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Outcomes of EUS-Guided Gallbladder Drainage: A Case Series from a Tertiary Referral Center in Ireland

Mohamed Wael Mohamed [1,2], Olufemi Aoko [1] and Danny Cheriyan [1,*]

[1] Department of Gastroenterology, Beaumont Hospital, D09 V2N0 Dublin, Ireland; oluaoko@gmail.com (O.A.)
[2] Department of Gastroenterology, King Hamed University, Royal Medical Services, Busaiteen 24343, Bahrain
* Correspondence: dannycheriyan@beaumont.ie

Abstract

Background/Objectives: Cholecystectomy remains the gold-standard treatment for acute cholecystitis. However, in patients deemed unfit for surgery, alternative gallbladder drainage techniques are required. These include percutaneous gallbladder drainage (PT-GBD), endoscopic transpapillary gallbladder drainage (ET-GBD), and the more recently adopted endoscopic ultrasound-guided gallbladder drainage (EUS-GBD). EUS-GBD has emerged as a promising minimally invasive option, offering high technical and clinical success with fewer complications and need for reinterventions. The objective of this study was to evaluate the clinical outcomes of EUS-GBD in high-risk surgical patients with acute cholecystitis. **Methods**: We conducted a single-center retrospective study evaluating outcomes of EUS-GBD in a tertiary referral center in Ireland. Data from ten high-risk patients with acute cholecystitis who underwent EUS-GBD using a 15 mm × 10 mm HOT AXIOS lumen-apposing metal stent (LAMS) between October 2017 and September 2018 were analyzed. Parameters assessed included technical and clinical success, adverse events, and 1-year mortality. **Results**: The mean age of patients was 79.5 years (range 65–95). Technical success of stent placement was achieved in all patients with no immediate complications. A trans-gastric approach was used in 7 patients while a trans-duodenal route was employed in the remaining 3. 1–year mortality following EUS-GBD was 20%. Stents were not removed in any patient in this series. No patient experienced stent-related adverse events, re-occurrence of cholecystitis, or the need for re-intervention. **Conclusions**: EUS-GBD has very high technical and clinical success rates, with low risk of complications and need for re-intervention in comparison to other options of GB decompression. It is, however, not widely available, and it requires a skilled endoscopist with experience in interventional EUS.

Keywords: acute cholecystitis; endoscopic ultrasound; gallbladder drainage; lumen-apposing metal stents; advanced endoscopy

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1. Introduction

Acute cholecystitis is a common clinical presentation encountered in emergency departments worldwide. It is most often the result of gallstone impaction in the cystic duct, leading to bile stasis, gallbladder distension, bacterial overgrowth, and subsequent inflammation of the gallbladder wall. Evidence-based diagnostic criteria rely on the integration of clinical features (such as right upper quadrant pain, fever, and Murphy's sign), laboratory markers (e.g., leukocytosis, elevated CRP), and imaging findings, particularly

from abdominal ultrasound or computed tomography [1]. Timely diagnosis and appropriate management are critical, as delayed intervention can result in complications such as gangrenous cholecystitis, gallbladder perforation, peritonitis, and sepsis [2,3].

Laparoscopic cholecystectomy is the definitive treatment for acute cholecystitis and is widely accepted as the gold standard. Early surgical intervention—typically within 72 h of symptom onset—is associated with lower complication rates, reduced conversion to open surgery, and shorter hospital stays [2,4]. However, a significant subset of patients, particularly the elderly and those with multiple comorbidities, are deemed unfit for surgery due to their elevated perioperative risk. This necessitates alternative approaches that can provide effective source control while minimizing procedural morbidity.

The Tokyo Guidelines 2018 provide an internationally accepted framework for classifying the severity of acute cholecystitis. According to these criteria, moderate (grade II) cholecystitis is diagnosed when features such as high WBC count (>18,000/mm^3), a palpable mass in the right upper quadrant, or symptom duration longer than 72 h are present. Severe (grade III) cholecystitis, on the other hand, is defined by the presence of organ dysfunction in one or more systems—cardiovascular, respiratory, renal, hepatic, hematologic, or neurologic [1]. These classifications assist clinicians in determining whether patients are suitable for immediate surgery or should instead be managed with gallbladder drainage and supportive care.

