# Is it Possible to Reduce Costs while Improving Quality in Health?

Sağlıkta Kaliteyi Yükseltirken Maliyeti Düşürmek Mümkün mü?

Güşta Çeliker[1], Şemsi Mustafa Aksoy[1], Ümit Güner[2], R. Haldun Gündoğdu[3], Abdulkadir But[1], Mehmet Kılıç[4]

[1]Ankara Yıldırım Beyazıt University Faculty of Medicine, Department of Anesthesiology and Reanimation, Ankara, Turkiye
[2]Kütahya Dumlupınar University Faculty of Applied Sciences Department of Banking and Finance, Kutahya, , Turkiye
[3]Yozgat Bozok University Faculty of Medicine Hospital, Department of General Surgery,Yozgat, , Turkiye
[4]Eskişehir Osmangazi University Faculty of Medicine, Department of General Surgery, Eskişehir, Turkiye

**ABSTRACT**

**Background:** All over the world, how health services can be provided in better quality and more economical way has been continuously investigated. In this regard, the implementation of rapid recovery procedures called ERAS (Enhanced Recovery After Surgery) is becoming more widespread recently. In this study, we aimed to investigate the effect of the ERAS protocol on reducing health expenditures.
**Materials and methods:** Patients who underwent elective colorectal surgery in a public hospital between 2008 and 2018 were retrospectively reviewed following the approval of the Ethics Committee. The patients were divided into two groups as those who were applied ERAS protocol and treated with traditional methods. Patient billing information was requested from hospital management for analysis of treatment costs.
**Results:** It was observed that invoices of all patients were arranged according to the common price tariff (Healthcare Implementation Communique (HIC)) which public institutions are subject to. There was no difference between the ERAS group and the control group in terms of demographic characteristics, smoking and alcohol use history, body mass index (BMI) and ASA (American Society of Anesthesiologists) score. All costs examined were statistically lower in the ERAS group ($p < 0.001$). Duration of hospitalization, time to return to daily activities, readmission rates within 30 days after discharge, rate of complication and mortality were similar in both groups. In the postoperative period, the rate of admission to the ICU (Intensive Care Unit) was considerably higher in the control group ($p < 0.001$).
**Conclusion:** The implementation of the ERAS protocol provided both clinically positive effects and significant cost savings. A large percentage of the cost savings was achieved by a decrease in the rate of ICU stay.

**Keywords:** Enhanced recovery after surgery, ERAS, saving, cost, intensive care, HIC, colorectal surgery

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**ÖZET**

**Giriş:** Tüm dünyada daha nitelikli sağlık hizmetinin daha ekonomik olarak nasıl verilebileceği araştırılmaktadır. Bu kapsamda, ERAS (Enhanced Recovery After Surgery) denilen cerrahi sonrası hızlı iyileşme prosedürlerinin uygulanması son zamanlarda giderek yaygınlaşmaktadır. Biz de bu çalışmada ERAS protokolünün sağlık harcamalarını azaltmaya dönük etkisini araştırmayı amaçladık.
**Gereç ve Yöntemler:** Bir kamu hastanesinde 2008-2018 yılları arasında elektif kolorektal cerrahi geçiren hastalar Etik Kurul onayı alınmasını takiben retrospektif olarak incelendi. Hastalar, önce ERAS protokolü uygulananlar ve geleneksel yöntemlerle tedavi edilenler olarak 2 gruba ayrıldı. Tedavi maliyetlerinin analizi için gereken hasta fatura bilgileri hastane yönetiminden temin edildi.
**Bulgular:** Bütün hastaların faturalarının kamu kurumlarının tabi olduğu ortak fiyat tarifesine (SUT) göre tanzim edildiği görüldü. Gruplar arasında demografik özellikler, sigara ve alkol kullanım öyküsü, beden kitle indeksi ve ASA (Amerika Anestezistler Derneği) risk skorları açısından farklılık yoktu. Ameliyathane içi masraflar, yatış süresince kullanılan sarf malzemelerinin bedelleri, hastalara verilen tüm ayrıntılı tıbbi hizmetlerin bedelleri ve hasta başına düşen toplam fatura değerleri ERAS grubundaki hastalarda istatistiksel olarak anlamlı derecede daha düşüktü ($p<0,001$). Hastane yatış süresi, günlük aktivitelere dönüş süresi, komplikasyon, mortalite, taburculuk sonrası 30 gün içerisinde yeniden başvuru oranları her iki grupta benzerdi. Postoperatif dönemde Yoğun Bakım Ünitesine yatış oranı kontrol grubunda anlamlı olarak daha yüksekti ($p<0,001$).
**Sonuç:** Hasta tedavilerinde ERAS protokolü uygulanması hem yoğun bakım imkanlarının daha efektif kullanılmasını, hem de geri ödeme kurumunun (SGK) belirgin tasarrufunu sağlamıştır. Bu uygulamaların yaygınlaşması halinde en azından kolorektal cerrahi geçirecek hastaların masraflarında büyük bir azalma sağlanması öngörülmektedir. Bu protokollerin mükemmeliyet merkezi statüsü kazanmış kurumlarda daha başarılı olacağını, sağlanacak tasarruftan bir payın hastane ve sağlık personeline de yansıtılması halinde ise daha fazla motivasyon elde edileceğini değerlendirmekteyiz.

