

Interventional procedure overview of endoscopic ultrasound-guided gallbladder drainage for acute cholecystitis when surgery is not an option

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Table 1 Abbreviations

Abbreviation	Definition
ASA	American Society of Anesthesiology
ATSEMS	Anti-migrating tubular self-expandable metal stents
CI	Confidence interval
ERCP	Endoscopic retrograde cholangiopancreatography
ETP-GBD	Endoscopic transpapillary gallbladder drainage
EUS-GBD	Endoscopic ultrasound-guided gallbladder drainage
IQR	Interquartile range
LAMS	Lumen-apposing metal stents
LC	Laparoscopic cholecystectomy
OR	Odds ratio
PT-GBD	Percutaneous gallbladder drainage
RR	Relative risk
SEMS	Self-expandable metal stent
SD	Standard deviation

Indications and current treatment

Acute cholecystitis is inflammation of the gallbladder. The most common cause of acute cholecystitis is gallstones (calculous cholecystitis) blocking the duct that drains the gallbladder (cystic duct). This means bile cannot drain from the gallbladder, causing pain, nausea, vomiting and fever.

Acalculous cholecystitis is a less common, but usually more serious, cause of acute cholecystitis. It usually develops as a complication of a serious illness, infection or injury that damages the gallbladder. It can be caused by accidental damage to the gallbladder during major surgery, serious injuries or burns, sepsis, severe malnutrition or HIV or AIDS.

Initial treatment usually involves fasting, pain relief and antibiotics if there is an infection. The gallbladder can be surgically removed (open or laparoscopic cholecystectomy) to prevent acute cholecystitis returning, and to reduce the risk of developing complications, such as gangrenous cholecystitis and peritonitis.

People who cannot have surgery may be able to have percutaneous cholecystostomy. This involves inserting a drainage catheter in the gallbladder through a small entry hole made in the abdominal wall. Endoscopic transpapillary gallbladder drainage is a less common alternative treatment. It involves inserting

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a plastic stent through the ampulla and cystic duct into the gallbladder endoscopically.

What the procedure involves

Endoscopic ultrasound-guided gallbladder drainage for acute cholecystitis is typically done under sedation or general anaesthesia using a specialist endoscope with an ultrasound probe and fluoroscopic guidance. Imaging is used before the procedure to determine its feasibility. An anastomotic tract is created into the gallbladder through either the wall of the antrum of the stomach (cholecystogastrostomy) or the wall of the duodenum (cholecystoduodenostomy) and a stent is inserted to establish biliary drainage into the gut and relieve the gallbladder obstruction. Occasionally, the anastomotic tract may be created between the gallbladder and jejunum (cholecystojejunostomy) if the anatomy has been altered by previous surgery.

Different technologies are used to create the anastomotic tract and deploy the stent, and stents can be made of different materials. Single-step devices allow for single-step delivery of the stent without the need to change instruments for track dilation. Multistep devices need track dilation with a cystotome and a biliary balloon.

The aim is to drain bile from the gallbladder and avoid the need for emergency cholecystectomy, particularly in people for whom surgery poses a high risk.

Outcome measures

The main outcomes included technical success (generally defined as the ability to access and drain the gallbladder by placement of a drainage tube or stent with immediate drainage of bile), clinical success (defined as resolution of clinical symptoms or improvement in biochemical parameters) and recurrence of cholecystitis. Other outcomes included reintervention rates, hospital readmissions and adverse events.

Evidence summary

Population and studies description

This interventional procedures overview is based on more than 15,000 patients from 3 systematic reviews (Fabbri 2022; Mohan 2020; Podboy 2021), 1 randomised controlled trial (Teoh 2020), 2 non-randomised comparative studies (Siddiqui 2019; Teoh 2021), 1 registry (Teoh 2019), 1 case series (Torres Yuste 2019) and 1 case report (Kim 2019). About 1,000 patients had the

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procedure. There was some overlap in patients between the studies and overlap in papers between the systematic reviews. Some of the studies summarised separately were also included in at least 1 of the reviews. The randomised controlled trial by Teoh et al. (2020) and the registry study by Teoh et al. (2017) were included in the systematic reviews by Podboy et al. (2021) and Fabbri et al. (2022). The non-randomised comparative studies by Siddiqui et al. (2019) and Teoh et al. (2021) were included in Podboy et al. (2021).

