

A Path to High-Value Gastric Cancer Surgery Care Delivery

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Objective: To evaluate the feasibility, safety, and effectiveness of a comprehensive regional program, including the Minimally Invasive Recovery and Empowerment Care (MIREC) pathway, that can significantly reduce hospital stays after laparoscopic gastrectomy without increasing adverse events.

Background: Cost-effectiveness and improving patient outcomes are crucial in providing quality gastric cancer care worldwide.

Methods: To compare the outcomes of gastric cancer surgery using 2 different models of care within an integrated healthcare system from February 2012 to March 2023. The primary endpoint was the length of hospital stay. The secondary endpoints were the need for intensive care unit care, emergency room (ER) visits, readmission, reoperation, and death within 30 days after surgery.

Results: There were 553 patients, 167 in the pre-(February 2012–April 2016) and 386 in the post-MIREC period (May 2016–March 2023). Perioperative chemotherapy utilization increased from 31.7% to 76.4% ($P < 0.0001$). Laparoscopic gastrectomy increased from 17.4% to 97.7% ($P < 0.0001$). Length of hospitalization decreased from 7 to 2 days ($P < 0.0001$), with 32.1% and 88% of patients discharged home on postoperative day 1 and postoperative day 2, respectively. When comparing pre- and post-MIREC, intensive care unit utilization (10.8% vs. 2.9%, $P < 0.0001$), ER visits (34.7% vs. 19.7%, $P = 0.0002$), and readmission (18.6% vs. 11.1%, $P = 0.019$) at 30 days were also considerably lower. In addition, more patients received postoperative adjuvant chemotherapy (31.4% to 63.5%, $P < 0.0001$), and the time between gastrectomy and starting adjuvant chemotherapy was also less (49–41 days; $P = 0.002$).

Conclusion: This comprehensive regional program, which encompasses regionalization care, laparoscopic approach, modern oncologic care, surgical subspecialization, and the MIREC pathway, can potentially improve gastric cancer surgery outcomes. These benefits include reduced hospital stays and lower complication rates. As such, this program can revolutionize how gastric cancer surgery is delivered, leading to a higher quality of care and increased value to patients.

Keywords: adjuvant therapy, gastric cancer, laparoscopic gastrectomy, length of stay, postoperative recovery, return to care, surgery

INTRODUCTION

In the United States, unlike in many other countries, gastric cancer is relatively rare compared with other cancers. Gastric cancer is the 5th most common cancer worldwide.^{1–3} The management of gastric cancer has evolved in the last decade. Modern systematic chemotherapeutic agents have advanced, and targeted therapy, either preoperatively or postoperatively, being introduced in a select group of patients. However, gastrectomy remains a vital pillar of current multimodal treatment

for gastric cancer.⁴ Surgical care accounts for almost one-third of US healthcare spending.⁵ While modern advances in the surgical management of gastric cancer have improved outcomes, their impact on cost is unclear. Laparoscopy, a minimally invasive approach, has shown favorable clinical outcomes compared with open gastrectomy.^{6,7} Integration of prehabilitation-early recovery after surgery (prehab-ERAS) programs have markedly improved perioperative care;⁸ however, it remains uncertain how these advances affect the length of hospital stay (LOS) and rate of unintended return to care after gastrectomy.

In early 2016, Kaiser Permanente Northern California implemented a regionalized care system for upper gastrointestinal cancer patients, aiming to increase physician specialization and ensure standardized workflows. We introduced a laparoscopic approach and a new care pathway (minimally invasive recovery and empowerment care pathway [MIREC]). This study aimed to evaluate the impact of these multifaceted systematic changes, from our program, on short-term outcomes, specifically the LOSs, and the rate of unintended return to care.

METHODS

Before early 2016, each of the 19 medical centers of Kaiser Permanente Northern California provided separate diagnoses and treatments for esophagogastric cancer. However, regionalizing care was implemented to improve clinician specialization, case volume, and delivery of guideline-concordant care. Surgically, this was achieved by limiting the number of hospitals and physicians treating such cases. As a result, a central multidisciplinary tumor board was created to review every newly diagnosed patient with gastric cancer and recommend guideline-concordant tests and treatment. Currently,

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only 2 medical centers and 6 surgeons are designated to perform gastric cancer surgery, while medical oncologists were also encouraged to subspecialize in each of the 19 medical centers. Laparoscopic gastrectomy and lymphadenectomy were conducted according to the Japanese Gastric Cancer Treatment Guidelines (Japanese Gastric Cancer Assoc., version 5).⁹ Gastrointestinal tract reconstruction was performed via Roux-En-Y with either esophagojejunostomy or gastrojejunostomy. The MIREC pathway was introduced at the 2 designated gastric cancer surgery centers to evaluate its impact on short-term outcomes, such as the LOS and rate of unintended return to care.

