Textbook outcome in the surgical treatment of acute cholecystitis

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Research Article

Keywords: acute cholecystitis, laparoscopic cholecystectomy, medicare, quality of health care, textbook

Posted Date: March 17th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2647625/v1

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Abstract

Background

Textbook Outcome (TO) is a novel composite measure of clinical outcomes that can be used to measure the quality of surgical outcomes. The aim of this cohort study was to propose TO criteria for laparoscopic cholecystectomy for acute cholecystitis and to identify reasons for TO failure and individual patient factors that predispose to failure.

Methods

We retrospectively analyzed data for 189 consecutive patients with acute cholecystitis who underwent laparoscopic cholecystectomy. TO was defined as laparoscopic cholecystectomy without conversion to open cholecystectomy, intraoperative complications, postoperative complications (Clavien–Dindo classification ≥ 2), prolonged length of stay (≥ 10 days), readmission within 30 days, or mortality. Demographic and clinical differences between patients with and without TO were compared using univariate and multivariate analyses.

Results

TO was achieved in 81% (n = 154) of 189 patients who underwent laparoscopic cholecystectomy for acute cholecystitis. Medical costs were lower in the TO-achieved group than in the TO-failure group. Factors associated with TO on univariate analysis were age, vascular disease, history of malignant tumor treatment, white blood cell count, hemoglobin, C-reactive protein, albumin, gallbladder perforation, and > 3 days since the onset of symptoms. Factors on multivariate analysis were age > 70 years, hemoglobin < 11.9 g/dl, and white blood cells > 18,000 / µl (all P < 0.05).

Conclusions

Applying TO to patients with acute cholecystitis allowed us to evaluate the overall quality of care related to hospitalization. TO may provide better assessment of the quality of care and help determine the treatment choice and reduce costs.

Background

Acute cholecystitis is a common abdominal emergency. However, among patients with acute cholecystitis, there is variability in the intra- and postoperative complications, and the rates of rehospitalization and mortality (1). These factors depend on the patient’s background, degree of inflammation (for example, the grade in the Tokyo guidelines), time from onset, and the presence or absence of treatment history. Although previous reports have evaluated some of these issues, such as the
relationship between preoperative inflammation and operation time (2), no reports have comprehensively evaluated these issues. Additionally, information about a single parameter does not capture the multidimensional aspects of the entire surgical process.

The concept of textbook outcome (TO) has emerged as a new tool to provide an overall measure of successful outcome, considering multiple measures of quality after surgical intervention (3). TO has been reported for elective laparoscopic cholecystectomy (4). We considered that it was valuable to adapt TO to acute cholecystitis, which is associated with a wide variety of patient backgrounds. The purpose of this study was to evaluate TO for acute cholecystitis and to improve the quality of future medical care by examining the factors related to TO failure.

**Methods**

**Patients**

This retrospective study involved 189 patients who underwent laparoscopic cholecystectomy for acute cholecystitis at the Department of Surgery, Saiseikai Fukuoka General Hospital between May 2012 and August 2022. The patients’ clinical data and surgical information were recorded.

**Perioperative Management**

Acute cholecystitis was diagnosed in accordance with the Tokyo guidelines (5), and if acute cholecystitis occurred within 1 week of onset and the patient was able to tolerate surgery, laparoscopic cholecystectomy was performed on the day of diagnosis or the day after. On the first day after the operation, oral intake of water and food were resumed, and if the drainage fluid was clear, the drain was removed and blood tests were performed. After confirming that the patient’s vital signs were stable and that the inflammatory response was improving, the patient was considered for discharge from the hospital on or after postoperative day 2. If there was a problem, hospitalization was continued.

**Laparoscopic Cholecystectomy Procedure**

We inserted two 12-mm trocars and three 5-mm trocars. Carbon dioxide was used for peritoneal insufflation, and the abdominal pressure was maintained at 8 mmHg. We routinely freed the cystic artery and cystic duct, achieving a critical view of safety, and then dissected the gallbladder. The cystic artery was sealed and dissected with laparoscopic coagulation shears after clipping, and the cystic duct was sharply dissected after clipping. A 19-Fr J-VAC™ drain (Ethicon, Somerville, NJ, USA) was placed in the gallbladder bed from the right side of the abdomen when intraperitoneal bile contamination was severe. One hundred twenty cases were operated by surgeons and 69 cases by residents. The resident operation was performed under the guidance of surgeons.
Textbook Outcome

TO was defined as laparoscopic cholecystectomy performed in the absence of conversion to open cholecystectomy, intraoperative complications, postoperative complications (Clavien–Dindo classification ≥ 2), prolonged postoperative length of stay (LOS) (≥ 10 days), readmission within 30 days, or mortality. Postoperative complications comprised biliary complications as well as other complications.