This is a rapid review of the literature, and a flow chart of the complete selection process is shown in [figure 1](#). This overview presents 9 studies as the key evidence in [table 2](#) and [table 3](#), and lists 68 other relevant studies in [table 5](#). Because of the large body of evidence, case series with 10 or fewer patients have been excluded.

Of the 72 studies included in the systematic review by Mohan et al. (2020), 7 were prospective and the rest were retrospective. Based on the Newcastle – Ottawa scale for cohort studies to assess bias, 37 studies were considered to be high quality, 33 studies were of medium quality, and 2 studies were considered to be of low quality. Of the 27 studies in Fabbri et al. (2022), 6 were prospective (including 1 randomised controlled trial) and the rest were retrospective. The authors described the overall quality of the included studies as sufficient. The only randomised controlled trial was at low risk of bias. Of the observational studies, 7 were high quality and the remaining studies were at high risk of bias. No study was at very high risk of bias. Of the 10 studies included in Podboy et al. (2021), 2 were randomised controlled trials and 8 were retrospective case cohort studies (1 matched 1:1 and 1 propensity score matched). The overall quality of evidence was evaluated using the Grading of Recommendations Assessment Development and Evaluation method. Of the retrospective studies, all 8 were considered very low quality, with studies lacking randomisation and allocation concealment. For the 2 randomised controlled trials, the level of evidence was considered moderate to low.

The systematic reviews did not report where the individual studies were done. The other studies included patients from Hong Kong, US, Denmark, Spain, Korea, China, Australia, India, Thailand and Singapore. In the review by Podboy et al. (2021), the median follow up was 212.5 days for patients who had EUS-GBD. The longest median follow up was 24.4 months, but this was a retrospective case series with only 22 patients (Torres Yuste 2019).

