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## Textbook outcomes in hepatobiliary and pancreatic surgery

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### Abstract

The concept of textbook outcome (TO) has recently gained popularity in surgical research and has been used to evaluate the quality or success of different surgical procedures, including hepatopancreatobiliary (HPB) operations. TO consists of individual outcome parameters that each reflect different domains of care including structure, process, and individual outcomes; in turn, the composite TO metric represents the optimal course after a surgical episode. TO can be used to assess patient-level outcomes, hospital performance, center designation and quality metrics. In addition to being an outcome measurement, TO may also be linked to healthcare costs. Future efforts should be directed towards establishing a universal definition of TO in HPB surgery so that surgeons and hospitals can assess and compare outcomes, identify shortcomings and improve real world patient outcomes.

**Key Words:** Textbook; Outcome; Hepatopancreatobiliary; Surgery

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**Core Tip:** The concept of textbook outcome (TO) has recently gained popularity in surgical research and has been used to evaluate the quality or success of different surgical procedures, including hepatopancreatobiliary (HPB) operations. TO can be used to assess patient-level outcomes, hospital performance, center designation and quality metrics. Future efforts should be directed towards establishing a universal definition of TO in HPB surgery so that surgeons and hospitals can assess and compare outcomes, identify shortcomings and improve real world patient outcomes.

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## INTRODUCTION

Traditionally, quality assessment of complex surgery has focused on analyzing and evaluating individual outcome parameters, mainly complications, length of stay (LOS), in-hospital mortality, as well as 30-, 90-d mortality and readmission<sup>[1]</sup>. More recently, there has been a shift in quality assessment from individual outcome parameters to composite outcomes, which have been considered superior to assess patient outcomes and hospital performance<sup>[2-5]</sup>. A recently introduced concept, “textbook outcome” (TO) represents the optimal course following surgery that is better aligned with patient expectations around “optimal” care<sup>[2-5]</sup>. TO uses an “all-or-none” approach in which the optimal or “textbook” outcome is not achieved unless patients achieve all of the individual parameters comprising a TO<sup>[2-5]</sup>.

The concept of TO has gained popularity in surgical clinical research and has been advocated as a measure to assess quality or success of complex surgical procedures, including abdominal aortic aneurysm repair, as well as hepatopancreatic, esophageal, gastric, sarcoma, colon cancer resection and transplantation<sup>[2-10]</sup>. Specifically, TO is a composite measure that aggregates various clinically important perioperative outcomes included in the definition of an “optimal” surgical episode. Such a composite measure encompasses determinants of quality of care from different domains including structure, process, and individual outcomes<sup>[2]</sup>. Indeed, each individual outcome may capture different domains of quality (e.g., perioperative mortality might be related to operative volume, failure-to-rescue may be related to structure or processes of perioperative care, while LOS or readmissions may be related to discharge planning processes in place for each institution)<sup>[5]</sup>. In turn, TO is particularly relevant in the care of complex cancers, including hepatopancreatobiliary (HPB) malignancies, which require coordination across a number of specialties and through various phases of multidisciplinary treatment to achieve the best possible outcome<sup>[3,5,11]</sup>. In addition, TO can be used as a “benchmark” to track the quality of care delivered to patients and compare hospital performance across different institutions or health systems<sup>[12-14]</sup>. In this article, we highlight the existing and emerging literature on TOs in HPB surgery.

