

# World Journal of *Gastrointestinal Oncology*

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*World Journal of Gastrointestinal Oncology*  
Baishideng Publishing Group Inc  
7901 Stoneridge Drive, Suite 501,  
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Telephone: +1-925-2238242  
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Prospective Study

# Introduction of laparoscopic gastrectomy for gastric cancer in a Western tertiary referral centre: A prospective cost analysis during the learning curve

Juul J Tegels, Charlotte E Silvius, Frederique E Spauwen, Karel W Hulsewé, Anton G Hoofwijk, Jan H Stoot

Juul J Tegels, Charlotte E Silvius, Frederique E Spauwen, Karel W Hulsewé, Anton G Hoofwijk, Jan H Stoot, Department of Surgery, Zuyderland Medical Centre, 6162BG Sittard, The Netherlands

**Author contributions:** Stoot JH, Tegels JJ, Hoofwijk AG and Hulsewé KW did the study conceptualization; Tegels JJ, Spauwen FE and Silvius CE were responsible for data acquisition; Tegels JJ, Spauwen FE, Silvius CE and Stoot JH performed quality control of data and algorithms; Tegels JJ, Spauwen FE, Silvius CE, Hulsewé KW, Hoofwijk AG and Stoot JH performed data analysis interpretation; Tegels JJ performed statistical analysis; Tegels JJ, Spauwen FE and Silvius CE performed manuscript preparation; Tegels JJ was responsible for manuscript edition and first and final draft writing; Tegels JJ, Spauwen FE, Silvius CE, Hoofwijk AG, Hulsewé KW and Stoot JH performed manuscript reviews, significant writing contributions and reviewed and approved the final version of the manuscript.

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**Correspondence to:** Juul J Tegels, MD, Department of Surgery, Zuyderland Medical Centre, Dr. H. van der Hoffplein 1, 6162BG Sittard, The Netherlands. [ju.tegels@zuyderland.nl](mailto:ju.tegels@zuyderland.nl)  
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## Abstract

### AIM

To evaluate the costs of the introduction of a laparoscopic surgery program for gastric cancer in a Western community training hospital and tertiary referral centre for gastric cancer surgery.

### METHODS

All patients who underwent surgery for gastric cancer with curative intent in 2013 and 2014 were prospectively included. Primary outcomes were costs regarding surgery and hospital stay.

### RESULTS

Laparoscopic gastrectomy was used in 52 patients [mean age 68 years ( $\pm 9$ , range 50 to 87)] and open gastrectomy was used in 25 patients [mean age 70 years ( $\pm 10$ , range 46 to 85)]. Mean costs (in euro's) of surgical instrumentation were significantly higher for laparo-



scopic surgery:  $2270 \pm 670$  vs  $1181 \pm 680$  in the open approach ( $P < 0.001$ ). Costs of theatre use were higher in the laparoscopic group: mean  $3819 \pm 865$  vs  $2545 \pm 1268$  in the open surgery ( $P < 0.001$ ). Total costs of hospitalization (*i.e.*, costs of surgery and admission) were not different between laparoscopic and open surgery,  $8187 \pm 4864$  and  $7673 \pm 8064$  respectively ( $P = 0.729$ ). Mean length of hospital stay was  $9 \pm 12$  d in the laparoscopic group vs  $14 \pm 14$  d in the open group ( $P = 0.044$ ).

### CONCLUSION

The introduction of laparoscopic gastrectomy for gastric cancer coincided with higher costs for theatre use and surgical instrumentation compared to the open technique. Total costs were not significantly different due to shorter length of stay and less intensive care unit (ICU) admissions and shorter ICU stay in the laparoscopic group.

**Key words:** Laparoscopic surgery; Healthcare costs; Gastric cancer

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**Core tip:** The introduction of laparoscopic surgery for gastric cancer did not seem to result in increased costs as compared to open gastrectomy for gastric cancer. Despite higher operating room costs (longer operating time and more costly operating room materials) costs were similar between the open and laparoscopic group due to reduced length of stay and complication rate in laparoscopic gastrectomy patients.