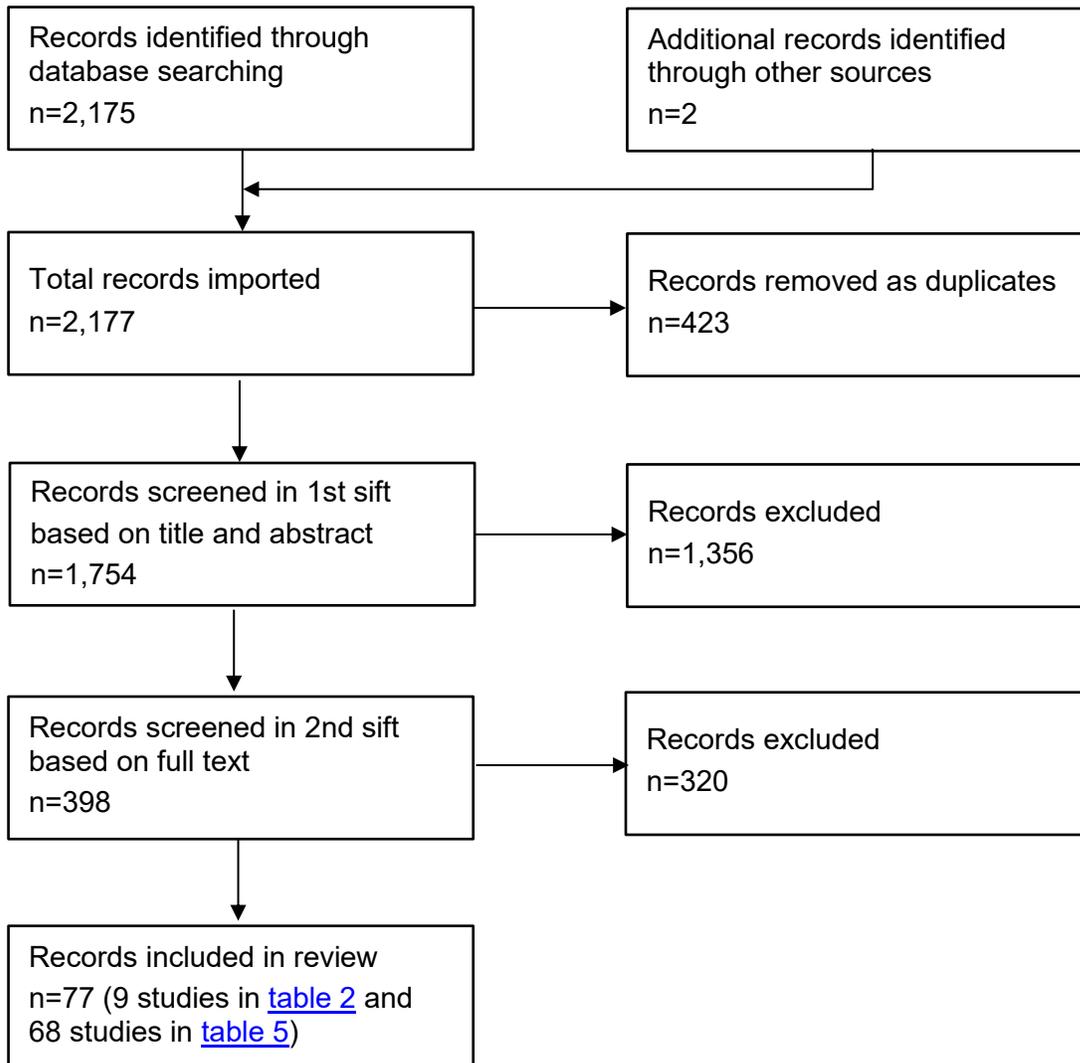
All studies included patients with acute cholecystitis for whom cholecystectomy was a high risk. The mean or median age ranged from 63 to 88 years. In the systematic review by Fabbri et al. (2022), 33% of patients had an underlying malignancy.

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Most of the comparative studies compared EUS-GBD with PT-GBD or ETP-GBD, but 1 compared it with LC (Teoh 2021).

[Table 2](#) presents study details.

Figure 1 Flow chart of study selection



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Table 2 Study details

Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
1	Fabbri C, 2022 Country not reported for individual studies	n=1,004 (56.3% male; 95% CI 51.3% to 61.2%)	Weighted mean 74 years (95% CI 71.9 to 76.1)	Systematic review and meta-analysis (27 studies); patients were enrolled between February 2009 and February 2020.	A study population which included patients treated with transmural EUS-GBD through metal stents for acute cholecystitis; an almost complete description of the baseline patients' clinical features analysed; and a complete description of technical and clinical success rates, together with the description of post-procedural adverse events.	Transmural EUS-GBD; 64% of procedures used a duodenal approach (n=699). Number of stents used: 654 LAMS, 205 ATSEMS, 145 SEMS or metal stent	Not reported
2	Mohan B, 2020 Country not reported for	n=15,131 (61% male)	The mean or median age ranged from 65 years to 85 years.	Systematic review and comparative meta-analysis (72 studies)	Studies that evaluated EUS-GBD, ETP-GBD, and PT-GBD in patients with acute	EUS-GBD (n=557), ETP-GBD (n=1,223) or PT-GBD (n=13,351).	Not reported