Statistical analysis

All data were expressed as median (interquartile range [IQR]). Categorical variables were compared using the χ² test. Continuous variables were compared using the Mann–Whitney U test. Receiver operating characteristic curves were created to determine the optimal cutoff values. A logistic regression model was used for the multivariate analyses. All statistical analyses were performed using JMP15 software (SAS Institute Inc., Cary, NC, USA). P < 0.05 was considered significant.

Results

Patient characteristics

The patients comprised 130 men and 59 women with a median age of 64 years (IQR: 53–75 years). Thirty-six patients had diabetes (19%), 39 patients had vascular disease (20.6%), 18 patients had a history of cancer treatment (9.5%), and 70 patients had hypertension (37%). Sixty patients had abdominal pain for more than 3 days (31.7%). Preoperative computed tomography revealed fluid retention around the gallbladder in 169 patients (89.4%) and gallbladder perforation in 23 patients (12.1%). Nineteen patients (10.1%) had previously received conservative treatment for cholecystitis. The median hospital cost was USD 5837 (Table 1). None of the patients underwent bailout surgery.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n = 189)</th>
<th>TO achieved (n = 154)</th>
<th>TO not achieved (n = 35)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient clinical background</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>64 (53–75)</td>
<td>63 (50–72)</td>
<td>74 (64–80)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Sex, male/female</td>
<td>130/59</td>
<td>107/47</td>
<td>23/12</td>
<td>0.666</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>36 (19.0)</td>
<td>27 (17.5)</td>
<td>9 (25.7)</td>
<td>0.280</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>39 (20.6)</td>
<td>25 (16.2)</td>
<td>14 (40.0)</td>
<td>0.003</td>
</tr>
<tr>
<td>History of malignant tumor treatment</td>
<td>18 (9.5)</td>
<td>11 (7.1)</td>
<td>7 (20.0)</td>
<td>0.032</td>
</tr>
<tr>
<td>Hypertension</td>
<td>70 (37.0)</td>
<td>56 (36.4)</td>
<td>14 (40.0)</td>
<td>0.689</td>
</tr>
<tr>
<td>White blood cell (/ul)</td>
<td>12900 (9850–15850)</td>
<td>12450 (9800–15500)</td>
<td>13700 (11100–18900)</td>
<td>0.048</td>
</tr>
<tr>
<td>Neutrophil (/ul)</td>
<td>10543 (7728–13608)</td>
<td>10452 (7566–13342)</td>
<td>11799 (8246–15434)</td>
<td>0.183</td>
</tr>
<tr>
<td>Lymphocyte (/ul)</td>
<td>1124 (703–1571)</td>
<td>1168 (756.7–1590.3)</td>
<td>900 (552.0–1537.6)</td>
<td>0.540</td>
</tr>
<tr>
<td>Hemoglobin (mg/dl)</td>
<td>14.2 (13.0–15.2)</td>
<td>14.4 (13.2–15.2)</td>
<td>13.2 (11.3–14.8)</td>
<td>0.003</td>
</tr>
<tr>
<td>CRP (mg/dl)</td>
<td>7.5 (0.69–18.9)</td>
<td>7.13 (0.61–15.57)</td>
<td>13.09 (4.82–24.66)</td>
<td>0.014</td>
</tr>
<tr>
<td>LCR</td>
<td>154 (62.3–1177.0)</td>
<td>196.2 (71.2–1344.5)</td>
<td>77.6 (42.5–271.6)</td>
<td>0.203</td>
</tr>
<tr>
<td>NLR</td>
<td>9.2 (5.8–16.2)</td>
<td>9.1 (5.3–15.1)</td>
<td>10.4 (7.2–22.1)</td>
<td>0.051</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>3.9 (3.4–4.3)</td>
<td>4.0 (3.6–4.4)</td>
<td>3.5 (2.9–3.7)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>0.74 (0.61–1.00)</td>
<td>0.74 (0.62–0.92)</td>
<td>0.90 (0.59–1.21)</td>
<td>0.994</td>
</tr>
</tbody>
</table>

Data are presented as n (%) or median (interquartile).