The MIREC pathway consists of multiple parallel care initiatives including a comprehensive, multifaceted patient education program created to guide the expectations of both patients and their families. The program included thorough education on perioperative preparation, surgical and anesthetic information, and the adoption of a prehab-ERAS protocol when it became available. Anesthesia, perioperative nursing, and dietary teams were educated on the MIREC pathway. These teams were essential partners who sought to understand each patient's condition, capacity, and needs; to provide guidance; to build trust; and to reinforce the treatment goals and MIREC program with the patients and their families during each encounter. For example, the surgical team, including a specialized nutritionist, uniformly emphasizes the critical role of nutritional optimization before gastrectomy, answers questions, and asks patients to summarize their understanding of the team. Our team provided patients with clear information on food choices and tips to increase their protein intake. We aimed to empower patients and instill confidence in them to take their nutritional guidelines seriously. We offer an accessible online patient portal to connect patients with the surgical team and provide ongoing support. As a team, we shared the same goals and assessed each patient's compliance at every encounter. We offer feedback to help patients progress towards their goals. On average, patients will have 5 encounters with the surgical team, including 2 visits with the surgeon, 2 appointments with the nutritionist, and 1 meeting with the physician assistant before gastrectomy.

Information for Patient and Family-Concerning Surgery-Recovery

The information involved in surgery recovery included: plan for help at home postoperatively, optimization of preexisting chronic medical conditions, expectations both before and after surgery, use of opioid-sparing pain management, early initiation of oral intake, need for physical activity very early postoperatively, instructions about incisional care, and situations that should stimulate contact with a medical provider.

Determination of Candidacy for the MIREC Pathway

After regionalization in the Kaiser Permanente Northern California network, all patients with gastric cancer were evaluated for the MIREC pathway. Because the MIREC pathway is a comprehensive perioperative approach to prepare patients for surgery and enhance their recovery. There are no strict criteria to exclude patients from this pathway before surgery. Our team actively implemented multimodal pain management (Tylenol, nonsteroidal anti-inflammatory drugs, gabapentin, and tramadol) to avoid long-acting narcotics and regional anesthesia. Surgical drains, feeding tubes, or postoperative upper gastrointestinal radiographic studies are no longer routinely used. A nasogastric tube and urinary catheter were used during surgery and removed in the operating room at the end of the operation. We encouraged the patients to ambulate and take oral liquids a few hours after surgery.

The decision to discharge the patients' homes was made by the individual surgeon, considering all aspects of care and support. The criteria for discharge included the absence of any symptoms or signs indicating postoperative complications, ability to walk, sip liquids, oral nutritional supplements without any nausea or vomiting, and reasonable pain control. The attending surgeons would walk with the patients the morning after surgery and explain the intraoperative findings and postoperative care plan, while also addressing any questions and understanding the patient's physical and emotional changes.

The process of discharging patients who have undergone gastric cancer surgery was carefully planned and executed. We ensured each patient had a reliable adult companion to assist them during their recovery at home, at least for the first night. Some patients may have required an extended hospitalization for medical or nonmedical reasons. We instructed the patients to follow a liquid diet, including broth, soup, and high-caloric protein shakes, with small volume and frequent intake, for the first week after the surgery. Gradually, they were allowed to introduce pureed-soft food in the second week. The patients were also required to use spirometry, ambulate several times a day, and adhere to the pain medication protocol specific to each patient. All these measures were taken to avoid any complications and promote healing. The surgical team conducted the first postdischarge visit via telephone or video within 24 to 48 hours of discharge. The team continued with several-day intervals to assess patients' recovery conditions, identify potential issues, listen to patients, and provide further support. Patients were instructed to visit the emergency room (ER) if they had any substantial concerns about their recovery, such as presyncope, shortness of breath, or chest pain. Follow-up visits were conducted within a few days of the surgery, and the information technology services tracked all patients using a computer algorithm that not only reported the outcomes, including 30-day ER visits, readmission, and reoperation, on an online dashboard but also alerted the team for the next scheduled "visit." The results were shared transparently via an online dashboard and with the surgery group during the regularly scheduled group meetings.

