation and circulatory support, which would limit early mobilization, timely removal of drains and tubes, and resumption of enteral nutrition. Nonetheless, Hajibandeh et al. [1] and Sethi et al. [44] posited that most components of ERAS pathways can be applicable and appropriate in the acute general surgery population. In our hospital, we faced certain challenges with multimodal intra- and postoperative analgesia, mostly because of a lack of special training and necessary equipment. Opioid IV analgesia remains the main method of controlling pain after the procedure in our setting. However, the application of mini-laparotomy incisions allowed us to reduce surgical stress and diminish the dependence on opioids postoperatively. Likewise, early patient mobilization with physiotherapy applied on POD 1 and ambulation out of bed started on POD 2-3 seem to enhance restoration of bowel motion and promote safe early discharge home. We feel that different elements of the ERAS protocol can reinforce one another, exerting a positive cumulative effect on postoperative recovery, and this assumption is confirmed by Malik et al. [5].

One interesting finding in the current study is a statistically significant difference in the application of a modified protocol for IV fluid management between urgent and elective patients. This aspect of perioperative care continues to be an issue of debate, and the optimal haemodynamic strategy remains to be defined, as the recent RCT [45] recruiting

401 patients undergoing major open abdominal surgery demonstrated similar outcomes after the application of goal-directed haemodynamic therapy versus restrictive normovolaemic therapy. Besides, this component requires particularly close collaboration between the surgical and anaesthesiological teams, and the resulting local protocol can deviate from the approach recommended. As an example, the maximum volume to be given in POD 1 varied among different authors from 1000 mL [46] to 2500 mL [47]. In our study, fully accepting the principle of restrictive IV fluid management, we nonetheless did not categorize the upper limit of IV fluids but instead focused on achieving a zero fluid balance using clinical and haemodynamic criteria. As a guideline, we applied the recommendations of the Enhanced Recovery Partnership [48] for IV fluid management, aiming to achieve by the end of the procedure the following: 1) patient temperature around 37°C; 2) no evidence of hypovolaemia or hypoxia; 3) no evidence of hypervolaemia or excess fluid; 4) haemoglobin above 7 g/dL; 5) no evident coagulopathy; 6) limited use of vasopressors. Regarding the choice of IV fluids, we used balanced crystalloids (Ringer's and Ringer-Lactate solutions) instead of 0.9% saline. The infusion of colloids (Gelofusine) was restricted to acute hypovolaemia when crystalloids were not considered sufficient, as suggested by Martin et al. [49]. Blood was transfused in acute bleeding with the haemoglobin dropped below 7 g/dL. As these elements properly correspond to the FTP and are more likely to be applied in acute abdominal surgery than during the less-volume elective cases in our hospital, the resulting compliance appeared to be different.

Thromboprophylaxis after surgery is another weak point in our perioperative care. Although our patients were commonly young, with rare incidences of medical comorbidities and a low risk of thromboembolic complications, and we routinely used non-pharmacological methods of thromboprophylaxis, this item is to be reinforced in clinical practice. The reasons for the low level of adaptation of this component could be attributed to the irregular supply of heparins to the hospital and the still low awareness among medical personnel about the spreading of non-communicable diseases in the developing world.

Recognizing the unique physiological and psychological characteristics of paediatric patients, we include seventeen operated children in the study. A review of the literature shows that ERAS interventions in paediatrics contribute to improved outcomes for patients and positively impact parents' satisfaction with the surgical process [4], and we anticipated clinical benefits for the children from their inclusion in the program. We understand that standard FTP principles applicable to adult patients may not be completely translatable to paediatric population. For example, no clear recommendations were found in the literature on the use of perioperative pharmacological thromboprophylaxis in children, so we focused on early mobilization and physiotherapy. At the same time, other components of the ERAS program may have exceptional weight in this population, and we applied them accordingly. For instance, we consider preoperative discussion with parents to be especially important for children, and whatever acute situation we faced, families were provided with full and timely information about the management process.