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Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
	individual studies				<p>cholecystitis who were considered high risk for immediate cholecystectomy because of age or underlying chronic disease processes such as malignancy were included.</p> <p>Exclusion criteria: studies on gallbladder drainage for malignant stricture of the bile ducts, studies with a sample size of fewer than 10 patients, studies conducted in a paediatric population (age less than 18 years), and studies not published in the English language.</p>		
3	Podboy A, 2021 Country not reported for	n=1,267 EUS-GBD 51% male	Median 71.0 years (range 62 to 82.7) for EUS-	Systematic review and network meta-analysis	Comparative studies assessing the efficacy of either of 2 or all modalities (PT-	EUS-GBD (n=472), PT-GBD (n=493) and ETP-GBD (n=302).	Median 212.5 days for EUS-

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Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
	individual studies	PT-GBD 58% male ETP-GBD 67% male	GBD, 74.7 years (range 60.4 to 81.2) for PT-GBD and 64.1 years (range 60 to 77.9) for ETP-GBD	(10 studies)	GBD, EUS-GBD, and ETP-GBD) used for treating acute cholecystitis in patients at high risk for cholecystectomy. Studies were included if they reported all 3 primary outcomes of interest: (1) technical success, defined as the ability to access and drain the gallbladder by placement of a drainage tube or stent with immediate drainage of bile; (2) clinical success, defined as resolution of clinical symptoms or improvement in biochemical parameters; and (3) postprocedure adverse events.	Wide variations in anatomic puncture location, stent size, and stent type were noted within the included studies.	GBD, 177.5 days for PT-GBD, and 150 days for ETP-GBD

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Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
4	Teoh A, 2020 Hong Kong	n=79 (42:37)	Mean 81.9 years (EUS-GBD); 79.8 years (percutaneous)	Randomised controlled trial	Consecutive patients aged 18 or over with grade 2 or 3 acute calculous cholecystitis, at very high risk for cholecystectomy. Patients were deemed very high risk if they satisfied 1 or more of the following criteria: Age 80 or above, American Society of Anesthesiology grade 3 or above, age adjusted Charlson Comorbidity Index above 5 or Karnofsky score less than 50.	EUS-GBD using LAMS (n=39) versus PT-GBD (n=40)	1 year
5	Siddiqui A, 2019 US, Denmark	n=372 (233:139)	Mean 63 years	Non-randomised comparative study (retrospective)	Patients with acute cholecystitis who were not candidates for cholecystectomy. Only patients with at least 3 months follow up were included.	EUS-GBD using LAMS (n=102), PT-GBD (n=146), ETP-GBD (n=124)	Median 3 months (range 3 to 9)

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Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
6	Teoh A, 2021 Hong Kong	n=60 (35:25)	Mean 78 years (EUS-GBD); 76.4 years (LC)	Non-randomised comparative study (propensity score analysis of a retrospective database)	<p>Patients with acute cholecystitis who had EUS-GBD or LC as a definitive management. In the EUS-GBD group, patients were at very high risk for cholecystectomy, satisfying 1 or more of the following criteria: age 80 years or above, ASA grade 3 or above, age adjusted Charlson comorbidity index more than 5, Karnofsky score less than 50. Elderly patients who refused surgery were also included.</p> <p>In the LC group, patients were surgically fit and presented with fewer than 7 days of pain.</p>	<p>EUS-GBD within 6 to 8 hours of diagnosis (n=30) or LC within 24 hours of diagnosis (n=30).</p> <p>Device used for EUS-GBD: LAMS (AXIOS, Boston Scientific, US). An additional double-pigtail plastic stent was inserted through the LAMS if there was concern that the gallstones could block the stent.</p>	Mean 571.9 days (EUS-GBD); 264.4 days (LC), p=0.002