Design of Study Population

This study analyzed the outcomes of patients who underwent elective gastrectomy for gastric cancer between February 2012 and March 2023, within the Northern California Kaiser Permanente health plan. This study compared results between annual inception cohorts, namely the pre- and post-regionalization eras, to eliminate systematic differences in disease and attribute outcome changes to care differences rather than selection bias. The study included patients aged 17 years and above while excluding nonelective surgery (ie, emergent, or urgent) and palliative resection performed within 48 hours of admission.

Patients were classified based on their date of treatment as preregionalized (February 2012–April 2016) or postregionalized (May 2016–March 2023). The MIREC pathway was applied to all surgical patients in the postregionalization era. The primary endpoint was LOS after implementing the MIREC pathway. The secondary endpoints were the rates of all-cause postoperative 30-day unintended return to care: emergency room visits, readmissions, reoperation, mortality, and need for care in the intensive care unit (ICU). All postoperative complications were evaluated retrospectively in this study. The program was approved by the institutional review board, and informed consent was waived because of the minimal risks to the participants.

Data Collection

Information was obtained from an integrated network electronic health plan registry. Patient demographic information was

TABLE 1.
Demographic of Patients With Gastric Cancer Who Underwent Elective Gastrectomy

Characteristic	Pre-MIREC		Post-MIREC		P Value
	(Feb 2012–Apr 2016)		(May 2016–Mar 2023)		
	(N = 167)		(N = 386)		
	N	%	N	%	
Age					0.741
Median	65.7	29.9	65.7	26.2	
18–59	50	28.7	101	32.9	
60–69	48	27.5	127	27.2	
70–79	46	13.8	105	13.7	
80+	23		53		
Sex					0.842
Female	69	41.3	163	42.2	
Race					0.700
White	40	23.9	99	25.7	
Asian	61	35.9	134	34.7	
African American	19	11.3	31	8.0	
Hispanic	41	24.0	108	28.0	
Others	6	4.2	14	3.6	
Body mass index (BMI)					0.666
Median	26.3	4.8	26.0	3.4	
Underweight (<18.5)	8	42.5	13	45.1	
Normal (18.5–25)	71	31.1	174	32.6	
Overweight (25–30)	51	22.2	126	18.9	
Obese (30 or higher)	37		73		
Neoadjuvant chemotherapy received					<0.0001
Yes	53	31.7	295	76.4	
Time between last chemotherapy to gastrectomy (days)					0.509
Median	46		41		
ASA class					0.003
Median	2.7	29	2.7	34.5	
1–2	54	59.9	133	63.7	
3	100	7.8	246	1.8	
4	13		7		
Tumor T-stage*					0.139
pT0–pTis	8	5.2	33	8.6	
pT1	28	18.1	98	25.4	
pT2	26	16.8	47	12.2	
pT3	46	29.9	100	25.9	
pT4	47	30.3	108	28	
Tumor N stage*					0.398
pN0	70	45.2	190	49.2	
pN1	36	23.2	66	17.1	
pN2	22	14.2	46	11.9	
pN3	27	17.4	84	21.8	

Kaiser Permanente Northern California, pre- and post-MIREC pathway, Feb 2012 to March 2023.

*Unknown tumor T-stage and N stages: n = 12.

ASA indicates American Society of Anesthesiologists; MIREC, minimally invasive recovery and empowerment care.

obtained from the membership data. The American Society of Anesthesiologists (ASA) class, body mass index (BMI), and surgical outcomes were obtained from electronic medical records integrated across all 19 Kaiser centers, including operative time, postoperative emergency room visit, readmission, reoperation, and mortality rates at 30 days.

Statistical Analysis

Data were analyzed using the SAS software, version 9.04.01 (SAS Institute, Cary, NC, USA). Chi-square was used in bivariate analyses to assess the association of regionalization (pre vs. post) with changes in care and outcomes. Mann–Whitney and *t* tests were used for bivariate and multivariate analyses of continuous variables, respectively.