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### INTRODUCTION

In patients with gastric cancer, surgical resection is the only treatment that can offer cure or increase long-term survival<sup>[1]</sup>. Laparoscopic surgery for gastric cancer has gained popularity despite initial concerns regarding safety and oncological adequacy<sup>[2]</sup>. Studies conducted in South Korea and Japan reported that laparoscopic gastrectomy is comparable to open gastrectomy with regard to surgical and oncological outcomes<sup>[2-4]</sup>. A meta-analysis by Memon *et al*<sup>[4]</sup> showed that laparoscopic procedures are associated with less blood loss but longer operation time. Many studies have reported outcomes of laparoscopic surgery for early gastric cancer (EGC), but

several authors have shown that a laparoscopic approach can also be used in cases of advanced gastric cancer<sup>[5-7]</sup>. This makes it a potentially important strategy in Europe where the vast majority of patients present at stage II or higher as opposed to Asian countries where EGC is far more common<sup>[8]</sup>.

In the current economic climate, governmental organizations and health insurance companies have a major influence on the regulation of costs in healthcare. Moreover, surgeons often have to prove that new techniques are cost-effective for hospital organizations. To the best of our knowledge, no cost-analysis studies have yet been performed concerning the introduction of the laparoscopic procedure for gastric resections. The aim of this study was to evaluate the costs of the introduction of a laparoscopic surgery program for gastric cancer in a Western community training hospital and tertiary referral centre for gastric cancer surgery.

### MATERIALS AND METHODS

#### Patients

Introduction of laparoscopic gastrectomy was started in January 2013. All consecutive patients with gastric adenocarcinoma eligible for curative surgery from January 2013 to December 2014 were included. Whether the patient would undergo laparoscopic or open surgery depended on the surgeon's experience in laparoscopic gastric surgery and surgeon preferences. Patients who underwent multivisceral resections were not included in this study. All data were collected in a prospective database. If non-equal groups were obtained, a consecutive number of patients who underwent open gastrectomy with curative intent would be retrospectively included to create two groups of equal size. All data, including intraoperatively used materials (*e.g.*, electrosurgical devices, staplers, suture materials and reusable instruments) were all available through the hospitals fully digitized patient information system, also for retrospectively included patients. This observational study collected data concerning direct hospital-related costs and complication rates and admission length. The Charlson comorbidity index (CCI) was used to classify comorbidities in patients<sup>[9]</sup>. Patients received care as usual. Approval for this study was obtained from the medical ethics committee.

#### Preoperative stage

Preoperatively all patients underwent gastroesophageal endoscopy and biopsies were taken to confirm the diagnosis. Further preoperative staging was done with computed tomography (CT) of the abdomen and chest. Magnetic resonance imaging and/or positron emission tomography/CT imaging was selectively performed when liver lesions were visible on CT-imaging. Multidisciplinary consensus regarding the treatment was obtained in all cases. Neo-adjuvant chemotherapy was administered whenever patient condition and comorbidities would