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Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
7	Teoh A, 2019 Hong Kong, Spain, Denmark, US, Korea, China, Australia, India, Thailand, Singapore	n=379 (199:180)	Mean 73.6 years	Registry (international retrospective)	Consecutive patients who had EUS-GBD planned and attempted for symptomatic gallstones, acute cholecystitis or conversion of percutaneous cholecystostomy were included. Cholecystectomy was considered to be unsuitable if patients satisfied 1 or more of the following criteria: Age 80 years or above, ASA grade 3 or above, age adjusted Charlson score 4 or higher or Karnofsky score less than 50.	EUS-GBD using a variety of LAMS and stents with antimigration designs. Single-step (including the HOT AXIOS stent, Boston Scientific) and multi-step (including the SPAXUS stent, Taewoong Medical, Korea; the BONA-AL stent, Standard Sci Tech Inc., Korea; and the Microtech stent, Nan Jing Co. Ltd., China) devices were used.	Mean 433.6 days
8	Torres Yuste, 2019 Spain	n=22 (14: 8)	Median 88.3 years (IQR 82.6 to 92.7 years)	Case series (retrospective)	Patients who had EUS-GBD for acute cholecystitis. Cholecystectomy was dismissed in all	EUS-GBD using LAMS. The deployment technique depended on the	Median 24.4 months (IQR (18.2 to

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Study no.	First author, date country	Patients (male: female)	Age	Study design	Inclusion criteria	Intervention	Follow up
					cases because of the patients' advanced age and poor physical status (class 3 or higher on the ASA Physical Status classification). None of the patients improved after 24 to 72 hours of conservative management with intravenous antibiotics, fluid replacement and bowel rest. Patients with a stent indwell time less than 12 months were excluded.	type of stent used. With a conventional LAMS (AXIOS, Boston Scientific) serial dilation with cystotome followed by a biliary balloon was done before insertion of the stent under EUS and fluoroscopic guidance. In case of an electrocautery-enhanced (hot) LAMS (AXIOS, Boston Scientific) the stent was deployed directly over the guidewire.	42.4 months)
9	Kim J, 2019 US	n=2 (0: 2)	80 and 86 years	Case reports	Patients with severe retrograde reflux of gastric contents into the gallbladder after EUS-GBD.	EUS-GBD	Not reported

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Table 3 Study outcomes

First author, date	Efficacy outcomes	Safety outcomes
Fabbri C, 2022	<p>Pooled results (27 studies, n=1,004 unless stated otherwise)</p> <ul style="list-style-type: none"> • Technical success=98.0% (95% CI 96.3 to 99.3%; I²=23.6%) • Per-procedure clinical success=98.8% (95% CI 97.2 to 99.8%; I²=29.4%) • Overall clinical success=95.4% (95% CI 92.8 to 97.5%; I²=35.3%) • Cholecystitis recurrence=3.4% (95% CI 1.6 to 5.7%; 21 studies, n=965, I²=32.3%) • Hospital stay (days)=8.0 (95% CI 6.4 to 9.6; 11 studies, n=687, I²=91.3%) <p>Technical success increased when studies reported an experience proxied to more than 10 cases per year (OR 2.84; 95% CI 1.06 to 7.59).</p> <p>The overall clinical success improved when the experience proxied more than 10 cases per year (OR 3.85; 95% CI 1.46 to 10.15). In addition, the use of anti-migrating devices (LAMs or ATSEMs) improved this outcome (OR 2.33; 95% CI 1.16 to 4.68).</p> <p>Multivariable meta-regression identified both as independent modifiers of the overall clinical success. The OR for experience was 3.52 (95% CI 1.33 to</p>	<p>Pooled results (27 studies, n=1,004)</p> <p>Procedure-related adverse events=14.8% (95% CI 8.8 to 21.8%; I²=82.4%)</p> <ul style="list-style-type: none"> • Stent malfunction or dislodgment=3.5% (95% CI 0.1 to 6.7%; I²=64.5%) • Procedure-related mortality=0.1% (95% CI 0.0 to 0.1%; I²=0%) • 30-day all-cause mortality=2.9% (95% CI 0.5 to 6.6%; I²=74.1%) • Bile leak or peritonitis=1.5% (95% CI 0.1 to 3.9%; I²=59.5%) • Bleeding=0.3% (95% CI 0.1 to 1.2%; I²=10.3%) • Pneumoperitoneum=0.5% (95% CI 0.0 to 0.6%, I²=0%) <p>Adverse events reduced when the experience proxied to more than 10 cases per year (OR 0.35; 95% CI 0.19 to 0.65). The use of anti-migrating devices also reduced adverse events (OR 0.30; 95% CI 0.17 to 0.52).</p> <p>Multivariable meta-regression identified the use of anti-migrating devices (OR 0.36; 95% CI 0.14 to 0.98) as the only modifier of procedure-related adverse events. After meta-regression, the residual I² was still substantial (67.8%, Egger's test: p=0.145).</p>