RESULTS

We identified 553 patients with gastric cancer who underwent elective gastrectomy with lymphadenectomy between February 2012 and August 2022, of whom 167 underwent pre- (February 2012–April 2016) and 386 post-MIREC (May 2016–March 2023). There were 426 subtotal and 127 total gastrectomies. Of these, 406 were laparoscopic gastrectomies, and 147 were open. Demographic characteristics of the pre- and post-MIREC cohorts were similar. The mean age was 65.7 years; 42% of them were female. When considering all patients, the average BMI was 26.3 kg/m², and the ASA class was 2.7. Almost one-third were Asian, and nearly a quarter were White and Hispanic (Table 1). Subtotal gastrectomy was performed in 73.6% of the pre- and 78.5% post-MIREC eras (*P* = 0.213). The proportion of patients who underwent a laparoscopic resection increased

from 17.4% in the pre- to 97.7% in the post-MIREC period ($P < 0.0001$).

The median LOS decreased from 7 to 2 days ($P < 0.001$) in the post-MIREC period, while all-cause postoperative need for care in the ICU (10.8%–2.9%, $P = 0.0001$), 30-day ER visits (34.7%–19.7%, $P = 0.0002$), and hospital readmissions (18.6%–11.3%, $P = 0.0186$) were also significantly lower in the post-MIREC era. The All-cause reoperations (6.0% vs. 6.7%, $P = 0.745$) and mortality (0.6% vs. 1.0%, $P = 0.618$) at 30 days did not differ (Table 2).

The percentage of patients discharged home on postoperative day-1 (POD-1) increased from 0% in the preregionalization era to 13% in 2016, the first year of the MIREC pathway initiation, and continued to increase over 5 years to 60% by 2022. Furthermore, the percentage of patients discharged home within 2 postoperative days (POD-1 and POD-2) also increased from 2.4% in the preregionalization era to 34% in 2016 and continued to increase further to 88% by 2022 (Fig. 1).

Patients discharged home within 2 days after surgery did not differ from those who stayed longer than 2 days in terms of age, sex, race, BMI, and ASA class (Table 3). Of note, more patients who went home within 2 days were more likely to have undergone a laparoscopic gastrectomy (100% vs. 93.4%, $P < 0.0001$) and somewhat shorter duration of surgery (232.2 vs. 251 min, $P = 0.0005$). After initiating the MIREC pathway, the findings on unintended return to care showed that the 30-day ER visit was 16.8% vs. 25.0% ($P = 0.053$), and the 30-day hospital

readmission rate was 9.2% vs. 14.7% ($P = 0.101$). The 30-day reoperation rate was 4.4% vs. 11.0% ($P = 0.013$), need for care in the ICU and mortality rates were 2% vs. 4.4% ($P = 0.174$) and 0.8% vs. 1.5% ($P = 0.534$), respectively, for these 2 groups of patients (Table 4). Changes over time since the initiation of the MIREC pathway showed that the duration of surgery and LOS continued to improve over time (Table 5). The effect of the minimally invasive surgical approach on clinical outcomes in the preregionalization era ($N = 29$) and postregionalization era ($n = 377$) was analyzed, and the results are shown in Table 6.

DISCUSSION

“Achieving a high value for patients must become the overarching goal of healthcare delivery, with value defined as the health outcomes achieved per dollar spent. This goal matters for patients and unites the interests of all actors in the system.” Porter et al.¹⁰

Healthcare expenses in the United States are substantially influenced by surgical care costs, particularly hospital beds and ICU utilization. A conventional hospital room can cost thousands of dollars daily, whereas an ICU room can cost 2 to 3 times more. Furthermore, the healthcare system incurs additional costs owing to unplanned returns to care after surgery, including emergency room visits, readmissions, and reoperations within 30 days. These returns can compromise the quality of care, elevate the median stay cost, and increase the overall

TABLE 2.
Clinical Characteristics of Patients With Gastric Cancer Who Underwent Elective Gastrectomy