Gallbladder drainage (GBD) is recommended for patients with severe cholecystitis who are not surgical candidates and may also be considered in moderate cases where surgery poses high risk or where there is failure to respond to conservative management [3]. Currently, three primary nonsurgical GBD modalities are employed: percutaneous transhepatic gallbladder drainage (PT-GBD), endoscopic transpapillary gallbladder drainage (ET-GBD), and endoscopic ultrasound-guided gallbladder drainage (EUS-GBD) [5].

PT-GBD is the most widely used technique, especially in centers without advanced endoscopic capabilities. The procedure involves image-guided percutaneous insertion of a catheter into the gallbladder to allow for external bile drainage. It provides rapid decompression and is technically straightforward with high initial success rates [6,7]. However, it has several limitations. These include patient discomfort related to the external drain, the potential for catheter-related complications such as dislodgement, infection, bile leakage, and the requirement for ongoing maintenance. Studies report catheter-related adverse events in up to 14% of cases [8]. Moreover, many patients undergoing PT-GBD never proceed to definitive cholecystectomy due to frailty or medical contraindications, thus making this temporary intervention a long-term solution by default [9].

ET-GBD is performed via endoscopic retrograde cholangiopancreatography (ERCP) by selectively cannulating the cystic duct and inserting a stent for internal drainage. While this approach avoids external drains and is more tolerable for patients, it is limited by anatomical challenges, such as cystic duct obstruction or tortuosity, and carries the inherent risks of ERCP—namely pancreatitis, bleeding, and perforation [10]. Technical success requires considerable operator expertise, and availability is often restricted to high-volume centers.

In contrast, EUS-GBD has emerged as an innovative and increasingly favored modality for high-risk patients. Using endoscopic ultrasound guidance, a covered self-expanding metal stent—commonly a lumen-apposing metal stent (LAMS)—is deployed to establish a direct fistulous tract between the gallbladder and the gastrointestinal tract (most often the duodenum or stomach) [11]. This technique enables internal drainage without reliance on external tubes and functionally mimics a surgical anastomosis.

The LAMS used in our center is the HOT AXIOS™ stent (Boston Scientific, Marlborough, MA, USA), which integrates electrocautery-enhanced delivery for a single-step deployment. Available in diameters of 10, 15, or 20 mm, the stent is 10 mm in length

and flanged on both ends to facilitate stable anchoring and prevent migration. In our experience, we utilized the 15 mm diameter stent exclusively, as it provided a balance between adequate drainage and procedural safety. Notably, our literature review identified no comparative studies assessing clinical outcomes based on LAMS length.

The design of the LAMS allows for direct gallbladder access and the possibility of future peroral cholecystoscopy, stone extraction, or stent exchange. Furthermore, the single-step cautery-enhanced access reduces procedural time and complexity, minimizing the risk of targeting errors or tissue misalignment that may occur with conventional multi-step stent placement.

Patient selection remains a cornerstone of successful EUS-GBD outcomes. Candidates must have a sufficiently distended gallbladder in close apposition to the gastrointestinal lumen, as well as hemodynamic stability to tolerate sedation or general anesthesia. Pre-procedural imaging, such as CT or EUS assessment, is essential to confirm anatomical suitability and avoid intervening vessels or anatomical barriers. Moreover, patients with large-volume ascites, coagulopathy, or suspected gallbladder perforation are generally considered poor candidates for EUS-GBD.

Growing evidence from multicenter studies and meta-analyses has reinforced the safety and efficacy of EUS-GBD. Technical success rates typically exceed 95%, with clinical success—defined as symptom resolution and no need for further intervention—achieved in over 90% of patients. Complication rates are generally lower than those reported for PT-GBD, and hospital stay duration is often shorter. A 2018 meta-analysis even showed a significantly lower rate of reintervention and post-procedural pain in patients who underwent EUS-GBD compared to PT-GBD [12]. In 2022, ESGE have recommended EUS-GBD over PT-GBD in high-risk surgical patients, based on fewer adverse events and lower re-intervention rate with the former.

In this article, we present our initial institutional experience with the use of the HOT AXIOS™ LAMS in patients deemed unsuitable for surgical cholecystectomy. Our findings suggest that EUS-GBD is a feasible, effective, and safe alternative for gallbladder drainage in high-risk surgical candidates, aligning with emerging international data and contributing to the evolving landscape of minimally invasive interventions for acute cholecystitis. As experience with this technique continues to grow, EUS-GBD may assume an increasingly central role in the management algorithm for patients with acute cholecystitis who cannot undergo surgery.