Abbreviations: TO, Textbook Outcome; CRP, C-reactive protein; LCR, lymphocyte-CRP ratio; NLR, neutrophil-lymphocyte ratio
<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n = 189)</th>
<th>TO achieved (n = 154)</th>
<th>TO not achieved (n = 35)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pericholecystic fluid</td>
<td>169 (89.4)</td>
<td>137 (88.9)</td>
<td>32 (91.4)</td>
<td>0.733</td>
</tr>
<tr>
<td>Gallbladder perforation</td>
<td>23 (12.1)</td>
<td>15 (9.7)</td>
<td>8 (22.9)</td>
<td>0.048</td>
</tr>
<tr>
<td>History of conservative treatment for acute cholecystitis</td>
<td>19 (10.1)</td>
<td>13 (8.4)</td>
<td>6 (17.1)</td>
<td>0.147</td>
</tr>
<tr>
<td>More than 3 days since the onset of symptoms</td>
<td>60 (31.7)</td>
<td>43 (28.0)</td>
<td>17 (48.6)</td>
<td>0.021</td>
</tr>
<tr>
<td>Severity grading for acute cholecystitis</td>
<td>79 (41.8)</td>
<td>55 (35.7)</td>
<td>24 (68.6)</td>
<td>0.001</td>
</tr>
<tr>
<td>Grade or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Stay</td>
<td>8 (4–8)</td>
<td>5 (4–6)</td>
<td>12 (10–18)</td>
<td></td>
</tr>
<tr>
<td>Medical costs ($)</td>
<td>5837 (4755–7594)</td>
<td>5209 (4587–6505)</td>
<td>10043 (7778–12967)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Data are presented as n (%) or median (interquartile).

Abbreviations: TO, Textbook Outcome; CRP, C-reactive protein; LCR, lymphocyte-CRP ratio; NLR, neutrophil-lymphocyte ratio

**To And Its Contributing Factors**

A total of 154 patients (81.5%) achieved TO for laparoscopic cholecystectomy with an unremarkable perioperative course and without conversion to open cholecystectomy, intraoperative complications, prolonged LOS (≥ 10 days), postoperative complications, readmission within 30 days, or mortality (Table 1). Medical costs were lower in the TO-achieved group compared with the TO-failure group (USD 5209 vs USD 10,043, respectively) (P < 0.001). Table 2 shows the outcomes in the TO-failure cases. Ten patients (5.3%) were converted to open cholecystectomy, 1 patient (0.5%) had intraoperative complications, 5 patients (15.3%) had postoperative complications, and 29 patients (82.9%) had prolonged LOS (≥ 10 days). No patients were readmitted or died. The intraoperative complication was bile duct injury. Postoperative complications comprised paralytic ileus, intraabdominal abscess, wound infection, bile leakage, and cholangitis.
Table 2
Perioperative data for patients who underwent laparoscopic cholecystectomy

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All (n = 189)</th>
<th>Contribution to TO failure (n = 35)</th>
<th>Single contributor to TO (n = 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converted to open cholecystectomy</td>
<td>10 (5.3)</td>
<td>10 (28.6)</td>
<td>6 (17.1)</td>
</tr>
<tr>
<td>Intraoperative complication</td>
<td>1 (0.5)</td>
<td>1 (2.9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Postoperative complications (Clavien-Dindo classification ≥2)</td>
<td>5 (2.6)</td>
<td>5 (14.3)</td>
<td>1 (0.1)</td>
</tr>
<tr>
<td>Prolonged LOS (≥ 10 d)</td>
<td>29 (15.3)</td>
<td>29 (82.9)</td>
<td>23 (65.7)</td>
</tr>
<tr>
<td>Readmission within 30 days</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Mortality</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Data are presented as n (%).

Abbreviations: TO, Textbook Outcome; LOS, length of stay.

Univariate And Multivariate Analyses Of The Prognostic Factors For To

Table 1 lists the univariate analysis results for factors associated with TO in patients who underwent laparoscopic cholecystectomy for acute cholecystitis. Univariate analysis showed that TO-failure patients were more likely to be older (P < 0.001), and to have had vascular disease (P = 0.003) and a history of malignant tumor treatment (P = 0.032) compared with TO-achieved patients. Compared with TO-achieved patients, TO-failure patients also had higher white blood cell counts (P = 0.048), lower hemoglobin (P = 0.003), higher C-reactive protein (CRP) (P = 0.0143), lower albumin (P < 0.001), more frequent gallbladder perforation (P = 0.0475), more than 3 days since the onset of symptoms (P = 0.0209), and severity grade II or III acute cholecystitis (P = 0.001). Inflammatory markers, such as lymphocyte-CRP ratio and neutrophil-lymphocyte ratio, which have recently attracted attention (6, 7, 8), were not associated with TO failure.