Characteristic	Pre-regionalization (Feb 2012–Apr 2016)		Post-regionalization (May 2016–Mar 2023)		P Value
	(N = 167)		(N = 386)		
	N	%	N	%	
Duration of surgery (min)					0.044
Median	226		239		
Length of hospital stays(day),					<0.0001
Median	7		2		
Surgical approach					<0.0001
Laparoscopic	29	17.4	377	97.7	
Open	138	82.6	9	2.3	
Type of gastrectomy					0.213
Subtotal gastrectomy	123	73.6	303	78.5	
Total gastrectomy	44	26.4	83	21.5	
Extend of lymphadenectomy					<0.0001
D2	7	4.2	340	88.1	
No. of lymph node dissected.					<0.0001
Median	17		40.5		
Resection margin					0.030
R0	152	91	371	96.1	
ER visit,					0.0002
30 days	58	34.7	76	19.7	
Readmission,					0.019
30 days	31	18.6	43	11.1	
Reoperation					0.745
30 days	10	6	26	6.7	
ICU utilization					0.0001
Yes	18	10.8	11	2.9	
Mortality,					0.618
30 days	1	0.6	4	1	
Post-op chemotherapy received.					<0.0001
Yes	57	34.1	245	63.5	
Time between gastrectomy to restarting chemotherapy (days)					0.002
Median	49		41		

Kaiser Permanente Northern California, pre- and post-regionalization pathway, Feb 2012 to March 2023. ICU indicates intensive care unit.

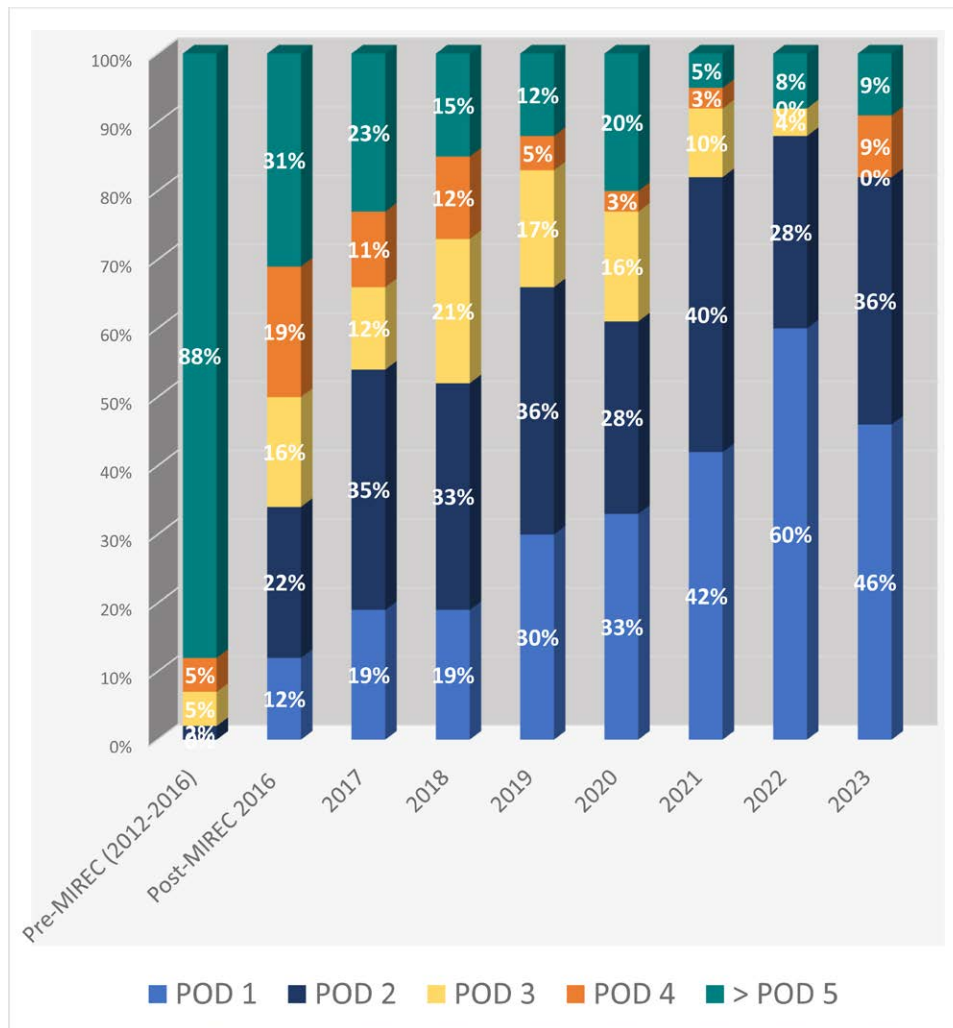


FIGURE 1. The trends of the length of hospital stay following elective gastrectomy for gastric cancer. Kaiser Permanente Northern California, Feb 2012 to March 2023. MIREC indicates minimally invasive recovery and empowerment care; POD, postoperative day.

cost of care.^{11,12} To mitigate these expenses, it is crucial to reduce hospital stays, minimize the rate of unintended returns following gastrectomy, and restrict ICU use. Our research indicates that reducing hospital stay to just 1 to 2 days after elective laparoscopic gastrectomy for gastric cancer is safe. This is an exciting finding because it is one of the first large cohort studies to investigate this possibility.