Ultimately, EUS-GBD represents a critical advance in therapeutic endoscopy and patient-centered care, offering an effective, internal, and durable alternative to percutaneous drainage with the added potential for future endoscopic management of gallstones and stents. Continued research, multidisciplinary collaboration, and experience-sharing between centers will be pivotal in refining indications, optimizing outcomes, and extending access to this promising intervention.

2. Materials and Methods

This is a single-center, retrospective, descriptive study evaluating the initial institutional of performing EUS-GBD using the HOT AXIOS™ LAMS system at Beaumont Hospital, a tertiary referral center located in the Republic of Ireland. The study period spanned from October 2017 to September 2018, during which all patients who underwent EUS-GBD were identified and included for analysis, without exclusions based on age, gender, or underlying comorbidities.

All procedures were either performed or directly supervised by a single senior interventional endoscopist with significant prior experience in therapeutic EUS. The procedural setting was a dedicated endoscopy unit equipped for advanced endoscopic interventions.

The indication for EUS-GBD in each case was based on a formal multidisciplinary team discussion, following assessment by the primary surgical team. All included patients were deemed unfit for cholecystectomy due to underlying comorbidities, frailty, or general anesthetic risk. The procedures were conducted under conscious sedation, administered and monitored by the endoscopist, in accordance with institutional protocols. Sedation regimens included combinations of Midazolam and Fentanyl, with Pethidine administered at the discretion of the endoscopist, depending on patient response and procedure duration. Continuous pulse oximetry and cardiopulmonary monitoring were used throughout.

EUS evaluation was initially performed to assess the gallbladder's position, wall thickness, anatomy, and surrounding vasculature using color Doppler to avoid vascular injury. The route of stent deployment—transgastric or transduodenal—was selected based on optimal anatomical alignment and stability of the target site. In all cases, a 15 mm × 10 mm HOT AXIOS™ LAMS was deployed using an electrocautery-enhanced delivery system under real-time endosonographic guidance, followed by confirmation of intraluminal positioning through direct endoscopic visualization. A diagnostic gastroscopy was routinely performed following stent deployment to assess for possible complications such as duodenal or pyloric obstruction.

Data were collected retrospectively from the hospital's electronic and paper-based medical records. Extracted variables included patient demographics, procedural details, stent route, technical and clinical success, adverse events, need for reintervention, and mortality at 6 months and 1-year post-procedure. Technical success was defined as successful deployment of the LAMS creating a fistulous tract between the gastrointestinal lumen (stomach or duodenum) and the gallbladder with adequate bile drainage. Clinical success was defined as resolution of signs and symptoms of acute cholecystitis, including improvement in abdominal pain, resolution of fever, and a reduction in inflammatory markers (white blood cell count and C-reactive protein) within 96 h of the procedure.

Adverse events were categorized as immediate (intra-procedural or within 24 h) and delayed (up to 30 days post-procedure). These included bleeding, stent migration, bile leakage, perforation, and post-procedure infection. The need for reintervention, defined as any unplanned procedure related to stent dysfunction or cholecystitis recurrence, was also documented. All-cause mortality at 6 and 12 months was recorded based on hospital records and follow-up documentation.

3. Results

Baseline patient demographics and clinical characteristics are summarized in Table 1. A total of 10 patients underwent endoscopic ultrasound-guided gallbladder drainage (EUS-GBD) at Beaumont Hospital between October 2017 and September 2018. The cohort included 3 males and 7 females, with a mean age of 79.5 years (range: 65–95 years), reflecting a population of predominantly elderly and medically complex individuals. The primary indication for EUS-GBD was acute calculous cholecystitis in 7 patients (70%), all of whom were considered high-risk surgical candidates due to age, comorbidities, or general anesthetic concerns. In 2 patients (20%), EUS-GBD was performed following endoscopic retrograde cholangiopancreatography (ERCP) with metal biliary stent placement, where cholecystitis occurred post cystic duct occlusion. The remaining 1 patient (10%) had malignancy-related cystic duct obstruction, precluding conventional drainage approaches. To objectively assess the pre-procedural functional status and comorbidity burden, both the American Society of Anesthesiologists Physical Status Classification System and the Charlson Comorbidity Index were employed. These tools provided a standardized method for evaluating baseline patient risk and suitability for endoscopic intervention and supported the clinical decision to proceed with EUS-GBD in lieu of surgical cholecystectomy.