One of the valid concerns while using the FTP is patients' safety after enforced early discharge. The advantages of an accelerated stay program should be carefully weighed against the risk of missing postoperative complications [38]. This is especially true in a setting where transport is difficult and local nursing staff might not be sufficiently qualified. It is well known that early hospital discharge without sufficient recovery and a lack of competent support can increase both patient and family anxiety and may lead to readmission [12]. In our work, despite the priority given to early discharge of the patients, we allowed them to go home only when they were considered safe, with strict recommendations given on the timing and the process of follow-up. We had four readmissions (a 30-day readmission rate of 3.7%) because of developed postoperative complications, and interestingly enough, the rehospitalisation of two of these patients actually followed a prolonged stay in the hospital when they were chosen to be observed for a few more days after the procedure. Thus, late discharge cannot guarantee uneventful postoperative recovery in patients who underwent abdominal surgery. By contrast, among the patients discharged early (by POD 4), the incidence of complications requiring readmission was low (2/61, 3.3%). A similar phenomenon was reported by Delaney and co-workers [50], suggesting that it is not the early discharge in itself that prevents the complication; rather, late complications are likely to be developed in patients who are not doing well postoperatively in one way or another. It is therefore evident that a substantial body of evidence must be accumulated to create an accurate, objective predictive model to prevent readmissions within the ERAS concept.

Despite this being our preliminary experience with FTP in abdominal surgery, and the study design was not intended to demonstrate the efficiency of ERAS interventions in this setting (as it was shown by previous research on the topic [3, 51, 52], the obtained figures for LOS and morbidity/mortality appear to be comparable with the literature findings [1, 20, 22, 43]. We achieved figures for successful patient recovery comparable with other studies [17]. We saw that implementation of an accelerated stay program for our patients was associated with a sufficiently low rate of complications and readmissions and provided benefits for the patients and the hospital, likely enabling efficient management of resources.

Analysis of the application of ERAS components in this study showed good adherence to the protocol in both elective and emergency groups (Table 3). What is important is that this assessment helped to reveal the barriers and

facilitators to the implementation process, which in turn can be used to adapt the evidence to develop tailored interventions within the ERAS concept. Among the internal barriers to the successful implementation process in our hospital, we faced the following: 1) individual-level resistance to a new protocol based on traditional perceptions of perioperative care (thromboprophylaxis, preoperative fasting, and carbohydrate loading); 2) differences in anaesthesia providers and lack of specialized training on multimodal analgesia; and 3) high turnover of nursing staff leading to inconsistent communication. It is understandable that external, or organizational, barriers like limited financial resources, challenges with the electronic medical record system (reducing access to audit data, among others), and difficulties in the transportation system in the local rural area (endangering follow-up service), if properly addressed by policy-makers, can enhance the implementation of fast-track protocol into everyday practice. There are also patient-related constraints reflecting the low socioeconomic status of the population (leading to inadequate support at home) [53] and patient complex comorbidities (presenting as a high ASA score) [54] that currently limit wide employment of the ERAS protocol, but, in our opinion, they can be considered modifiable and warrant further research. Interestingly, the increased complexity of the ERAS guidelines was viewed [55] as both an obstacle and a facilitator of program implementation.

On the one hand, the multimodality of the program can be associated with poor adherence to the protocol and disruption to clinical practice. On the other hand, the diversity of the elements included allows healthcare professionals to test the components before widespread adaptation, and this 'trialability' [55] of the program is seen as a potential enabler. The researchers consider that pliability may act both as a facilitator if the protocol is modifiable and as a challenge if there are no clear and concise guidelines. An example of this is the study carried out by Slieker et al. [56], in which after the application of the original ERAS protocol for colorectal surgery to patients undergoing ileostomy closure, the incidence of postoperative complications and LOS remained unchanged. A critical audit and subtle modifications to the program done by the authors resulted in statistically significant improvements in the outcomes. It seems that the ability to standardize perioperative care with clear instructions while at the same time tailoring the care to the specific needs of different patients significantly facilitates the acceptance and incorporation of the ERAS program into surgical practice, ultimately leading to clinical benefits. Other facilitators to FTP recorded in the literature [53, 57] and related to our hospital are strong, motivating leadership of the program, including dedicated clinical nurses, effective communication within the team focusing on improving patient outcomes and comfort, and the possibility of sharing data about ERAS research and practice with the medical community, which was one of the goals of the present paper.