**Table 1** Costs of disposable instruments for laparoscopic surgery and open surgery

| Item  | Price    |
|---|----------|
| Laparoscopic surgery  |          |
| Ligasure Impact 5 mm, Medtronic, Ireland <sup>1</sup>             | € 448.22 |
| Ligasure Impact 10 mm, Medtronic, Ireland <sup>1</sup>            | € 376.00 |
| Autosuture endobag, endocatch, Medtronic, Ireland <sup>1</sup>    | € 63.56  |
| Autosuture EndoGIA 12 mm, Medtronic, Ireland <sup>1</sup>         | € 203.00 |
| Reload EndoGIA purple 45, Medtronic, Ireland <sup>1</sup>         | € 173.00 |
| Reload EndoGIA purple 60, Medtronic, Ireland <sup>1</sup>         | € 176.00 |
| Reload EndoGIA Gold 45, Medtronic, Ireland <sup>1</sup>           | € 181.00 |
| Endopaddle 12 mm, Medtronic, Ireland <sup>1</sup>                 | € 81.84  |
| Alexis small/medium, applied medical                              | € 31.00  |
| Endoshear 5 mm, Medtronic, Ireland <sup>1</sup>                   | € 73.50  |
| EEA XL, Covidien United States                                    | € 439.62 |
| EEA Orvil, Covidien United States                                 | € 94.20  |
| Bladeless trocar 5 mm, Medtronic, Ireland <sup>1</sup>            | € 48.88  |
| Bladeless trocar 5-12 mm, Medtronic, Ireland <sup>1</sup>         | € 48.88  |
| Blunt trocar 5-12 mm, Medtronic, Ireland <sup>1</sup>             | € 47.81  |
| Pyramidal bladed trocar 10-15 mm, Medtronic, Ireland <sup>1</sup> | € 80.43  |
| Hem-o-lok L filling, Weck United States                           | € 23.00  |
| Hem-o-lok XL filling, Weck United States                          | € 23.00  |
| Open surgery  |          |
| Ligasure Impact, Medtronic, Ireland <sup>1</sup>                  | € 343.80 |
| Purssting stapler, Medtronic, Ireland <sup>1</sup>                | € 57.34  |
| TA Green 30, Medtronic, Ireland <sup>1</sup>                      | € 106.30 |
| Reload TA Green 30, Medtronic, Ireland <sup>1</sup>               | € 60.50  |
| TA Green 60, Medtronic, Ireland <sup>1</sup>                      | € 110.09 |
| Reload TA Green 60, Medtronic, Ireland <sup>1</sup>               | € 65.00  |
| GIA Blue 60, Medtronic, Ireland <sup>1</sup>                      | € 119.68 |
| Reload GIA Blue 60, Medtronic, Ireland <sup>1</sup>               | € 75.51  |
| GIA Blue 80, Medtronic, Ireland <sup>1</sup>                      | € 147.48 |
| Reload GIA Blue 80, Medtronic, Ireland <sup>1</sup>               | € 81.74  |
| GIA Green 80, Medtronic, Ireland <sup>1</sup>                     | € 148.96 |
| Reload GIA Green 80, Medtronic, Ireland <sup>1</sup>              | € 81.74  |
| CEEA 21, Medtronic, Ireland <sup>1</sup>                          | € 408.97 |
| CEEA 25, Medtronic, Ireland <sup>1</sup>                          | € 384.48 |
| CEEA 28, Medtronic, Ireland <sup>1</sup>                          | € 388.33 |
| CEEA 25 XL, Medtronic, Ireland <sup>1</sup>                       | € 439.62 |

<sup>1</sup>Formerly Covidien United States.

allow.

### Outcome measurement

Primary outcomes included costs regarding surgery and hospital stay. Costs were obtained from the Financial Controllers of the involved departments. Data (*e.g.*, duration of operation, use of disposables) were collected prospectively. For patients who were retrospectively included all data were available through the electronic patient record system. This system also recorded which disposable and reusable operating theatre materials were used during surgery. Costs of ward stay were 180 euro's per day; ICU admission was 665 euro's per day. Costs of operating theatre use were hourly rates for surgery and anesthesiology combined at 800 euro's per hour. Sterilization costs of reusable instruments were also accounted for and varied for different types of surgical sets that were used. All used instruments, disposable and reusable, were noted during the procedure by one of the operating room nurses on a prepared list that was provided to prospectively collect data. Costs of the

disposable instruments for the laparoscopic and open surgery are shown in Table 1. Postoperatively all patients were admitted to the recovery ward before they were transferred to the general ward. For laparoscopic and open gastrectomy, costs of both disposable and reusable instruments, operating theatre use, ICU stay and hospital stay were calculated separately.

Secondary outcomes were estimated blood loss, duration of operation, length of ICU stay, length of hospital stay, anastomotic leakage rate and complications. Complications were graded according to Clavien-Dindo classification: Grade 3a (*i.e.*, complication requiring reintervention) or greater was considered a major complication<sup>[10]</sup>. Tumour stage was classified in line with the American Joint Committee on Cancer tumor node metastasis 5<sup>th</sup> edition.

### Surgical technique and postoperative care

Open surgery was performed by three surgeons prior to introduction of laparoscopic surgery for gastric cancer. All three had extensive experience in open surgery for gastric cancer.