Table 1. Patient characteristics.

Patient No.	Age	Gender	ASA Score *	Charlson Comorbidity Index **	Etiology of Cholecystitis	Site of Puncture
1.	80	male	3	12	calculous	stomach
2.	95	female	3	9	calculous	duodenum
3.	84	male	3	7	calculous	stomach
4.	66	female	3	10	malignant	stomach
5.	65	female	3	2	calculous	duodenum
6.	80	male	3	8	post ERCP	stomach
7.	78	female	3	6	post ERCP	stomach
8.	79	female	3	4	calculous	duodenum
9.	83	female	3	5	calculous	stomach
10.	85	female	3	6	calculous	stomach

* American Society of Anesthesiologists physical status classification. See Appendix A.1 ** See Appendix A.2.

All patients included in the study had a definitive diagnosis of acute cholecystitis, confirmed based on clinical presentation, laboratory findings, and imaging criteria. According to the Tokyo Guidelines 2018 diagnostic and severity grading system [1], all cases were classified as moderate in severity (Grade II), reflecting the presence of features such as elevated white blood cell count, localized inflammatory findings, or symptom duration exceeding 72 h. Prior to undergoing endoscopic intervention, all patients were initiated on appropriate empiric intravenous antibiotic therapy, in accordance with institutional protocols and international guidelines for the management of moderate acute cholecystitis.

The EUS-guided gallbladder drainage (EUS-GBD) procedure was performed under real-time endoscopic ultrasound guidance. In all patients, gallbladder access was achieved via a freehand direct puncture using the electrocautery enhanced stent. Wire placement or fluoroscopy was not required for any patient in this series. Regarding access route, a transgastric approach was selected in 7 patients (70%), typically based on favorable anatomical orientation between the gallbladder and the posterior gastric wall. In the remaining 3 patients (30%), a transduodenal route was utilized, often due to closer proximity of the gallbladder to the duodenal bulb or anatomical constraints precluding safe gastric access.

Procedural outcomes are summarized in Table 2. Technical success—defined as the successful deployment of the HOT AXIOS™ LAMS with immediate confirmation of stent patency and absence of gastrointestinal luminal obstruction—was achieved in all 10 patients (100%). Importantly, no immediate procedure-related complications were observed during or immediately following the intervention. Clinical success, defined as complete resolution of signs and symptoms of acute cholecystitis within 96 h of stent placement, was also observed in 100% of patients. There were no adverse events reported within the first 30 days post-procedure, indicating a favorable short-term safety profile. However, it is noteworthy that one patient succumbed to aspiration pneumonia within a few days following the procedure; this event occurred in the context of advanced underlying malignancy and was not attributed directly to the EUS-GBD intervention.

At six-month follow-up, 9 out of 10 patients (90%) remained alive without any documented recurrence of cholecystitis, procedural complications, or requirement for reintervention. Over the course of one year, two patients died: one from metastatic lung cancer at 230 days post-procedure, and the other from aspiration pneumonia, as previously described. Thus, the 1-year mortality rate was 22.2% (2 out of 9 patients), with one additional patient lost to follow-up by that time point. Importantly, none of the patients required subsequent stent removal, and no cases of stent-related adverse events or migrations were identified during the follow-up period.

Table 2. Procedure outcomes.

Patient No.	Technical Success *	Immediate Adverse Events	Clinical Success **	30-Day Adverse Events	6 Months Morality	12 Months Mortality	Subsequent Stent Removal
1.	yes	none	yes	none	no	yes	no
2.	yes	none	yes	none	no	no	no
3.	yes	none	yes	none	no	no	no
4.	yes	none	yes	none	no	no	no
5.	yes	none	yes	none	no	no data	no
6.	yes	none	yes	none	no	no	no
7.	yes	none	yes	not applicable ***	yes	yes	no
8.	yes	none	yes	none	no	no	no
9.	yes	none	yes	none	no	no	no
10.	yes	none	yes	none	no	no	no

* Defined as successful gallbladder access and adequate transmural LAMS deployment. ** Defined as resolution of clinical parameters of acute cholecystitis within 96 h. *** Patient died of aspiration pneumonia in the setting of advanced malignancy few days post procedure.