## ASSESSING PATIENT-LEVEL OUTCOMES USING TO

Although the concept of TO was initially described in 2013 by a group of colorectal surgeons in Netherlands<sup>[2]</sup>, it was used for the first time to assess outcomes of patients undergoing hepatopancreatic surgery in 2018<sup>[4]</sup>. Merath *et al*<sup>[4]</sup> first assessed TO rates after hepatopancreatic surgery among Medicare beneficiaries from 2013 to 2015<sup>[4]</sup>. TO was defined no postoperative complications, no prolonged LOS (*i.e.*,  $\leq 75^{\text{th}}$  percentile), no 90-d readmission and no 90-d postoperative mortality<sup>[4]</sup>. The study analyzed patients with all surgical indications (*i.e.*, both benign and malignant diseases) and demonstrated that TO was achieved in 44% of individuals undergoing hepatopancreatic surgery<sup>[4]</sup>. Of note, among patients who underwent pancreatic resection, TO was achieved in 47.8% following minor pancreatic resection (*i.e.*, distal pancreatectomy or other partial pancreatectomy) and 24.7% following major pancreatic resection (*i.e.*, proximal pancreatectomy, pancrea-ticoduodenectomy, total pancreatectomy)<sup>[4]</sup>. Similarly, while TO was achieved in 46.8% of patients undergoing minor hepatectomy, the incidence of TO decreased to 33.3% among patients who had undergone a major liver resection<sup>[4]</sup>. These data highlighted the fact that less than one-half of patients overall experienced an optimal or “textbook” outcome after hepatopancreatic surgery; in particular, achievement of TO was markedly lower among patients undergoing major pancreatic or liver resections.

Due to the inherent limitations of administrative billing databases, several important perioperative outcomes were not captured and assessed in the initial study by Merath *et al*<sup>[4]</sup>. Rather, the use single- or multi-center institutional databases that contain more granular data to provide more clinically important information and allow for a more thorough assessment of postoperative outcomes was needed. To this

end, Merath *et al*<sup>[3]</sup> published a subsequent study that assessed the incidence of TO following resection of intrahepatic cholangiocarcinoma (ICC) using a multi-institutional database that incorporated data from 15 major HPB centers<sup>[3]</sup>. In this study, the authors defined TO as R0 resection, no perioperative transfusion, no postoperative complications, no prolonged LOS, no 30-d readmission and no 30-d mortality<sup>[3]</sup>. Among 687 patients analyzed, TO was achieved only in 25.5% of patients undergoing curative-intent resection for ICC. Younger patient age (age < 60 years), absence of preoperative jaundice, earlier T-category disease (*i.e.*, T1a, T1b), node-negative disease, and no bile duct resection were independent predictors of TO<sup>[3]</sup>. Although 30-d mortality was less than 5%, a TO was achieved in only one-fourth of patients largely due to high rates of complications and LOS, highlighting the need for further improvements in managing patients undergoing complex HPB procedures<sup>[3]</sup>.

Another study examined TO after curative-intent resection of hepatocellular carcinoma (HCC)<sup>[5]</sup>. TO was defined as R0 resection, no reoperation, no severe postoperative complications (Clavien-Dindo  $\geq$  III), no prolonged LOS, no 90-d readmission and no 90-d mortality<sup>[5]</sup>. In analyzing 605 patients, the incidence of TO was 62.3% after curative-intent resection of HCC<sup>[5]</sup>. Patients with BCLC-0 HCC and albumin-bilirubin grade 1 (*i.e.*, good liver function) had higher odds of achieving a TO<sup>[5]</sup>. In addition to examining perioperative outcomes, the impact of TO on long-term outcomes was also assessed. Of note, patients who experienced a TO had a better 5-year overall survival (OS) of 69.6% compared with a 5-year OS of 56.9% among individuals who did not achieve a TO<sup>[5]</sup>, which was in line with previous studies on esophageal and gastric cancer<sup>[6]</sup>. Similarly, Heidsma *et al*<sup>[15]</sup> reported an incidence of TO that was 49.3% among patients undergoing resection for pancreatic neuroendocrine tumors; the odds of TO varied based on the type of procedure performed<sup>[15]</sup>. In fact, the highest TO rates were noted among individuals undergoing distal pancreatectomy (56.7%) followed by those undergoing enucleation (52.0%) and then pancreatoduodenectomy (32.5%)<sup>[15]</sup>. TO was also an independent predictor of long-term outcomes, with 3-year disease-free survival ranging from 91.7% among patients who achieved a TO to 85.2% among patients who did not<sup>[15]</sup>. These data validated the clinical relevance of TO among cancer patients, aligning the importance of surgical quality (and outcomes) with the primary goal of achieving a potentially curative operation. As more investigators integrate TO into the field of surgical oncology, TO may evolve to incorporate other variables representing domains of multidisciplinary care delivery (*i.e.*, negative margin resection, adequate lymph node sampling, receipt of neoadjuvant/adjuvant chemotherapy) to create an oncologic composite outcome measure [*i.e.*, textbook oncologic outcome (TOO)]<sup>[16,17]</sup>. Although consensus as to which individual components should define a TOO has not been reached (Table 1), the use of a TOO might be a better way to characterize patient and hospital-level outcomes among cancer patients.