Laparoscopic procedures were performed by two of the abovementioned three surgeons. Both surgeons also had extensive prior expertise in laparoscopic surgery for other gastrointestinal malignancies mainly colorectal surgery and gastric GIST tumours. Prior to introducing laparoscopic surgery for gastric cancer, specific expertise and proficiency was obtained by the laparoscopic surgeons by taking expert courses in the Netherlands and Singapore.

Surgical resections for gastric malignancy were defined as either distal or total gastrectomies. The type of resection performed depended on the localization and depth of invasion of the tumour. In both open and laparoscopic surgery, a standard D2 or D1+ lymph node dissection (dissection of group 1 and number 8a and 9 lymph nodes) was performed in accordance with Dutch guidelines. Continuity of the gastrointestinal tract in subtotal gastrectomies was restored either by a Billroth-II or a Roux-en-Y reconstruction. In the case of a total gastrectomy a Roux-en-Y reconstruction was always performed. Patients were not routinely admitted to the ICU postoperatively. ICU admission was always for complication management (*e.g.*, sepsis, pulmonary complications).

Postoperative care of both open and laparoscopic patients included several aspects of a multimodal perioperative Enhanced Recovery After Surgery (ERAS) program for gastrointestinal cancer<sup>[11]</sup>. These include early enteral feeding (*i.e.*, resumption of liquids on postoperative day one) and early mobilization. Follow-up of the patients after discharge was performed periodically. Follow-up consisted of physical examination, blood tests, and CT-imaging if indicated.

### Statistical analysis

Data were analyzed using SPSS 20 (IBM Corp. Armonk,

**Table 2** Baseline characteristics *n* (%)

|                           | Open gastrectomy<br>( <i>n</i> = 25, 32%) | Laparoscopic<br>gastrectomy ( <i>n</i><br>= 52, 68%) | <i>P</i><br>value |
|---------------------------|---|--|-------------------|
| Age                       | 70.0 (± 10, 46-85)                        | 68 ± 9, 50-87)                                       | 0.470             |
| Sex (male/female)         | 17/8                                      | 32/20  | 0.623             |
| BMI <sup>1</sup>          | 25 ± 4, 18-36                             | 25 ± 5, 15-38  | 0.824             |
| CCI <sup>2</sup>          |   |  | 0.158             |
| 0-2                       | 16 (64)                                   | 27 (52)  |                   |
| 3-4                       | 7(28)                                     | 11 (21)  |                   |
| > 4                       | 2 (8)                                     | 14 (27)  |                   |
| Tumour stage <sup>3</sup> |   |  | 0.681             |
| 0                         | 0 (0.0)                                   | 2 (4)  |                   |
| 1 <sup>1</sup>            | 4 (16)                                    | 11 (21)  |                   |
| 1 <sup>2</sup>            | 6 (24)                                    | 15 (29)  |                   |
| 2                         | 5 (20)                                    | 4 (8)  |                   |
| 3 <sup>1</sup>            | 4 (16)                                    | 10 (19)  |                   |
| 3 <sup>2</sup>            | 3 (12)                                    | 4 (8)  |                   |
| 4                         | 3 (12)                                    | 6 (11)   |                   |
| Subtotal gastrectomy      | 16 (64)                                   | 38 (73)  | 0.436             |
| Total gastrectomy         | 9 (36)                                    | 14 (27)  |                   |
| Neoadjuvant chemotherapy  | 11 (44)                                   | 36 (69)  | 0.046             |

<sup>1</sup>BMI: Body mass index in kg/cm<sup>2</sup>; <sup>2</sup>CCI: Charlson comorbidity index; <sup>3</sup>In accordance with tumor node metastasis 5<sup>th</sup> edition.

NY). Continuous variables were expressed as mean ± SD or mean (range) if appropriate.  $\chi^2$  tests were used to compare the difference in frequencies of categorical variables. To compare the means of two independent samples, *t*-tests and non-parametric tests were used. The threshold for statistical significance was set at a *P*-value of < 0.05.