**Anahtar Sözcükler:** ERAS, tasarruf, maliyet, yoğun bakım, kolorektal cerrahi, SUT

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**ORCID IDs:** G.Ç. 0000-0003-3715-7207, Ş.M.A. 0000-0003-3197-5655, Ü.G 0000-0001-9630-8373, R.H.G. 0000-0002-7021-4827, A.B. 0000-0001-9635-9613, M.K. 0000-0002-4511-1527

**Address for Correspondence / Correspondence:** Ümit Güner, Kütahya Dumlupınar University, Faculty of Applied Sciences, Department of Banking and Finance, Kutahya, Turkiye E-mail: umit.guner@dpu.edu.tr

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## INTRODUCTION

After major surgeries, the transition to a full recovery period, return to normal physiological functions and discharge required a long process, which led to the search for solutions to these problems. After 2000, those who work on this issue came together to produce common protocols based on evidence, and they started publishing guidelines in scientific journals. These protocols were called as fast-track surgery, rapid recovery and ERAS (Enhanced Recovery After Surgery). In Turkey, from those guidelines, which is similar to each other, the most widely accepted one has been ERAS protocol, and the use of the guidelines is becoming increasingly common among health workers. This protocol offers benefits such as providing rapid recovery, decreasing morbidity and shortening the length of hospital stay, while not increasing mortality, readmission after discharge and complication rates; therefore, accelerates the adoption process among the health community.

The components of the ERAS protocol were first identified by Kehlet as 15, but the number of these elements was increased to 22 by other researchers (Table 1) (1,2).

In the ERAS program, the patient is brought to the optimum conditions for surgery by being informed, training, treatment of concomitant diseases and prehabilitation in the preoperative period. By maintaining physiological limits in the intraoperative period, it is ensured that the return to normal functions of the body is fast in the postoperative period. Thus, surgical stress is minimized. Despite all these positive results, ERAS has not yet been sufficiently adopted due to the multidisciplinary implementation of the protocol, the need for training of all members of the team, the need for self-dedication by practitioners, lack of economic return and the difficulty of changing traditional beliefs and practices.

In this period when health expenditures are increasing significantly, economic benefits as well as evidence-based medical benefits may be offered to increase compliance and contribution to ERAS. In our study, we aimed to investigate the economic effects of compliance with the ERAS protocol in patients who underwent colorectal surgery in public hospitals.

**Table 1.** Elements of the ERAS protocol

| |
|---|
| Preoperative information and education of the patient |
| Prehabilitation and optimization |
| Assessment of nutritional status and nutritional support if necessary |
| No mechanical bowel cleansing |
| Prophylaxis of thromboembolism |
| Avoid long-acting drugs for premedication |
| Preoperative prophylactic antibiotic administration |
| Shortening the preoperative fasting period |
| Administration of oral glucose solutions up to 2 hours before surgery |
| Use of regional anesthesia and short-acting anesthetics |
| Ensuring appropriate fluid volume in perioperative period |
| Short surgical incision selection (minimally invasive approach, transverse incisions) |
| Prevention of perioperative hypothermia |
| Multimodal management of postoperative nausea and vomiting |
| Opioid-free analgesia selection |
| Non-routine use of nasogastric tube and surgical drain |
| Early removal of urinary catheter |
| Stimulation of gastrointestinal motility, use of prokinetics |
| Early enteral nutrition and effective control of blood sugar |
| Early mobilization |
| Determination of discharge criteria, patient follow-up, and control of results |

## MATERIALS and METHODS

This study was initiated with the approval of Ankara Yıldırım Beyazıt University Faculty of Medicine Clinical Research Ethics Committee decision no. (42) of 21.02.2018. Patients who underwent elective colorectal surgery with the same diagnosis between 2008 and 2018 at the Atatürk Training and Research Hospital were evaluated retrospectively. The number of patients who were applied ERAS protocol was 93. Another 93 patients to whom ERAS was not applied were selected as the control group. 38 patients who underwent simultaneous surgical intervention on an organ other than colorectal surgery (liver, spleen, etc.) and were taken to the emergency operation were excluded from the study. In the ERAS group, there were 71 patients (47 in the colon group and 24 in the rectum group), and there were 77 patients in the control group (49 in the colon group and 28 in the rectum group).