4. Discussion

Our experience, which we believe represents the first series of patients in Ireland to undergo endoscopic ultrasound-guided gallbladder drainage (EUS-GBD), demonstrates that this novel procedure offers an excellent technical and clinical success rate, as well as a favorable safety profile, particularly in high-risk surgical populations. At six-month follow-up, 90% of patients were alive and free from recurrent gallbladder-related symptoms or complications. The majority of patients were alive at one year, and notably, all deaths observed were unrelated to either gallbladder disease or stent placement, further reinforcing the safety of this approach. We recognize that the retrospective nature of our study is a potential limitation. However, these results mirror outcomes from other large multicenter studies, which consistently demonstrate similarly high technical and clinical success rates across a range of healthcare settings [12–14].

Existing modalities for gallbladder decompression—most notably percutaneous transhepatic gallbladder drainage (PT-GBD)—continue to play an important role, especially in critically ill or unstable patients. EUS-GBD, while associated with superior internal drainage and patient comfort, necessitates certain prerequisites: a distended gallbladder, favorable anatomy, and a patient stable enough to tolerate endoscopic intervention. For patients who meet these criteria, EUS-GBD has emerged as an attractive alternative with important advantages. In several comparative studies, EUS-GBD has been associated with lower rates of post-procedural complications, shorter hospital stays, reduced readmission rates, and fewer reinterventions when compared with PT-GBD [15]. Furthermore, a 2018 meta-analysis confirmed that EUS-GBD achieves comparable technical and clinical success, while providing significantly lower post-procedural pain and better patient satisfaction [16].

EUS-GBD, however, is not without risk. Potential complications include bleeding, perforation, stent migration, occlusion, and bile leak [17]. Operator experience and appropriate patient selection are therefore critical. A systematic review and meta-analysis by Fabbri et al. pooled data from 27 studies (n = 1004) and reported a technical success rate of 98.0%, clinical success of 95.4%, and an overall adverse event rate of 14.8%. Importantly, meta-regression identified institutional experience (>10 cases/year) and the use of anti-migrating stents as key contributors to success. These findings emphasize the importance of procedural volume, expertise, and device choice in optimizing patient outcomes [18].

Following the resolution of cholecystitis after EUS-GBD, management of the lumen-apposing metal stent (LAMS) becomes a key consideration. One strategy involves performing a peroral cholecystoscopy approximately 4–6 weeks post-procedure to inspect the

gallbladder and facilitate stone clearance. During this session, the LAMS may be exchanged for double-pigtail plastic stents to maintain the cholecystoenteric fistula and ensure long-term drainage. This strategy has demonstrated a technical success rate of 93.1% [19,20]. Alternatively, in frail patients or those unwilling to undergo further procedures, the LAMS may be left in place indefinitely. A recent three-year registry follow-up has shown that this is a safe and effective long-term approach, though LAMS-related adverse events were more common when the stent was placed transgastrically versus transduodenally [21].

The decision regarding long-term stent management should be individualized. Factors to consider include patient frailty, gallstone burden, life expectancy, and institutional expertise in advanced endoscopy. Leaving the LAMS in situ indefinitely may be preferable in patients with limited physiological reserve, while elective cholecystoscopy and stent exchange may be better suited to patients with longer anticipated survival and higher functional capacity. Surveillance imaging may be warranted in patients managed conservatively to monitor for late adverse events such as stent occlusion or migration [22,23].

Emerging strategies have proposed the conversion of PT-GBD to EUS-GBD in stable patients once the acute phase resolves. This approach allows for internal drainage and eventual PT drain removal, improving quality of life. One Japanese retrospective study reported a successful conversion rate of 90% [24]. Saline flushes through PT drains can be used to re-expand the gallbladder, facilitating endoscopic access. EUS-GBD has shown superior technical and clinical outcomes compared to PT-GBD, with lower rates of recurrent cholecystitis and improved patient comfort [25].

Beyond benign disease, EUS-GBD is being explored for malignant indications. A recent Spanish multicenter registry evaluated EUS-GBD as a salvage option for patients with malignant distal biliary obstruction after failed ERCP or EUS-guided bile duct drainage. Technical success was achieved in 99%, and clinical success (defined by $\geq$50% bilirubin reduction) in 78.1%. Notably, more than half of these patients were subsequently able to receive chemotherapy, suggesting that EUS-GBD may enable further oncologic treatment in appropriately selected individuals [26]. These findings underscore the evolving utility of EUS-GBD not only as an alternative to percutaneous drainage, but also as a potentially enabling therapy in patients requiring timely cancer treatment.