## RESULTS

### Baseline characteristics

A total of 77 patients underwent gastrectomy with curative intent from January 2013 to December 2014. The laparoscopic approach was used in 52 (68%) patients. The open approach was used in 25 (32%) patients. There were no statistically significant differences in sex, age, CCI (*i.e.*, comorbidities) or tumour stage. Patients undergoing laparoscopic gastrectomy had significantly more frequently received neoadjuvant chemotherapy (69% vs 44%, *P* = 0.046) (Table 2).

A consecutive series of 30 patients who underwent open surgery were included retrospectively, these patients underwent surgery between May 2012 and January 2013. These patients did not differ from patients who underwent open surgery in the prospective series with regards to the baseline characteristics mentioned in the prospective group.

### Primary outcome

The costs (in euro's) of surgical instrumentation were significantly higher for laparoscopic surgery compared to open gastrectomy, 2270 ± 670 and 1181 ± 680 respectively, *P* < 0.001 (Table 3). Also, the costs of theatre use were significantly higher in the laparoscopic group compared to open gastrectomy, 3819 (± 865) and

**Table 3** Primary outcome, costs of surgery, hospital admission and intensive care unit stay

| Costs (in euro's)        | Open<br>gastrectomy ( <i>n</i><br>= 25, 32.5%) | Laparoscopic<br>gastrectomy ( <i>n</i><br>= 52, 67.5%) | <i>P</i> value |
|--------------------------|--|--|----------------|
| Surgical instrumentation | 1181 ± 680                                     | 2270 ± 670   | < 0.001        |
| Operating theatre use    | 2545 ± 1268                                    | 3819 ± 865   | < 0.001        |
| Ward stay                | 2218 ± 1810                                    | 1381 ± 1298  | 0.023          |
| ICU stay                 | 1729 ± 6499                                    | 716 ± 3299   | 0.366          |
| Admission                | 3947 ± 6719                                    | 2097 ± 4419  | 0.153          |
| Total costs              | 7673 ± 8064                                    | 8187 ± 4864  | 0.729          |

ICU: Intensive care unit.

2545 ± 1268 respectively, *P* < 0.001. Costs of general ward stay were significantly lower in the laparoscopic group compared to open gastrectomy, 1381 ± 1298 and 2218 ± 1810 respectively, *P* = 0.023. ICU stay and total admission costs (*i.e.*, ward stay and ICU stay combined) were not significantly different. The total costs of admission and surgery did not significantly differ between open and laparoscopic gastrectomy, 7672 ± 8064 and 8187 ± 4863 respectively, *P* = 0.729.

When a retrospective consecutive series of open gastrectomies was included to obtain equal sized groups (*i.e.*, 55 open vs 52 laparoscopic gastrectomies), total admission costs were significantly lower in the laparoscopy group, 2097 ± 4420 vs 4611 ± 7991, *P* = 0.048. Costs difference of total hospitalisation (*i.e.* operating theatre and ward stay) between open and laparoscopic gastrectomy was smaller at 8187 ± 4868 for laparoscopic patients vs 7915 ± 8653 for patients who underwent open surgery, *P* = 0.843.

### Secondary outcomes

Comparison between the two techniques showed that total theatre time utilized was 191 min ± 95 for the open procedure and 286 min ± 65 for the laparoscopic gastric resection (*P* < 0.001) (Table 4). Results for secondary outcome parameters are listed in Table 4. Mean intraoperative blood loss was significantly less in the laparoscopic gastrectomy group (267 mL vs 592 mL, *P* = 0.002). In three cases, the laparoscopic approach was converted to an open procedure. In one case this was due to a splenic rupture, which was caused during laparoscopic surgery. In the other two patients the reason for conversion to an open procedure was a limited view of suspected ingrowth of tumour in the pancreas.

Laparoscopic gastrectomy was associated with a lower rate of overall complications and major complications, 16 (31%) vs 15 (60%), *P* = 0.025 and 6 (12%) vs 7 (28%), *P* = 0.104 respectively. Anastomotic leakage rates were higher in patients undergoing open gastrectomy than laparoscopic gastrectomy 2 (12%) and 2 (4%) respectively, *P* = 0.322. The differences in major complications and anastomotic leakage rates were not statistically significant in the prospective series. Also, patients who underwent laparoscopic resection had a shorter length of hospital stay and ICU stay (Table 4).