Data about the patients such as implementation of the ERAS elements specified in Table 1, the presence of local or general complications, readmission within 30 days after discharge, the number of days spent to return to daily activities after discharge, the total number of days of hospital stay were obtained from patient files in the hospital archive, HIMS (Hospital Information Management System) and direct communication with patients. Cost analysis was performed by examining the data obtained from the hospital billing unit.

The billing tariff list for the devices used for the treatment of patients and the services provided is common and obligatory for all public hospitals. These lists are published by SSI (Social Security Institution) under the name of Health Implementation Communique and updated annually. In HIC, pricing determined as a fixed package price for some surgeries. If the fixed package price has been determined for the treatment, hospitals must use this value without taking actual costs into consideration during the billing process. If there is no fixed package price listed for surgery, transactions will be charged for each item separately, provided that they are still stuck to the HIC list.

In the cost analysis, six different cost amounts (patient service amount, total cost, intraoperative cost, HIMS invoice amount, GHI (General Health Insurance) invoice amount, invoice amount on the second admission) were evaluated. Patient service cost, total cost, and intraoperative cost are the amounts calculated by us using the data provided to assess the economic impact of the protocol on the hospital.

Patient service invoice amount; when the fixed package price is assumed to be absent, it is the sum of the cost of materials used and the medical service fees given to the patient. Intraoperative cost; this is the total cost amount in the operating room without including the fixed package price implementation. Total cost; it is the sum of the costs such as material fees and medicine expenditures, which doesn't require human labor (establish vascular access, catheter insertion, room cleaning, etc.).

HIMS and GHI invoice amounts; are the official amounts which are reflected on the invoice. HIMS invoice amount; is the service price calculated by the hospital software system according to the HIC tariff for the materials used and the service provided to the patient without taking fixed package price into account, and the software used is inspected by the Ministry of Health. Since the GHI invoice is calculated by including the fixed package price, the HIMS invoice is lower than the GHI invoice. The amount of GHI is the amount paid by the SSI which constitutes the actual income of the hospital.

Invoice on the second admission; This is the total invoice amount for the patients who need to be hospitalized within 1 month after discharge.

*Statistical analysis*

Statistical analyses were performed using IBM SPSS Statistics 17.0 program (IBM Corporation, Armonk, NY, USA). Kolmogorov Smirnov test was used to determine whether the distribution of continuous numerical variables was close to normal and the homogeneity of the variances was investigated using the Levene test. Descriptive statistics were reported as mean ± standard deviation or median (minimum-maximum) for continuous numerical variables, and the number of cases and percentage (%) for categorical variables.

Student's t-test was used to examine the significance of the difference between the groups in terms of mean values, and the Mann Whitney U test was used to examine the significance of the difference in terms of continuous numerical variables and orderable variables where parametric test statistics assumptions were not met.

Categorical variables were analyzed by means of Fisher's exact test, Pearson's chi-squared test and the continuity corrected chi-square test. P-value < 0.05 was considered statistically significant. However, Bonferroni Correction was performed in the present study to check for Type I error in all possible multiple comparisons.

## RESULTS

The distribution of age and sex, working status, education status, smoking, mean body mass index, ASA scores (Table 2), diagnosis and type of operation (Table 3) were statically similar in the control group and ERAS group ($p > 0.05$).