## ASSESSING HOSPITAL PERFORMANCE, DESIGNATIONS AND QUALITY METRICS USING TOs

Hospital performance remains an important topic among patients and stakeholders, such as insurance and pharmaceutical companies as well as the government. To date, different designations and ranking systems are available to evaluate hospital performance. Of note, teaching hospitals have been assigned with the mission to teach the next generation of physicians, support research and provide excellent patient care<sup>[18,19]</sup>. Previous studies had demonstrated contradictory results when examining individual outcome parameters (*i.e.*, mortality, morbidity, readmissions) relative to teaching hospital status<sup>[18,19]</sup>. To this point, Mehta *et al*<sup>[12]</sup> investigated the impact of teaching status on TO among Medicare beneficiaries undergoing hepatopancreatic surgery<sup>[12]</sup>. Of note, patients undergoing surgery for pancreatic cancer at a major teaching hospital were more likely to achieve a TO *vs* patients treated at a minor teaching hospital<sup>[12]</sup>. When assessing only high volume hospitals, the odds of a TO were comparable among patients treated at major *vs* minor teaching centers, highlighting that the beneficial effect of teaching hospital status was largely mediated by procedural volume and not necessarily by teaching status itself<sup>[12]</sup>.

Another study investigated a commonly used ranking system, the United States News & World Report (USNWR) Best Hospital rankings, relative to TO<sup>[21]</sup>. Although the USNWR rankings are commonly used by patients and are thought to influence patient decision-making and choice of hospital to undergo treatment, a recent study demonstrated similar odds of achieving a TO among patients undergoing complex

**Table 1 Existing literature around textbook outcome in hepatopancreatobiliary surgery**

Ref.	Study period	Database	Indication	Components of TO	TO rates
Merath <i>et al</i> <sup>[3]</sup> , 2019	2013-2015	Medicare	Benign and malignant hepatopancreatic lesions	No complications. No prolonged LOS. No 90-d mortality. No 90-d readmission	44.0%
Merath <i>et al</i> <sup>[4]</sup> , 2020	1993-2015	Multi-institutional ICC database	Intrahepatic cholangiocarcinoma	R0 resection No transfusion. No complications. No prolonged LOS. No 30-d mortality. No 30-d readmission	25.5%
Tsilimigras <i>et al</i> <sup>[5]</sup> , 2020	2000-2015	Multi-institutional HCC database	Hepatocellular carcinoma	R0 resection No reoperation. No complications (Clavien-Dindo $\geq$ III) No prolonged LOS. No 90-d mortality. No 90-d readmission	62.3%
Heidsma <i>et al</i> <sup>[15]</sup> , 2020	2000-2016	US Neuroendocrine Tumor Study Group database	Pancreatic neuroendocrine tumors	R0 resection No complications (Clavien-Dindo $\geq$ III). No prolonged LOS. No 90-d mortality. No 90-d readmission	49.3%

TO: Textbook outcome; LOS: Length of stay; ICC: Intrahepatic cholangiocarcinoma; US: Ultrasonography; HCC: Hepatocellular carcinoma.

cancer surgery (*i.e.*, lung, colorectal, esophageal, liver and pancreatic resections) at honor roll (top 20 institutions) *vs* non-honor roll hospitals<sup>[13]</sup>. These data suggested that the USNWR ranking had only a minor impact on the likelihood of achieving a TO and, thus, should not necessarily be used to choose institutions to undergo complex cancer surgery. In addition, these data suggested that composite outcomes such as TO should perhaps be taken into consideration among policymakers to establish the methodology of hospital ranking systems for complex cancer surgery.