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First author, date	Efficacy outcomes	Safety outcomes
	9.33) and that of anti-migrating devices was 2.16 (95% CI 1.07 to 4.36). After meta-regression, the residual I ² was 0% (Egger's test: p=0.147).	
Mohan B, 2020	<p>Pooled rates of technical success</p> <ul style="list-style-type: none"> EUS-GBD=95.3% (95% CI 92.8 to 96.9, I²=0%; 14 studies, 557 patients) ETP-GBD=83% (95% CI 80.1 to 85.5, I²=29%; 21 studies, 851 patients) PT-GBD=98.7% (95% CI 98.0 to 99.1, I²=0%; 33 studies, 2,203 patients) <p>p=0.001 for EUS-GBD versus ETP-GBD and PT-GBD</p> <p>Pooled rates of clinical success</p> <ul style="list-style-type: none"> EUS-GBD=96.7% (95% CI 94.0 to 98.2, I²=0%; 14 studies, 557 patients) ETP-GBD=88.1% (95% CI 83.6 to 91.4, I²=50%; 22 studies, 1,223 patients) PT-GBD=89.3% (95% CI 86.6 to 91.5, I²=84%; 38 studies, 11,800 patients) <p>p=0.001 for EUS-GBD versus ETP-GBD and PT-GBD</p> <p>Pooled rates of recurrence</p> <ul style="list-style-type: none"> EUS-GBD=4.2% (95% CI 2.4 to 7.4, I²=0%; 14 studies, 557 patients) ETP-GBD=4.6% (95% CI 2.8 to 7.4, I²=53%; 22 studies, 1,223 patients) PT-GBD=10.8% (95% CI 8.3 to 13.9, I²=76%; 37 studies, 3,677 patients) 	<p>Pooled rates of adverse events</p> <ul style="list-style-type: none"> EUS-GBD=12.4% (95% CI 6.9 to 21.1, I²=6%; 13 studies, 546 patients) ETP-GBD=9.6% (95% CI 5.9 to 15.3, I²=27%; 21 studies, 1,209 patients) PT-GBD=15.1% (95% CI 11.1 to 20.3, I²=95%; 39 studies, 11,997 patients) <p>p=0.32 for EUS-GBD versus ETP-GBD and p=0.56 for EUS-GBD versus PT-GBD</p> <p>Pooled rates of bleeding</p> <ul style="list-style-type: none"> EUS-GBD=4.3% (95% CI 2.7 to 6.8, I²=0%; 13 studies, 546 patients), p=0.02 ETP-GBD=1.9% (95% CI 1.1 to 3.1, I²=0%; 21 studies, 1,209 patients) PT-GBD=2% (95% CI 1.5 to 2.7, I²=0%; 37 studies, 3,597 patients) <p>Pooled rates of perforation</p> <ul style="list-style-type: none"> EUS-GBD=3.7% (95% CI 2.3 to 6, I²=0%); 13 studies, 546 patients), p=0.04 ETP-GBD=2% (95% CI 1.2 to 3.2, I²=0%; 21 studies, 1,209 patients) PT-GBD=2% (95% CI 1.4 to 2.9, I²=0%; 36 studies, 3,524 patients)