**Table 2.**Demographic and clinical features

| | Control (n=77) | ERAS (n=71) | p-value |
|---|---|---|---|
| **Age (years)** | 60.2±12.2 | 61.2±12.0 | 0.592† |
| **Sex** | | | 0.221‡ |
| **Male** | 54 (%70.1) | 42 (%59.2) | |
| **Woman** | 23 (%29.9) | 29 (%40.8) | |
| **Job** | | | 0.611¶ |
| **Not working** | 18 (%25.0) | 20 (%32.8) | |
| **Retired** | 24 (%33.3) | 18 (%29.5) | |
| **Working** | 30 (%41.7) | 23 (%37.7) | |
| **Education status** | | | 0.868$ |
| **Not literate** | 8 (%10.8) | 5 (%8.2) | |
| **Literate** | 0 (%0.0) | 1 (%1.6) | |
| **Primary school** | 38 (%51.4) | 33 (%54.1) | |
| **Middle school** | 5 (%6.8) | 5 (%8.2) | |
| **High school** | 12 (%16.2) | 9 (%14.8) | |
| **University** | 11 (%14.9) | 8 (%13.1) | |
| **Smoking history** | | | 0.070¶ |
| **Never** | 66 (%85.7) | 47 (%70.1) | |
| **Ex-smokers** | 3 (%3.9) | 7 (%10.4) | |
| **User** | 8 (%10.4) | 13 (%19.4) | |
| **Alcohol history** | 1 (%1.3) | 0 (%0.0) | - |
| **BMI (kg/m²)** | 27.3±4.5 | 27.8±6.0 | 0.526† |
| **ASA** | | | 0.279$ |
| **I** | 29 (%37.7) | 28 (%40.0) | |
| **II** | 38 (%49.4) | 34 (%48.6) | |
| **III** | 10 (%13.0) | 8 (%11.4) | |

† Student's t-test, ‡ Continuity corrected chi-square test, ¶ Pearson's chi-square test, $ Mann Whitney U test.

**Table 3.**Frequency distribution of cases according to surgical procedure

| | Control (n=77) | ERAS (n=71) | p-value |
|---|---|---|---|
| **Abdominoperineal resection** | 8 (%10.4) | 7 (%9.9) | 0.999† |
| **Low anterior resection** | 20 (%26.0) | 17 (%23.9) | 0.924† |
| **Right hemicolectomy** | 16 (%20.8) | 22 (%31.0) | 0.218† |
| **Left hemicolectomy** | 9 (%11.7) | 3 (%4.2) | 0.174† |
| **Subtotal resection** | 4 (%5.2) | 1 (%1.4) | 0.369‡ |
| **Transverse colectomy** | 5 (%6.5) | 6 (%8.5) | 0.889† |
| **Sigmoid resection** | 15 (%19.5) | 15 (%21.1) | 0.965† |

† Continuity corrected Chi-Square test, ‡ Pearson's Chi-Square test, ¶ Fisher's exact test.

Frequency of diabetes (DM), hypertension (HT), chronic obstructive pulmonary disease (COPD), coronary artery disease (CAD) and other comorbidities were also similar in both groups (p > 0.05).

There was no statistically significant difference between groups (p > 0.05) regarding postoperative hospital stay, hospitalization, preoperative and postoperative chemotherapy (CT) intake, time to return to daily activities, readmission, mortality, local and general complication rates (Table 4).

**Table 4.**Intraoperative and postoperative findings

| | Control (n=77) | ERAS (n=71) | p-value |
|---|---|---|---|
| **Intraoperative fluid replacement (l)** | 2500 (1000-5000) | 2500 (1500-6000) | 0.930† |
| **Intraoperative blood replacement** | 5 (%7,1) | 2 (%2.9) | 0.441‡ |
| **Processing time (min)** | 180 (90-300) | 150 (90-330) | **0.002**† |
| **Postoperative drain removal day** | 6 (3-32) | 4 (2-11) | **< 0.001**† |
| **Postoperative NG removal day** | 2 (0-10) | 0 (0-1) | **0.014**† |
| **Postoperative urinary catheter removal day** | 6 (2-15) | 3 (2-15) | **< 0.001**† |
| **First flatulation day** | 3 (1-5) | 3 (1-5) | 0.735† |
| **First defecation day** | 5 (2-9) | 3 (1-6) | **0.040**† |
| **Postoperative fluid food start day** | 4 (1-15) | 1 (0-13) | **< 0.001**† |
| **Postoperative solid food intake day** | 5 (2-16) | 2 (1-14) | **< 0.001**† |
| **Complication** | | | |
| **No** | 63 (%82.9) | 52 (%73.2) | 0.223¶ |
| **Local** | 4 (%5.3) | 10 (%14.1) | 0.124¶ |
| **General** | 9 (%11.8) | 9 (%12.7) | 0.999¶ |
| **Readmission rate** | 4 (%5.2) | 4 (%5.6) | 0.999‡ |
| **Day of return to daily activities** | 30 (3-45) | 15 (3-45) | 0.228† |
| **Mortality after discharge** | 7 (%9.1) | 1 (%1.4) | 0.065‡ |

† Mann Whitney U test, ‡ Fisher's exact test, ¶ Continuity correction chi-square test. NG: Nasogastric tube

In the postoperative period, the rate of admission in the ICU was significantly lower in the ERAS group than in the control group ($p < 0.001$) (Figure), but there was no statistically significant difference in terms of length of stay in the ICU ($p = 0.104$).