We have improved the quality of gastric cancer surgery care in our integrated healthcare system by regionalizing it, hiring highly subspecialized care specialists, and adopting the laparoscopic gastrectomy technique and the MIREC pathway. These systematic changes have enabled us to discharge patients within 2 days after gastrectomy. These changes create a synergistic effect and complement each other in achieving positive outcomes. Therefore, we consider them a combined strategy rather than separate interventions to bring about positive changes. We observed a significant increase in the use of the laparoscopic technique after regionalization. The MIREC pathway also underwent a transition period of the first 18 months, during which the adoption rate increased from 62% in 2016 to 82% in 2017 and continued to increase in subsequent study periods. These collective systematic changes were associated with lower rates of postoperative complications, such as 30-day ER visits, readmissions, and reoperations, compared with the period before the systematic changes. As healthcare providers, we are dedicated to delivering high-value healthcare to patients while reducing

the cost of care. The success of these initiatives in our integrated healthcare system, with a high uptake rate, demonstrates that it is a feasible and effective way to shorten hospital stays and healthcare expenses while improving patient outcomes. Several studies¹²⁻¹⁷ have shown that laparoscopic foregut and colorectal surgery can provide better pain control, faster return of bowel function, and fewer postoperative morbidities than traditional open surgery. Additionally, laparoscopic gastrectomy for gastric cancer has been found to have favorable outcomes, including less operative blood loss, faster patient recovery, and fewer operative morbidities, while maintaining equivalent oncological results.¹⁸⁻²⁰ However, most large comparative series from both the West and the East have shown only a 1 to 2-day decrease in the LOS favoring laparoscopic surgery over traditional open surgery. The average LOS for a laparoscopic gastrectomy is 8 days in the United States,²¹ 8.6 days in Europe,²² 8.1 days in Korea, The Korean Laparoendoscopic Gastrointestinal Surgery Study,²³ 10.9 days in China, The Chinese Laparoscopic Gastrointestinal Surgical Study,²⁴ and 12 days in Japan.²⁵

The prehab-ERAS pathway has also revolutionized modern perioperative care by enhancing physiological and metabolic responses to surgical stress.²⁶ As demonstrated by others, this program can facilitate faster recovery, improve clinical outcomes, and reduce costs.²⁷⁻³¹ A recent meta-analysis showed that ERAS, compared with conventional care, reduced cost, time to return of gut function, and hospital stays by 2 days without

TABLE 3.
Demographic of Patients According to the Length of Hospital Stays, Post-MIREC Pathway (May 2016–March 2023) in Kaiser Permanente Northern California Table 2

Characteristic	Patient Discharged Home (POD 1 and 2)		Patient Discharged Home (>POD 3)		P Value
	N = 250		N = 136		
	N	%	N	%	
Age					0.214
Median	68	22.8	66	32.4	
18–59	57	35.2	44	28.7	
60–69	88	27.6	39	26.5	
70–79	69	14.4	36	12.5	
80+	36		17		
Sex					0.324
Female	101	40.4	62	45.6	
Race					0.096
White	62	24.8	37	27.2	
Asian	96	38.4	38	27.9	
African American	22	8.8	9	6.6	
Hispanic	64	25.6	44	32.4	
Others	6	2.4	8	5.9	
Body mass index (BMI)					0.321
Median	24.9	3.6	25.8	2.9	
<18.5	9	47.6	4	40.4	
18.5–25	119	32.4	55	33.1	
26–30	81	16.4	45	23.5	
30+	41		32		
Neoadjuvant chemotherapy received					0.627
Yes	193	77	102	75	
ASA class					0.205
Median	3	37.6	3	28.7	
1–2	94	60.8	39	69.1	
3	152	1.6	94	2.2	
4	4		3		
Year of surgery					<0.0001
2016	11	4.4	21	15.4	
2017	31	12.8	26	19.2	
2018	27	10.8	25	18.4	
2019	42	16.8	22	16.2	
2020	37	14.8	23	16.9	
2021	49	16.9	11	8.1	
2022	44	17.6	6	4.4	
2023	9	3.6	2	1.5	

ASA indicates American Society of Anesthesiologists; POD, postoperative day.

increasing postoperative morbidity in gastric cancer surgery.³² Despite its many benefits, such as the laparoscopic approach, the prehab-ERAS pathway alone has yet to drastically shorten the LOS for patients undergoing gastrectomy.