**Table 4 Secondary outcome parameters**

|                                | Open gastrectomy ( <i>n</i> = 25, 32.5%) | Laparoscopic gastrectomy ( <i>n</i> = 52, 67.5%) | <i>P</i> value |
|--------------------------------|--|--|----------------|
| Intraoperative blood loss (mL) | 592 (± 529, 100-2500)                    | 267 (± 316, 20-2000) <sup>1</sup>                | 0.002          |
| OR time (min)                  | 191 (± 95, range 95-554)                 | 286 (± 65, range 207-597)                        | < 0.001        |
| Lymph node yield ( <i>n</i> )  | 25 (± 10, 751)                           | 26 (± 8, 10-47)                                  | 0.651          |
| Any complication               | 15 (60%)                                 | 16 (31%)   | 0.025          |
| Grade Clavien-Dindo ≥ 3a       | 7 (28%)                                  | 6 (12%)  | 0.104          |
| Anastomotic leakage            | 3 (12%)                                  | 2 (4%)   | 0.322          |
| Mean length of stay (d)        | 15 (± 14, 5-59)                          | 9 (± 12, 2-84)                                   | 0.044          |
| Mean ICU stay (d)              | 3 (± 10, 0-49)                           | 1 (± 5, 0-35)                                    | 0.366          |
| Readmission                    | 4 (16%)                                  | 6 (12%)  | 0.720          |

<sup>1</sup>Five missing values for intraoperative blood loss in laparoscopic group. ICU: Intensive care unit.

When comparing equal sized groups (*i.e.*, 55 open and 52 laparoscopic gastrectomies), significantly more major complications occurred in the open surgery group, 17 (31%), compared to the laparoscopic group, 6 (12%), *P* = 0.019. Also, the anastomotic leakage rate was significantly higher in the open surgery group at 10 (18.2%) compared to 2 (4%) in the laparoscopic group, *P* = 0.029.

In the prospective series two patients died after surgery 1 (4%) after open gastrectomy and 1 (2%) after laparoscopic gastrectomy. In the total series (*i.e.*, including the retrospective series of open gastrectomies) four patients (7.3%) died after open gastrectomy, three died after septicemia from anastomotic leakage with one patient who also had a concurrent pancreatic leakage. One patient died of a severe aspiration pneumonia. One patient (1.9%) died after a laparoscopic gastrectomy from intestinal ischemia of the right and transverse colon.

Both techniques had a similar lymph node yield: mean 29 ± 10 and 26 ± 8.5 for open and laparoscopic gastrectomy respectively (*P* = 0.103). There were three cases of microscopically irradical resection: One in the open group and two in laparoscopic gastrectomy group (*P* = 0.614). Analysis of equal sized groups (*i.e.*, 55 open vs 52 laparoscopic gastrectomies) resulted in similar results for the abovementioned secondary outcome parameters.

## DISCUSSION

The aim of this study was to evaluate the costs of laparoscopic surgery for gastric cancer during the introduction of this new technique in a tertiary referral centre. The results show a significant increase in costs of surgery associated with the laparoscopic procedure. These costs are mainly due to increased use of (non-) disposable instrumentation and theatre time. The secondary outcomes suggest that laparoscopic gastrectomy is safe. This is represented by less blood loss, and less (major) post-operative complications in laparoscopic surgery. With regards to oncological safety the number of harvested lymph nodes and microscopically irradical resections were equal in laparoscopic and open surgery. Only two patients died in this study, one following open and one following laparoscopic gastrectomy.

This study was conducted at the time when laparoscopic approach was introduced in our tertiary referral

hospital for gastric cancer. The complexity of the laparoscopic approach is one of the reasons for a more time-consuming procedure. As surgeons gain experience, operative time is expected to decrease and theatre costs (at an hourly rate) will decline. Moreover, knowledge of the postoperative care on the clinical wards and safety of earlier discharge (ERAS) for patients who underwent laparoscopic as well as open surgery may help reduce hospital stay. This study shows positive results with regards to financial aspects of laparoscopic surgery even during the introduction and learning curve phase of its introduction.