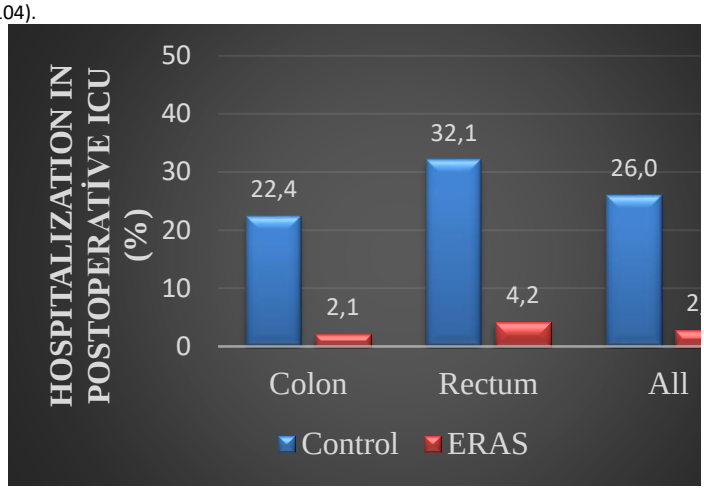


**Figure:** The rate of hospitalization in the intensive care unit during the postoperative period

According to the findings obtained from the study, ERAS protocol elements such as short-acting anesthetic use, no premedication, thromboembolism/antibiotic prophylaxis, respiratory rehabilitation, pain assessment, and glucose level management were applied at the same rate in patients in the ERAS group as well as in the control group. Being informed about ERAS, carbohydrate loading, management of nausea and vomiting by anesthesia team, use of warming blankets in the intraoperative period to provide normothermia were applied only in the ERAS group. Use of epidural catheters, lack of bowel cleansing, early mobilization (2 hours in the first day, at least 6 hours in the following days), early oral intake, early removal of drains and catheters were applied to the ERAS group at a higher rate than the control group (Table 5). These differences, observed in the rates of protocol implementation between the groups, formed the basis of financial and clinical results.

**Tablo 5.**Implementation rates of ERAS procedures

| | Control | | ERAS | | p-value |
|---|---|---|---|---|---|
| | N | n (%) | N | n (%) | |
| **Preoperative information and education(*)** | - | - | 71 | 71 (100.0) | - |
| **Use of short-acting anesthetics** | 71 | 71 (100.0) | 67 | 67 (100.0) | - |
| **Fasting from preoperative night (solid foods)** | 77 | 9 (11.7) | 68 | 4 (5.9) | 0.352† |
| **Preoperative carbohydrate loading** | - | - | 18 | 17 (94.4) | - |
| **Bowel preparation** | 66 | 63 (95.5) | 68 | 12 (17.6) | **< 0.001**‡ |
| **Premedication** | 77 | 0 (0.0) | 68 | 0 (0.0) | - |
| **Thromboembolism/Antibiotic prophylaxis** | 77 | 77 (100.0) | 68 | 68 (100.0) | - |
| **Risk assessment of nausea and vomiting** | - | - | 43 | 43 (100.0) | - |
| **Epidural catheter usage** | 70 | 3 (4.3) | 67 | 21 (31.3) | **< 0.001**† |
| **Postoperative pain assessment** | 69 | 69 (100.0) | 54 | 54 (100.0) | - |
| **Respiratory rehabilitation** | 33 | 33 (100.0) | 57 | 57 (100.0) | - |
| **Glucose level management** | 27 | 27 (100.0) | 19 | 19 (100.0) | - |
| **Chewing gum** | - | - | 44 | 44 (100.0) | - |
| **Mobilization on postoperative day 0** | 3 | 3 (100.0) | 50 | 49 (98.0) | - |
| **Mobilization on the first postoperative day** | - | - | 44 | 44 (100.0) | - |

N: Total number of cases in which the procedure can be questioned, n: Number of cases in which the procedure was performed, † Continuity corrected Chi-Square test, ‡ Pearson's Chi-Square test.
(*)The number of patients who were evaluated and informed by the ERAS team (surgeon, anesthesiologist, nurse) in the preoperative period was 43. The remaining 28 patients were evaluated and informed only by the surgeon in years before 2013.