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First author, date	Efficacy outcomes	Safety outcomes
	<p>p=0.99 for EUS-GBD versus ETP-GBD and p=0.001 for EUS-GBD versus PT-GBD</p>	<p>Pooled rates of bile leak or bile peritonitis</p> <ul style="list-style-type: none"> • EUS-GBD=2.9% (95% CI 1.6 to 5.1, I²=0%; 13 studies, 546 patients) • ETP-GBD=1.4% (95% CI 0.8 to 2.5, I²=0%); 21 studies, 1,209 patients) • PT-GBD=2.7% (95% CI 2.1 to 3.5, I²=0%; 37 studies, 3,597 patients) <p>Pooled rates of pancreatitis</p> <ul style="list-style-type: none"> • EUS-GBD=1.4% (95% CI 0.7 to 3.1, I²=0%; 13 studies, 546 patients) • ETP-GBD=5.1% (95% CI 3.5 to 7.3, I²=17%; 21 studies, 1,209 patients), p=0.003 • PT-GBD=1.1% (95% CI 0.7 to 1.7, I²=0%; 36 studies, 3,524 patients) <p>Pooled rates of stent occlusion</p> <ul style="list-style-type: none"> • EUS-GBD= 2.6% (95% CI 1.2 to 5.6, I²=0%; 12 studies, 506 patients) • ETP-GBD=1.8% (95% CI 0.9 to 3.6, I²=0%; 20 studies, 1,171 patients) • PT-GBD=1.8% (95% CI 1.1 to 2.8, I²=56%; 36 studies, 3,524 patients) <p>Pooled rates of stent migration</p> <ul style="list-style-type: none"> • EUS-GBD=2.7% (95% CI 1.3 to 5.4, I²=0%; 13 studies, 546 patients) • ETP-GBD=2.2% (95% CI 1.2 to 3.9, I²=0%; 20 studies, 1,171 patients)

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First author, date	Efficacy outcomes	Safety outcomes
		<ul style="list-style-type: none"> • PT-GBD=7.4% (95% CI 5.5 to 10, I²=79; 38 studies, 3,977 patients), p=0.01 <p>Pooled rates of mortality</p> <ul style="list-style-type: none"> • EUS-GBD=26% (95% CI 16.7 to 38.1, I²=86%); 9 studies, 398 patients), p=0.001 • ETP-GBD= 16.6% (95% CI 10.5 to 25.2, I²=77%; 13 studies, 884 patients) • PT-GBD=11.2% (95% CI 8.7 to 14.1, I²=83%; 37 studies, 3,597 patients)
Podboy A, 2021	<p>Technical success – network meta-analysis:</p> <ul style="list-style-type: none"> • PT-GBD vs EUS-GBD, RR=1.04 (95% CI 1.01 to 1.09, 7 studies, 782 patients) • ETP-GBD vs EUS-GBD, RR= 0.81 (95% CI 0.43 to 0.99, 3 studies, 589 patients) • ETP-GBD vs PT-GBD, RR=0.78 (95% CI 0.42 to 0.96; 1 study, 270 patients) <p>There was no statistically significant heterogeneity between the pooled studies.</p> <p>On the network ranking estimate PT-GBD was noted to be ranked most likely to result in technical success followed by EUS-GBD and ETP-GBD (EUS-GBD vs PT-GBD vs ETP-GBD: 2.00 vs 1.02 vs 2.98).</p> <p>Clinical success – network meta-analysis:</p> <ul style="list-style-type: none"> • PT-GBD vs EUS-GBD, RR=0.99 (95% CI 0.87 to 1.05, I²=40.3%; 7 studies, 778 patients) 	<p>Adverse events – network meta-analysis:</p> <ul style="list-style-type: none"> • PT-GBD vs EUS-GBD, RR=1.02 (95% CI 0.42 to 1.91; 6 studies, 702 patients) • ETP-GBD vs EUS-GBD, RR=1.16 (95% CI 0.42 to 2.38; 3 studies, 498 patients) • ETP-GBD vs PT-GBD, RR=1.26 (95% CI 0.41 to 3.06; 2 studies, 341 patients) <p>There was statistically significant heterogeneity between the pooled studies comparing EUS-GBD and PT-GBD (p=0.013, I²=65.3%) but not for the remaining pooled categories.</p> <p>The network ranking estimate was lowest for PT-GBD followed by EUS-GBD (EUS-GBD vs PT-GBD vs ETP-GBD: 1.96 vs 1.88 vs 2.16), although there was wide variability.</p> <p>Unplanned admissions – network meta-analysis:</p>