Even though the duration of operation is expected to decline, the longer operative time compared to open surgery will probably remain. This has been shown in larger meta-analyses with weighted mean differences ranging from + 48 to + 82 min longer operative time for laparoscopy<sup>[12-14]</sup>.

These meta-analyses also show several other advantages of laparoscopic surgery compared to open surgery such as significantly shorter hospital stay (2.5-3.6 d) and significantly lower complication rates<sup>[13,14]</sup>. These differences can be expected to be associated with lower costs. Moreover, laparoscopic gastrectomy has been shown to be associated with improved quality of life<sup>[15]</sup>. Studies in liver surgery, pancreatectomy and wedge resections for gastrointestinal tumours, have shown that laparoscopic surgery has the same advantages discussed above compared to open surgery (*e.g.*, shorter hospital stay, less intraoperative blood loss, decreased medical complications and no differences in operative mortality)<sup>[16-18]</sup>. For pancreatic and wedge resections this was performed at the cost of a longer operative time and a more expensive procedure due to costly surgical instruments<sup>[16,17]</sup>. In these studies increased costs associated with the procedure and instrumentation are offset by a reduction in other costs (*e.g.*, shorter hospital stay). This possibly makes laparoscopy a viable and cost effective option.

Another potential cost benefit of laparoscopic surgery could be found in long term complications of open abdominal surgery. Incidence of incisional hernia can be expected to be much lower in laparoscopic surgery compared to patients who underwent midline laparotomy. Therefore costs of treating incisional hernia might be



lower in laparoscopic compared to open surgery for gastric cancer.

Multimodal fast-track programs such as ERAS could further decrease hospital stay and complication rates and therefore costs. A fast-track program in laparoscopic gastrectomy for gastric cancer has been shown to be associated with decreased hospital stay and costs<sup>[19]</sup>.

One of the main limitations of this study is its non-randomized design. Therefore a selection bias cannot be excluded. Also the non-equal sized groups is a consequence of this fact. By partially retrospectively studying prospectively maintained digital registration data of used materials an effort could be made to compare equal sized groups. Most data and all costs-related data regarding laparoscopic procedures however were collected prospectively. Despite this, statistically significant differences were shown for the primary and secondary outcomes. No definitive conclusions can be drawn with regard to aspects such as postoperative complications and long term oncological safety. However, secondary outcomes show differences in favor of laparoscopic surgery. These are in line with other studies and show a shorter length-of hospital stay and fewer complications. Another limitation is that only patients who underwent surgery with curative intent for gastric adenocarcinoma were included. No conclusions can be drawn with regard to costs of palliative resections.

In conclusion, during the introduction of a laparoscopic gastrectomy programme for gastric cancer costs for theatre use and surgical instrumentation were higher compared to the open technique but overall costs were similar due to reduced length of stay and lower complication rates (and therefore lower ICU admission rates and costs). Similar results regarding surgical safety, feasibility and post-operative complications between laparoscopic and open gastrectomy were found. Larger prospective studies will be needed to determine cost effectiveness of laparoscopic surgery for gastric cancer.

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## COMMENTS

### Background

Laparoscopic surgery for gastric cancer has gained popularity despite initial concerns regarding safety and oncological adequacy. Studies conducted in Korea and Japan reported that laparoscopic gastrectomy is comparable to open gastrectomy with regard to surgical and oncological outcomes.

### Research frontiers

A meta-analysis by Memon *et al* showed that laparoscopic procedures are associated with less blood loss but longer operation time. Many studies have reported outcomes of laparoscopic surgery for early gastric cancer, but several authors have shown that a laparoscopic approach can also be used in cases of advanced gastric cancer.

## Innovations and breakthroughs

The authors aimed to evaluate the costs of the introduction of a laparoscopic surgery program for gastric cancer in a Western community training hospital and tertiary referral centre for gastric cancer surgery.

## Applications

Larger prospective studies will be needed to determine cost effectiveness of laparoscopic surgery for gastric cancer.

## Peer-review

An interesting manuscript describing cost analysis for laparoscopic gastric cancer surgery. It contains an important message for gastric cancer surgeons, to provide proof in favor of laparoscopic surgery for fellow surgeons, hospital directory boards and insurance companies. Nice short and concise manuscript.

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