According to the results of the cost analysis, patient service invoice amount, total cost, intraoperative cost, HIMS invoice amount and GHI invoice amount were significantly lower in the ERAS group than the control group ($p < 0.001$) (Table 6). Since the readmission rate was very low, no statistical comparison could be made on the invoice amount in the second hospitalization (this invoice amount did not reach at a significant level to be included in the cost analysis in the subgroups).

**Tablo 6.**Cost levels according to groups among all cases (TL)

| | Average | Standard Deviation | Median | Lowest | Highest | p-value † |
|---|---|---|---|---|---|---|
| **Patient service invoice amount** | | | | | | **< 0.001** |
| Control | 4528.77 | 1759.79 | 4186.65 | 2080.53 | 13452.88 | |
| ERAS | 3553.17 | 1911.44 | 3108.79 | 1494.45 | 10626.75 | |
| **Intraoperative cost** | | | | | | **< 0.001** |
| Control | 2592.67 | 893.70 | 2462.30 | 1072.91 | 5792.79 | |
| ERAS | 2374.30 | 1589.23 | 1858.31 | 1035.84 | 9977.23 | |
| **Total cost** | | | | | | **< 0.001** |
| Control | 1831.79 | 1241.33 | 1526.76 | 3.40 | 7648.81 | |
| ERAS | 1341.12 | 1205.35 | 987.68 | 177.04 | 6997.51 | |
| **HIMS invoice amount** | | | | | | **< 0.001** |
| Control | 3549.34 | 1660.84 | 3396.73 | 0.00 | 8124.86 | |
| ERAS | 2574.00 | 1062.64 | 2377.76 | 0.00 | 5409.07 | |
| **GHI invoice amount** | | | | | | **< 0.001** |
| Control | 3485.67 | 1717.26 | 3354.12 | 0.00 | 8081.79 | |
| ERAS | 2559.35 | 1409.73 | 2232.73 | 0.00 | 9736.50 | |
| **Invoice amount on the second admission** | | | | | | - |
| Control | 1119.21 | 1067.90 | 892.64 | 81.42 | 2610.16 | |
| ERAS | 1208.93 | 1506.34 | 1208.93 | 143.78 | 2274.07 | |

† Mann Whitney U test.

When patients who underwent colorectal surgery were divided into subgroups (colon surgery and rectal surgery) according to the types of surgery; for those who underwent colon surgery, all cost amounts were lower in the ERAS group compared to the control group ($p < 0.001$). When the patients who underwent rectal surgery were evaluated, the invoice amount of patient service, intraoperative cost, and total cost were lower in the ERAS group compared to the control group, but this difference did not reach statistical significance ($p = 0.061$, $p = 0.263$, $p = 0.304$, respectively). However, the HIMS invoice amount and GHI amount were significantly lower in the ERAS group ($p < 0.001$, $p = 0.003$, respectively).

## DISCUSSION

As a result of population growth together with scientific and technological developments, the number of surgeries increases seriously all over the world. This number was reported to reach 310 million worldwide in 2012 (3). In the studies, the probability of occurrence of complications after surgical procedures was determined to be 16%, and this situation increased the mortality five times. The mortality rate following uncomplicated surgery was less than 1% (4). Considering all these rates, improving the management of an increasing number of surgical cases should be among the primary objectives in the medical field. It is aimed to spread the ERAS protocol, which is designed for this purpose, worldwide and to increase compliance with the protocol. One of the most important factors in the implementation of the protocol is whether it has an economic return. We designed this study to evaluate the barriers to ERAS and the clinical and financial results of the protocol.

ERAS implementation requires teamwork and takes more time for patients than traditional methods. Since there is no ERAS training nurse in our hospital, a protocol was applied with a volunteer nurse brought from outside to our institution. In addition to this, since the number of surgeons who adopted the procedure was limited, the number of patients in the ERAS group could not be increased further in order not to prolong the working time.

In our study, the number of cases was sufficient in terms of statistical analysis in the evaluation of patients who underwent colorectal surgery. However, when we analyzed the patients who underwent colon and rectal surgery into separate groups; as the number of cases was not sufficient, although the numerical differences in some of the results among the groups were obvious, they were not statistically significant. Increasing the number of cases will enable the studies on the same subject to provide more informative results in terms of subgroups.