However, certain contraindications must be respected. EUS-GBD is not suitable in cases of gallbladder perforation, biliary peritonitis, large-volume ascites, coagulopathy, or in patients unable to tolerate anesthesia [27]. Additionally, while LAMS placement does not preclude future cholecystectomy, it may render it more technically challenging due to the formation of a cholecystoenteric fistula [28]. In rare cases, persistent fistulae or stent-related complications may necessitate further intervention, and patients should be counseled accordingly.

In summary, EUS-GBD represents a major advance in the management of gallbladder disease for high-risk patients, providing effective, durable, and internal drainage with a relatively low complication rate. Careful multidisciplinary assessment and operator expertise are essential to ensuring optimal patient outcomes. The growing body of literature supports its safety, efficacy, and potential for broad clinical utility in both benign and malignant settings. As the technology matures, future studies will be essential in standardizing post-procedure protocols, refining patient selection criteria, and establishing long-term outcome data. EUS-GBD has the potential to become a cornerstone intervention in the non-surgical management of gallbladder disease.

5. Conclusions

EUS-GBD demonstrates high technical and clinical success rates and represents an effective minimally invasive alternative for GBD in patients deemed unfit for surgery. Its

advantages include internal drainage without the discomfort and complications associated with external catheters, contributing to better patient tolerance and improved quality of life. However, despite its clinical promise, the widespread adoption of EUS-GBD remains limited. A major barrier is the restricted availability of endoscopists with the specialized training and expertise required to perform the procedure safely and effectively. In addition, many institutions lack around-the-clock access to interventional endoscopy services, making urgent EUS-guided interventions less feasible in emergency settings, particularly when compared to percutaneous cholecystostomy.

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Data Availability Statement: Anonymized data are available from the corresponding author upon reasonable request and with permission from the institutional ethics committee.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ASA	American Society of Anesthesiologists
ERCP	Endoscopic Retrograde Cholangiopancreatopraphy
ET-GBD	Endoscopic transpapillary gallbladder drainage
EUS	Endoscopic Ultraosound
EUS-GBD	Endoscopic ultrasound-guided gallbladder drainage
GBD	Gallbladder Drainage
LAMS	Lumen-apposing metal stent
SEMS	Self-expandable metal stent
PT-GBD	Percutaneous gallbladder drainage

Appendix A

Appendix A.1

Table A1. American Society of Anesthesiologists physical status classification.

ASA Physical Status Classification	
Classification	**Definition**
ASA I	A normal healthy patient Healthy, non-smoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease Mild diseases only without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease

Table A1. *Cont.*

ASA Physical Status Classification	
Classification	**Definition**
ASA III	A patient with severe systemic disease Substantive functional limitations; One or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI $\geq$ 40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction in ejection fraction, ESRD undergoing regularly scheduled dialysis, history (>3 months) of MI, CVA, TIA, or CAD/stents.
ASA IV	A patient with severe systemic disease that is a constant threat to life Recent (<3 months) MI, CVA, TIA or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction in ejection fraction, shock, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes.

Appendix A.2

Table A2. Updated Charlson comorbidity index.

Updated Charlson Comorbidity Index	
Comorbid Conditions	**Weights**
Myocardial infarction	0
Congestive heart failure	2
Peripheral vascular disease	0
Cerebrovascular disease	0
Dementia	2
Chronic pulmonary disease	1
Rheumatic disease	1
Peptic ulcer disease	0
Mild liver disease	2
Diabetes without chronic complication	0
Diabetes with chronic complication	1
Hemiplegia or paraplegia	2
Renal disease	1
Any malignancy without metastasis, leukemia or lymphoma	2
Moderate or severe liver disease	4
Metastatic solid tumor	6
AIDS (excluded asymptomatic infection)	4
Maximum comorbidity score	24

To calculate Charlson comorbidity index, the following comorbid conditions were mutually exclusive: diabetes with chronic complications and diabetes without chronic complications; mild liver disease and moderate or severe liver disease; and any malignancy and metastatic solid tumor.

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