Delivering exceptional care for patients with gastric cancer that is both affordable and of the highest quality can prove challenging owing to various factors. These factors may include the culture of care within countries and surgical teams, patient selection, postoperative physical discomfort, emotional stress, patient expectations, and availability of home support, among others. Our program was developed to overcome these obstacles by integrating new changes into modern clinical perioperative practices. This parallel strategy aims to optimize patients preoperatively, lead to realistic patient expectations, enhance the overall patient experience, and improve outcomes, despite potential challenges.

Our Permanente Gastric Cancer Surgery group, established in 2016, offers a laparoscopic approach to all types of gastrectomy, with Japanese-type D2 lymphadenectomy as the standard of care. Adherence to the ERAS-gastric surgery guidelines for gastric surgery has varied since their publication by the ERAS Society in 2014.³³ However, our group has taken steps to ensure adherence to these guidelines by utilizing best practices from other fields

of gastric surgery. Our program recommends avoiding the use of surgical drains, urinary catheters, nasogastric tubes, and routine upper GI examinations during elective gastrectomy. Our pathway promotes early oral fluid intake and ambulation. These small steps cumulatively resulted in less physical discomfort, fewer interventions, reduced risk of morbidities, and enhanced postoperative comfort and rest, ultimately alleviating emotional stress and empowering patients' overall self-confidence in their path to recovery.^{34,35} Our approach has yielded excellent results, with over 96% of our laparoscopic surgeries for gastric cancer patients resulting in excellent clinical and oncologic outcomes at 3 years, with an overall survival rate of 66.0% in the preregionalization cohort and 83.0% in the postregionalization cohort.¹⁹

It is essential to provide patients and their families with thorough education and equally important expectations regarding postoperative care, especially when hospital stays are shorter than preconceived expectations. Our program puts a strong emphasis on empowering patients and their families to play an active role in their care. In addition to education on surgical and anesthetic techniques, our program includes initiatives such as multimodal pain management and structured oral intake and emphasizes the importance of good home support. We also prioritized consistent expectations and increased telehealth-based

TABLE 4.

Clinical Characteristics of Patients According to the Length of Hospital Stays, Post-MIREC Pathway (May 2016–to March 2023) in Kaiser Permanente Northern California

Characteristic	Patient Discharged Home (POD 1 and 2)		Patient Discharged Home (>POD 3)		P Value
	N = 250		N = 136		
	N	%	N	%	
Duration of surgery (min)					0.0005
Median	232.2		251.0		
Surgical approach,					<0.0001
Laparoscopic	250	100	127	93.4	
Open	0	0	9	6.6	
Type of gastrectomy					0.135
Subtotal gastrectomy	202	80.8	127	93.4	
Total gastrectomy	48	19.2	9	6.6	
ER visit					0.053
30 days	42	16.8	34	25	
Readmission					0.101
30 days	23	9.2	20	14.7	
Reoperation					0.013
30 days	11	4.4	15	11	
ICU utilization					0.174
Yes	5	2.0	6	4.4	
Mortality					0.534
30 days	2	0.8	2	1.8	
Post-op chemotherapy received					0.012
Yes	170	68	75	55.2	
Time between gastrectomy to restarting chemotherapy (days)					0.019
Median	40		41		

ICU indicates intensive care unit; POD, postoperative day.

TABLE 5.