The increasing number of elderly populations in the world and despite the additional diseases of elderly patients, the need for many surgical procedures and the high mortality/morbidity rates make the surgical process management more important in these patients.

Although the ERAS program is avoided in high-risk patients, many studies have reported that the group that has benefited the most from the ERAS protocol is the high-risk group (5,6). Therefore, elderly patients (65-85 years) and comorbidity patients were also included in our study. 60% of the ERAS group consists of ASA 2-3 patients. When the mortality rates of the ERAS and the control groups were compared, although the mortality rate was lower in the ERAS group, it did not reach a statistically significant level (9.1% vs. 1.4%) (Table 3.3).

In a study conducted on more than 900 patients examining compliance with ERAS protocol in colorectal surgery, it has been observed that postoperative complications, 30-day morbidity, and readmission rates were significantly reduced compared with compliance with ERAS at 70% and above, and compliance with less than 50% (7). In our hospital, due to the shortage of personnel who believed in ERAS, the desired level of compliance with the protocol components could not be reached. We think that the failure to achieve the expected decrease in the rates of complications, mortality, and morbidity in the ERAS group depends on this limitation.

One of the claims of ERAS is that it reduces hospital stay. However, this situation causes concerns about the increase in hospital admissions and complications after early discharge. When traditional methods are used for open surgery, the need for a hospital stay of approximately 8-10 days, reaching 20% of surgical site infections and 35% of readmission after discharge, reveals the need for maintenance revision in colorectal surgery (8). Therefore, colorectal surgery is the surgery in which the ERAS protocol is first applied. Stephen et al. evaluating 138 patients who underwent colorectal surgery, found that the length of hospital stay in the ERAS group was lower than those in the control group, although not statistically significant (6.6 ± 3.3 days versus 3.7 ± 1.5 days) (9). In a meta-analysis of 4 randomized controlled trials; compared with conventional methods and ERAS in colorectal surgery, it was found that the complication rate and length of hospital stay were significantly reduced, and there was no significant difference in readmission rates (10). In the literature, it was reported that ERAS reduced the duration of hospitalization from 7 days to 3 days (11), and from 7 days to 5 days (12) in patients undergoing colorectal cancer surgery. In another study, this period was shown to be shortened by 2 to 4 days (13). In our study, the mean postoperative hospital stay was 9 days in both groups. The total length of hospital stay was 9 days in the ERAS group and 11 days in the traditional group, but this 2-day difference was not statistically significant. Despite drainage and catheter withdrawal, early feeding and early mobilization of patients in the ERAS group, the discharge was delayed. (Table 3.3, Table 3.4). We believe that this situation is due to the inability to change the wrong habits established in our society, the lack of health literacy yet, the majority of the patients coming from outside the city, and their anxiety about the problems that may develop after discharge and the lack of trained ERAS teams.

One of the aims of ERAS teams should be to increase the confidence of patients in early discharge, thus shortening the length of hospitalization Like most tertiary hospitals in our country, our hospital has a bed occupancy rate of 100%. Shortening the length of stay will allow more patients to be served. In this way, it will not only increase the satisfaction of the patients waiting for the time of hospitalization but will also bring a higher saving because the bed usage efficiency is provided.

One of the most important health problems in our country; because of the limited number of intensive care beds in hospitals and high demand, many patients have to be followed up in the emergency department despite the need for intensive care. In a recent study, 40% of the intensive care beds were reported to be composed of perioperative care patients (14). Improving perioperative care and reducing the need for intensive care for patients who will undergo elective surgery will provide room for patients with general condition disorder, need for organ support, and need for multi-trauma or other emergency surgery. One of the most important results of our study is the significant decrease in the need for intensive care unit admission in the postoperative period with the implementation of ERAS. (ICU admission rate; 2.8% in ERAS group; 26% in traditional group) (Figure). Although the age, comorbidity and ASA scores of the patients in the two groups were similar (Table 3.1), the decrease in the need for intensive care was achieved by ERAS. ERAS not only reduces the need for intensive care hospitalization and increases the efficiency of the intensive care unit, but also reduces the cost of intensive care hospitalization, which is quite costly. In a study of 117 patients who underwent liver resection, the rate of patients who were referred to the postoperative intensive care unit decreased significantly in the ERAS group (87% versus 20%; $p < 0.001$), and there was no difference in complication, mortality and readmission rates. In addition to this, hospital cost was significantly lower in the ERAS group. All the data obtained in this study, except for the type of surgical procedure, have similar characteristics to our study (15).