The appropriate TO cutoff points and their respective areas under the curve values were as follows: age, 70 years (0.704); white blood cell count, 18,000/µL (0.591); hemoglobin, 11.9 g/dl (0.641); CRP, 12.86 mg/dl (0.630); and albumin 3.7 g/dl (0.726). A white blood cell count of > 18,000/µL, which was calculated by receiver operating characteristic curve, was consistent with that of the Tokyo guidelines for moderate cholecystitis (5). Moreover, multivariate analysis showed that age > 70 years (odds ratio (OR): 3.362, 95% confidence interval (CI): 1.319–8.569; P = 0.0111), hemoglobin < 11.9 g/dl (OR: 5.874, 95% CI: 1.717–20.091; P = 0.0048), and white blood cells > 18,000/µL (OR: 39.682, 95% CI: 1.698–927.148; P = 0.00221) were significantly associated with TO failure (Table 3).
Table 3
Multivariate logistic regression of variables associated with not achieving TO

<table>
<thead>
<tr>
<th>Independent variable for outcome of TO failure</th>
<th>OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) &gt; 70</td>
<td>3.362 (1.319–8.569)</td>
<td>0.0111</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>1.793 (0.647–4.971)</td>
<td>0.2612</td>
</tr>
<tr>
<td>History of malignant tumor treatment</td>
<td>3.064 (0.879–10.684)</td>
<td>0.0788</td>
</tr>
<tr>
<td>White blood cell &gt; 18000 /ul</td>
<td>39.682 (1.698-927.148)</td>
<td>0.0221</td>
</tr>
<tr>
<td>Hemoglobin &lt; 11.9 (g/dl)</td>
<td>5.874 (1.717–20.091)</td>
<td>0.0048</td>
</tr>
<tr>
<td>CRP &gt; 12.86 (mg/dl)</td>
<td>0.883 (0.305–2.556)</td>
<td>0.8199</td>
</tr>
<tr>
<td>Albumin &lt; 3.7 (g/dl)</td>
<td>1.654 (0.573–4.771)</td>
<td>0.3511</td>
</tr>
<tr>
<td>Preoperative radiological findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gallbladder perforation</td>
<td>5.331 (0.914–31.093)</td>
<td>0.0629</td>
</tr>
<tr>
<td>More than 3 days since the onset of symptoms</td>
<td>5.329 (0.686–41.380)</td>
<td>0.1096</td>
</tr>
<tr>
<td>Severity grading for acute cholecystitis</td>
<td>0.277 (0.027–2.833)</td>
<td>0.2794</td>
</tr>
<tr>
<td>Grade or</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: TO, Textbook Outcome; OR, odds ratio; CI, confidence interval; CRP: C-reactive protein.

Discussion

Quality assessment of complex surgical procedures has focused on analysis of individual outcome parameters, such as mortality, serious morbidity, and length of stay (9, 10, 11). Kolfschoten et al. first reported the concept of TO in 2012 (12). TO offered a simplified performance measure that might be easier for stakeholders to interpret when evaluating the frequency of overall delivery of the desired clinical result (12). This concept has been applied to various diseases (4, 13, 14, 15). In the present article, to our knowledge, we reported the first TO assessment for acute cholecystitis. Regarding the evaluation of patients who underwent surgical treatment for acute cholecystitis, laparoscopic techniques have improved remarkably compared with the past, and the complications rate is relatively low. However, other causes may result in extended hospital stays, readmissions, and higher medical costs for some patients (16). By applying TO to acute cholecystitis, we were able to evaluate the quality of medical care from various aspects.

Selection of the TO factors was an important task in this study. Lucocq et al. reported that the TO criteria for elective cholecystectomy were conversion to open cholecystectomy, subtotal cholecystectomy, intraoperative complications, postoperative complications (Clavien–Dindo classification ≥ 2), postoperative imaging or intervention, prolonged postoperative LOS (> 2 days), readmission, or mortality (4). We determined the TO factors in this study by referring and modifying the findings of Lucocq et al.
Gallaher and Charles reported a median length of hospital stay of 10 days for patients with acute cholecystitis who underwent laparoscopic cholecystectomy more than 3 days after onset (1). Therefore, we determined the definition of prolonged postoperative LOS as 10 days or more. We did not include postoperative imaging as a TO factor because some hospitals routinely perform postoperative imaging. It is necessary to consider whether to include postoperative imaging tests as a TO factor in future studies. There are few reports on the indication of TO for benign diseases, and it is necessary to examine TO factors from various reports.