Clinical Characteristics of Gastrectomy, Chemotherapy, and Rate of Unintended Return to Care Over Time After Initiating the MIREC Pathway

Characteristic	Post-MIREC		Post-MIREC		P Value
	(May 2016–Dec 2017)		(Jan 2018–Mar 2023)		
	(N = 89)		(N = 297)		
	N	%	N	%	
Pre-op chemotherapy received.					0.046
Yes	61	68.5	234	78.8	
Time between last chemotherapy to gastrectomy (days)					0.932
Median	43		41		
Duration of surgery (min)					0.001
Median	267		233		
Length of hospital stays(day)					<0.0001
Median	3		2		
Adherence to MIREC					0.003
	68	79%	278	94%	
ER visit					0.096
30 days	23	25.8	53	17.9	
Readmission					0.007
30 days	17	19.1	26	8.8	
Reoperation					0.334
30 days	8	9	18	6.1	
ICU utilization					0.736
Yes	3	3.4	8	2.7	
Mortality					0.926
30 days	1	1.1	3	1	
Time between gastrectomy to restarting chemotherapy (days)					0.056
Median	49		41		
Weight changes after gastrectomy (kg)					0.240
Median	-6.1		-5.4		
Post-op chemotherapy received					0.532
Yes	54	60.7	191	64.3	

ICU indicates intensive care unit; MIREC, minimally invasive recovery and empowerment care.

TABLE 6.
The Effect of the Minimally Invasive Approach on Clinical Outcomes in the Pre-regionalization Era (N = 29) and Post-regionalization Era (n = 377)

Characteristic	Pre-Regionalization Laparoscopic Gastrectomy		Post-Regionalization Laparoscopic Gastrectomy		P Value
	N	%	N	%	
Duration of surgery (min)					0.870
Median	238		239		
Length of hospital stay (days)					<0.0001
Median	6		2		
Type of gastrectomy					0.006
Subtotal gastrectomy	29	100	297	78.8	
Total gastrectomy	0	0	80	21.2	
ER visit					0.268
30 days	8	27.6	72	19.1	
Readmission					1.000
30 days	3	10.3	39	10.3	
Reoperation					0.956
30 days	2	6.9	25	6.6	
ICU utilization					0.350
Yes	0	0	11	2.9	
Mortality					0.578
30 days	0	0	4	1.1	
Post-op chemotherapy received					0.034
Yes	15	51.7	262	69.5	
Time between gastrectomy to restarting chemotherapy (days)					0.153
Median	51		41		

ICU indicates intensive care unit.

communication for easy access to the surgical team. Our program allows patients to recover comfortably in their own homes, which can improve their physical and psychological recovery through better sleep and pain management. As shown here, our program is accumulative of all the positive, avoidance of the potential negative, accompanied by cultural changes in the surgical practice and empowerment of the patients' strategies, dramatically decreasing the median length of stay to 2 days, with most patients able to be safely discharged home a day after their elective gastrectomy.

One of the biggest challenges we faced was the reluctance of some surgeons to alter their routine practices and embrace the new care pathway. To tackle this, we organized regular meetings and discussions, presented evidence on safety, and allowed them to witness the positive outcomes of other surgeons who had implemented the new protocol. Over time, as favorable results were achieved, we successfully overcame this obstacle. One of the main concerns of sending a patient home as early as our data demonstrated was the concern about serious postoperative complications. However, our cohort study found that the implementation of our program resulted in a statistically lower incidence of adverse effects and comparable or better outcomes when compared with open curative intent gastrectomy for gastric cancer reported in the literature.^{36,37} The success of our program can be attributed to the willingness to change in 4 adaptable factors: surgeon, patient, health care system support, and perioperative care.^{38,39} The strengths of this study include its setting in an integrated health-care system with a large number of patients and diverse patient cohorts, mimicking those of the general population.

Nevertheless, our study has some limitations, such as the use of administrative data that relies on accurate surgical reports. Chart audits were conducted to ensure data integrity; however, detailed information concerning specific comorbidities or perioperative complications was not examined. Additionally, the adaptation of individual surgeons to our program varies. We acknowledge that the generalizability of our findings is an area of improvement. However, a regional

initiative like our program is feasible in some US settings, particularly with the critical role of tracking postoperative outcomes. With time and the introduction of healthcare technology, more healthcare systems can implement components of our program, even with the limited or partial adoption of these concepts.

In conclusion, our program, which encompasses regionalization care, laparoscopic approach, modern oncologic care, surgical subspecialization, and the MIREC pathway, can potentially improve gastric cancer surgery outcomes. These benefits include reduced hospital stays and lower complication rates. As such, this program can revolutionize how gastric cancer surgery is delivered, leading to a higher quality of care and increased value to patients.

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Conflict of interest statement

The authors report no conflicts of interest.

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