Recently, the impact of ERAS implementation on cost has started to be emphasized in Turkey and the entire world. In the cost analysis of Stephen et al., the hospital cost of the ERAS group was calculated to be 2 240 $ less cost than the control group (9 310 ± 5 170 $ versus 7 070 ± 3 670 $). This reduction in cost was achieved without affecting the complication and readmission rate (9).

When the financial results of our study shown in Table 3.5 are evaluated, it is observed that the ERAS group provides an advantage in all costs and this advantage arises most from the decrease in the need for intensive care. The reduction of the official invoice amount concerning the SSI will please the central government. In our country, SSI covers the treatment costs of 98% of the patients applying to public hospitals. 84% of these patients were paying his own premium, and 14% were from the green card group whose treatment costs were directly covered by the government due to difficulties in paying premiums. SSI usually does not give individual prices to the procedures applied to the patient. Many operations are subject to a fixed package price to prevent invoicing of the components of surgery and treatment separately. This gives the institution an economic advantage, while the money entering the hospital vault decreases. Therefore, it is undesirable for hospital administrations to reduce the invoice amount. However, since both the operating room costs and all the material costs will be reduced, the hospital management will not be worried even though the total invoice amount has been reduced.

The savings shown in our study were achieved despite the lack of a trained ERAS team and the possibility to implement all of the elements of ERAS. With the completion of the training and increasing the number of the team members, we consider that the length of hospital stays and the return to daily life will be significantly shortened and greater savings can be achieved. Expenditures for the training of the ERAS team may put a certain financial burden on management. However, it has been shown in many studies that the cost to be allocated for education will drop to a negligible level with the spread of application. In New Zealand, a study of 100 patients undergoing elective colon surgery comparing the two groups with ERAS and standard treatment, the cost of training in ERAS was compensated after 15 patients. And a savings of 6 900 New Zealand Dollars (NZD) per patient was achieved (training cost of ERAS; 2 000 NZD per patient) (16). Since historical records of the hospital were incomplete, education expenditures could not be included in our calculations. Although we were unable to evaluate the cost of education of general surgery and anesthesia physicians, we think that these costs are not large enough to affect the outcome.

In a cost-effectiveness study conducted by Gerardi et al without the inclusion of ERAS training costs, a cost reduction of $ 5 410 per patient was reported ($ 25 110 versus $ 19 700; p=0.028) (17). In another study in which 1626 patients were evaluated, ERAS saved 73-83% and made a profit of $ 1 768 ($ 920 – $ 2 619) per patient (18). Unlike other studies (16,17,18) in which cost analysis is calculated per patient, a study conducted in the United States based on annual hospital costs, net savings were reported to be $ 395 717 per year (19).

In an ERAS cost analysis conducted in Canada, social costs were calculated besides the hospital costs. Different costs such as hospital services, outpatient health service after discharge, community health service, caregiver cost, and loss of workforce of the patient were also included in the total cost. In the study, which included a total of 190 patients, the cost of ERAS was calculated to be $ 153 and the ERAS group saved $ 2 985 per patient. As a result, when all costs, especially social costs are taken into consideration, almost 100% savings were achieved thanks to ERAS (20). In our study, in order to evaluate the social costs, the loss of labor of the patients, the need for caregiver after discharge and loss of labor if the care of the patients were performed by one of their own families were questioned. However, the results could not reach statistical significance, as the effective evaluation could not be made due to patients' difficulty of remembering. If social costs could have been evaluated, we think that the cost savings would be more.

lthough ERAS achieves better clinical outcomes and contributes to health economics by using resources more efficient, it is an issue that needs to be considered why ERAS has not yet become standard practice. It should also be remembered that the results obtained in colorectal surgery can be obtained in other surgical areas. In order for the application to become widespread, the centers using the ERAS protocol should be structured as centers of excellence and the qualities that these centers will bear should be determined. It is thought that it would be beneficial to make additional payments to these centers from the savings made and to give some of this payment to the ERAS team. The protocol may not be easy to adopt by healthcare professionals who think that implementation of this protocol will bring additional workload to them if there is no economic return reflected to the staff.

We hope that our study will lead the way in eliminating the lack of existing studies in our country in terms of evaluating the cost-effectiveness of ERAS, and the interest in ERAS will increase thanks to the results to be achieved.

**Conflict of interest**

No conflict of interest was declared by the authors.

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