For oncologic patients, quality of care is of particular importance as patients seek a holistic, multidisciplinary care in the battle against cancer. To date, there are only 10 dedicated cancer centers (DCCs) that provide care to cancer patients<sup>[20]</sup>. Another important designation for hospitals providing cancer care is the National Cancer Institute cancer center (NCI-CC) designation, which approximately 70 institutions in the United States hold for outstanding efforts related to prevention, diagnosis and treatment of cancer<sup>[21]</sup>. In another study by Mehta *et al*<sup>[20]</sup>, the authors compared outcomes of patients undergoing hepatopancreatic surgery at DCC *vs* NCI-CC for cancer<sup>[20]</sup>. Of note, patients who underwent hepatopancreatic surgery had increased odds of achieving a TO when treated at a DCC *vs* NCI-CC (pancreatic resections: 22% higher chance of a TO; liver resection: 31% higher chance of a TO), despite the fact that DCCs more frequently cared for patients with multiple comorbidities<sup>[20]</sup>. Higher TO rates translated into reduced Medicare expenditures at DCCs, which suggested a higher value proposition of DCC *vs* NCI-CC in the treatment of patients with hepatopancreatic malignancies<sup>[20]</sup>.

Several other national quality metrics have been proposed to assess quality of care provided to patients. For example, hospital magnet recognition, established by the American Nurses Credentialing Center has been used to identify institutions with a focus on improving nursing care and, in turn, quality of care delivered to patients<sup>[22]</sup>. In addition, the Leapfrog Group has set a minimum annual hospital surgical volume for certain operations—including pancreatic resection (*i.e.*, > 20 pancreatic resections)—associated with improved outcomes<sup>[23]</sup>. Another quality indicator made available by the Leapfrog group is the Leapfrog safety grade which is solely focused on patient safety<sup>[23,24]</sup>. In analyzing data from 4853 Medicare beneficiaries, Merath *et al*<sup>[14]</sup> examined all 3 quality indicators (*i.e.*, leapfrog minimum volume standards, safety grade and magnet status) relative to TO following hepatopancreatic resections<sup>[14]</sup>. Of note, patients undergoing pancreatectomy at hospitals meeting all 3 quality metrics (*i.e.*, quality trifactor) had 28% higher odds of experiencing a TO compared with individuals undergoing pancreatectomy at non-trifactor hospitals<sup>[14]</sup>. When examining each of the quality indicators separately, magnet status and safety grade A were alone not enough to confer high TO rates. Rather, the positive effect of the quality trifactor was largely mediated by the compliance with the Leapfrog minimum volume standards that were associated with lower odds of mortality and serious complications and, in turn, greater odds of TO<sup>[14]</sup>.

## ASSESSING TRENDS IN TOs OVER TIME

TO has also been assessed relative to changes in practice and outcomes in HPB surgery over time. By analyzing the American College of Surgeons National Surgical Quality Improvement Program database, Beane *et al*<sup>[25]</sup> reported an increase in optimal or “textbook” outcomes after pancreatic surgery in North America<sup>[25]</sup>. There was a decrease in postoperative morbidity, mortality and LOS between 2013-2017 that resulted in an increase in the incidence of TO by 3% to 5% after pancreatic surgery on a nationwide level<sup>[25]</sup>. A number of reasons might be responsible for this improvement. First, there was a decrease in superficial and deep surgical site infections, and a decrease in the rates of shock/sepsis after pancreatic resection<sup>[25]</sup>. In addition, an increase in minimally invasive pancreatic resection was noted over time (mainly robotic resection) that may have contributed to a decrease in LOS. The broad dissemination and implementation of enhanced recovery after surgery protocols over the past 5 to 10 years likely also contributed to the observed reduction in LOS<sup>[26,27]</sup>. Furthermore, the increase in TO incidence over time may also have been to centralization of pancreatic cancer care at specialized centers and increased access to multidisciplinary oncologic teams. In turn, the modest improvement in the incidence of TO noted over time may be a reflection of the varied distribution of pancreatic cancer cases, and not an actual improvement in the majority of centers throughout the nation<sup>[25]</sup>.