Taking these observations into account, the answer to our research question is yes: the ERAS pathway is the right choice of perioperative management in general surgery employed at a peripheral hospital. We see the incorporation of FTP into routine surgical practice in a low-resource environment as an incredible opportunity to standardize care, improve outcomes, save lives, and reduce healthcare costs. Implementation of elements of the ERAS program is in line with recommendations of the Global Surgery Foundation to improve surgical care in LMIC [58] and Zambia's first National Surgical, Obstetric, and Anaesthesia Strategic Plan [13]. At the time of the study, the ERAS® Society (www.erassociety.org) produced targeted guidelines for hospitals in LMIC [59], and we became particularly encouraged to intensify our efforts to refine the protocol of perioperative care following new recommendations. We feel that it is possible to extend the area of application of the program to include emergency patients and those admitted in critical condition, naturally, with some modification of the protocol or the use of selected interventions of ERAS. Our data suggest that a patient-centred individual approach with flexible application of FTP components could increase the chances for a safer and faster recovery in every particular patient. In this respect, I agree with Fawcett [12] that 'ERAS does not make bad surgery good, but it does make good surgery optimal.'

5. Limitations and Strengths

The generalisability of the study results is subject to certain limitations. This was a retrospective record review, and some data has inevitably been missed. A standard method of complete case analysis—to exclude patients with missing information—was employed. The research was based on a database from a single center and thus had a limited sample size. There is a risk that some patients, potential participants, may not survive the transfer to our hospital or be admitted in a critical condition with an ASA score of V and consequently be excluded from the study. At the same time, during the study period, we transferred four of our patients with complicated conditions to a higher referral institution. As a result, morbidity/mortality figures may be underreported. The research was designed and controlled by a single investigator, and this could lead to subjective assessments of the data. Clearly defined exclusion criteria and objective outcome measures, a detailed description of the demographics, intervention and processing of the data aimed to reduce selection and observer biases.

Among the advantages of the study are: first, this work represents a provincial initiative to change surgical care according to the principles of evidence-based medicine aiming to improve patient outcomes. As our hospital is peripheral, the sample investigated can be considered representative of the wider, predominantly rural population of the country. Next, this is a clinical study, so our results are close to those obtained in routine surgical practice, and

they might be considered sufficiently relevant. In general, by selecting a descriptive, "how-we-do-it", design for the study, we focused on practical aspects of the ERAS program implementation and gained valuable lessons during this work. We presume that our findings could be of some interest to the medical society. We hope our positive experience will facilitate the spread of the ERAS message across institutions, and our results can influence healthcare policy change in our country and other developing nations. We expect this paper will be useful in defining areas for future larger-scale clinical trials and experimental studies.

6. Conclusion

Patients undergoing abdominal surgery in a resource-scarce setting constitute a serious challenge, as most of them present with emergent and/or complicated conditions. In our institution, the introduction of the ERAS program led to a change in perioperative management towards increased use of the fast-track surgery pathway. We applied the ERAS protocol to elective and emergency surgical patients with a total compliance of 72% and achieved successful recovery in almost half of the study population. Together, the study results suggest that the application of the ERAS program for general surgery patients at a second-level hospital is safe and practicable. Judicious adjustments to the FTP protocol with respect to local resources and possibilities can be advantageous to selective patients. Therefore, incorporation of the fast-track protocols into routine surgical practice at hospitals operating in resource-constrained environments is recommended. In order to facilitate the further spread and adoption of the ERAS pathways worldwide, ERAS training programs should be offered to the medical community in developing nations.

The shortcomings of this research warrant new studies with a higher level of evidence. Future research should focus on the verification of the use of the ERAS approach in the emergency population and high-risk surgical patients. Besides, new studies, based in low-income countries and conducted with different methodological approaches, are required to present the local initiatives, describe facilitators, and identify barriers to the implementation of the enhanced recovery protocols in general surgery.

7. Declarations

7.1. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7.2. Funding

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7.3. Acknowledgements

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7.4. Ethical Approval & Institutional Review Board Statement

The work was conducted according to the ethical principles of medical research disclosed in the Declaration of Helsinki with all respect shown for the privacy and confidentiality of the personal information of the participants. Permission to perform the study and to publish results was obtained from the Ethical Committee of Roan Antelope General Hospital, Luanshya, Zambia. As it was a retrospective study of the database, the requirement for informed consent to participate in the study was waived by the hospital Ethical Committee.

7.5. Informed Consent Statement

Not applicable.

7.6. Declaration of Competing Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the author.

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