Severity grading for acute cholecystitis was categorized in accordance with the Tokyo guideline, in this study. The Tokyo guideline classifies severity of acute cholecystitis into mild (grade I), moderate (grade II), and severe (grade III) acute cholecystitis on basis of the presence of any of the following: organ dysfunction (cardiovascular, neurological, respiratory, hepatic, and hematological), white blood cell counts, palpable tender mass in the right upper abdominal quadrant, duration of complaints, and evidence of marked local inflammation (gangrenous cholecystitis, pericholecystic abscess, hepatic abscess, biliary peritonitis, emphysematous cholecystitis) (5). In the present article, white blood cells > 18,000/µl, and gallbladder perforation and pain lasting more than 3 days, which was the diagnostic criteria for moderate cholecystitis, were selected as investigated factors. Moderate to severe cholecystitis was also included as an investigated factor. These were risk factors for TO failure in the univariate analysis, but surprisingly, in the multivariate analysis, gallbladder perforation, pain lasting more than 3 days, and moderate to severe cholecystitis were not risk factors. Treatment guidelines suggest laparoscopic cholecystectomy or biliary drainage followed by laparoscopic cholecystectomy for moderate cholecystitis (5). Therefore, for moderate cholecystitis, white blood cell counts might be a factor when considering therapy.

Patients in the TO-failure group had approximately twice the cost of care compared with those in the TO-achieved group. Therefore, applying TO to acute cholecystitis might lead to a reduction in medical costs. If inflammation is marked (white blood cells > 18,000/µl), it is conceivable that adhesions or fibrosis around Calot's triangle are strong, which increases surgical difficulty (17). Older and anemic patients might have worse performance status compared with younger and non-anemic patients (18, 19). We showed that age > 70 years and hemoglobin < 119 g/l were factors associated with TO on multivariate analysis. Therefore, it might be possible to prevent TO failure by performing surgery more carefully in elderly patients with marked inflammation and anemia. Non-surgical treatment options for acute cholecystitis are cholecystostomy and antibiotics. Patients with risk factors might avoid TO failure with non-surgical options if their condition permits, and medical costs might be reduced. Additionally, identifying a patient's risk factors for TO failure could help surgeons understand patient variability and guide an individualized consent process. During the explanation of a medical condition to a patient with risk factors for TO failure, it is also possible to explain the possibility of TO failure.

There are some limitations in our study. This was a single-center retrospective study, and the results may not extrapolate to other environments. Additionally, the sample size was small. Multicenter studies with larger cohorts are needed to overcome these limitations.
Conclusions

We applied TO to patients with acute cholecystitis, which allowed us to focus on the overall quality of care related to hospitalization. These outcomes should help improve assessment of the quality of care and drive quality improvement, treatment choice, and cost reduction. Increasing the rates of TO use should be a goal toward achieving cost-effective care.

Abbreviations

CRP
c-reactive protein
IQR
interquartile range
LOS
length of stay
TO
textbook outcome

Declarations

Ethics approval and consent to participate

The protocol for this research project has been approved by a suitably constituted Ethics Committee of Saiseikai Fukuoka General Hospital.

All informed consent was obtained from the subjects. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable

Availability of data and materials

The data used in the current study can be obtained on request from our corresponding author.

Conflict of interest statement

The authors declare that they have no competing interests

Funding information

The authors confirm that this study was not supported by any grants or other funding sources.
Author contributions

Conception and design: Norifumi Iseda and Tomohiro Iguchi. Development of the methodology: Norifumi Iseda, Tomohiro Iguchi, Shinji Itoh and Shun Sasaki. Acquisition of data: Norifumi Iseda and Tomohiro Iguchi. Analysis and interpretation of the data: Norifumi Iseda, Tomohiro Iguchi, and Takuya Honboh. Writing, review and/or revision of the manuscript: Norifumi Iseda, Tomohiro Iguchi, Noriaki Sadanaga, and Hiroshi Matsuura. Study supervision: Tomoharu Yoshizumi, Noriaki Sadanaga and Hiroshi Matsuura.

Acknowledgments

We thank Jane Charbonneau, DVM, from Edanz Group (https://jp.edanz.com/ac) for editing a draft of this manuscript.

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