Indeed, by combining two multi-institutional datasets, Tsilimigras *et al*<sup>[11]</sup> analyzed the trends in TO rates after curative-intent resection of primary liver malignancies (*i.e.*, ICC and HCC) at major HPB centers over a 12-year period<sup>[11]</sup>. Overall, 62.0% of patients achieved a TO after ICC or HCC resection at major HPB centers. In assessing the trends of TO over the years, no significant improvement was noted over the study period examined (2005-2017) ( $P_{\text{trend}} = 0.90$ )<sup>[11]</sup>. When analyzing the individual components comprising TO, no specific factor demonstrated an increasing trend over time (all  $P_{\text{trend}} > 0.05$ ). Perhaps more surprisingly, no increasing trends in TO rates were noted among patients undergoing either major (2005 to 2009: 49%; 2014 to 2017: 48%) or minor liver resection (2005 to 2009: 71%, 2014 to 2017: 71%) over the study period (both  $P_{\text{trend}} > 0.05$ )<sup>[11]</sup>. Apart from TO itself, the year of surgery was also not associated with improved long-term outcomes among patients with either ICC or HCC<sup>[11]</sup>. These data highlight the fact that despite advances in surgical techniques and perioperative care, only modest improvements in the outcomes of HCC and ICC patients occurred over the last decade. In turn, there is still a long way to optimize real world outcomes among patients with HPB malignancies.

## FINANCIAL IMPACT OF TOs

Besides representing a quality outcome measure, TO may also have financial implications. In fact, the financial impact of TO has been investigated and data have suggested that a disproportionate amount of money is spent on patients who do not achieve a TO after hepatopancreatic surgery. For example, Merath *et al*<sup>[4]</sup> noted that among patients who achieved a TO, Medicare payments were approximately \$11000 less following minor hepatopancreatic resections and \$14000 less for patients undergoing major resection when compared with individuals who did not achieve a TO<sup>[4]</sup>. Similarly, Mehta *et al*<sup>[12]</sup> suggested that TO resulted in an average of \$5000 less in Medicare expenditures after hepatopancreatic surgery at teaching hospitals (TO: \$19191, *vs* no TO: \$24165,  $P < 0.001$ )<sup>[12]</sup>. The association of decreased overall costs with the achievement of a TO was consistent across major and minor teaching hospitals, as well as among high and low volume institutions, highlighting that TO has financial implications irrespective of the hospital setting<sup>[12]</sup>. Collectively, the data suggest that TO might be a composite metric that reflects value – *i.e.*, high quality combined with lower costs. In turn, improving TO rates after hepatopancreatic surgery may not only optimize the quality of care provided to patients, but also decrease health care costs and lead to cost-effective and high-value care.

## ADVOCATING FOR WIDER IMPLEMENTATION OF TO IN HPB SURGERY

Advocates of TO note that this composite metric provides a more comprehensive estimate of quality of perioperative care<sup>[28]</sup>. However, a primary criticism of TO is that there is no consensus in the literature as to what should be considered an “optimal”

outcome after a specific operation. Moreover, patient risk factors strongly influence outcomes and require comprehensive risk adjustment in order to make valid comparisons. With the thoughtful implementation of composite quality metrics in HPB surgery, surgeons and centers will hopefully gain a better understanding of the perioperative processes of care and develop insights to improve patient outcomes. Moreover, the optimization of expectation management will be facilitated, especially in high-risk patients. Improved understanding of these gaps through the use of TO can allow systems to identify patients who are high risk of failure to achieve optimal short- and long-term outcomes after surgery and redirect resources accordingly. Thus, fundamentally the concept of TO aligns with the patient best interest, which is the ideal outcome after surgery.

## CONCLUSION

TO provides a more realistic assessment of patient-centered perioperative care and represents the optimal experience around a surgical episode. TO should be the ideal outcome that surgeons should strive to achieve for their patients. The use of TO in cancer populations is of paramount importance as a measure of both short- and long-term outcomes. TO can be used to assess performance across different institutions as well as assess quality metrics or hospital designations. Future efforts should be directed towards establishing a universal definition of TO in HPB surgery so that surgeons and hospitals can assess and compare outcomes, as well as identify shortcomings and improve real-world patient outcomes.

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