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First author, date	Efficacy outcomes	Safety outcomes
	<ul style="list-style-type: none"> ETP-GBD vs EUS-GBD, RR=0.75 (95% CI 0.38 to 0.97, I²=; 4 studies, 402 patients) ETP-GBD vs PT-GBD, RR=0.76 (95% CI 0.40 to 0.98; 1 study, 71 patients) <p>There was no statistically significant heterogeneity between the pooled studies.</p> <p>The network ranking estimates closely preferred EUS-GBD over PT-GBD and ETP-GBD (EUS-GBD vs PT-GBD vs ETPGBD:1.48 vs 1.55 vs 2.98).</p> <p>Recurrent cholecystitis – network meta-analysis:</p> <ul style="list-style-type: none"> PT-GBD vs EUS-GBD, RR=1.96 (95% CI 0.75 to 4.09; 6 studies, 708 patients) ETP-GBD vs EUS-GBD, RR=3.72 (95% CI 1.39 to 7.54; 3 studies, 443 patients) ETP-GBD vs PT-GBD, RR=2.20 (95% CI 0.66 to 5.37; 1 study, 270 patients) <p>There was no statistically significant heterogeneity between the pooled studies.</p> <p>Ranking estimates preferred EUS-GBD over other modalities (EUS-GBD vs PT-GBD vs ETP-GBD: 1.089 vs 2.02 vs 2.891).</p> <p>Need for reintervention – network meta-analysis:</p> <ul style="list-style-type: none"> PT-GBD vs EUS-GBD, RR=3.07 (95% CI 1.52 to 2.94; 4 studies, 394 patients) ETP-GBD vs EUS-GBD, RR=0.77 (95% CI 0.23 to 0.68; 2 studies, 216 patients) 	<ul style="list-style-type: none"> PT-GBD vs EUS-GBD, RR=4.54 (95% CI 1.52 to 8.92; 4 studies, 658 patients) ETP-GBD vs EUS-GBD, RR=1.32 (95% CI 0.06 to 5.83; 1 study, 226 patients) ETP-GBD vs PT-GBD, RR=0.31 (95% CI 0.02 to 1.31; 1 study, 270 patients) <p>There was statistically significant heterogeneity between EUS-GBD and PT-GBD ($p=0.029$, $I^2=66.9%$).</p> <p>The network rating preferred ETP-GBD over other modalities (EUS-GBD vs PT-GBD vs ETP-GBD: 1.582 vs 2.944 vs 1.474).</p> <p>Disease-specific mortality – network meta-analysis:</p> <ul style="list-style-type: none"> PT-GBD vs EUS-GBD, RR=0.83 (95% CI 0.19 to 1.81; 3 studies, 287 patients) ETP-GBD vs EUS-GBD, RR=0.47 (95% CI 0.03 to 1.80; 1 study, 71 patients) ETP-GBD vs PT-GBD, RR=0.81 (0.04 to 3.93; 0 studies, 0 patients) <p>There was no statistically significant heterogeneity between the pooled studies.</p> <p>Ranking estimate EUS-GBD vs PT-GBD vs ETP-GBD: 2.62 vs 2.09 vs 1.29.</p>

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First author, date	Efficacy outcomes	Safety outcomes
	<ul style="list-style-type: none"> ETP-GBD vs PT-GBD, RR=0.26 (95% CI 0.08 to 0.23; 1 study, 270 patients) <p>There was no statistically significant heterogeneity between the pooled studies.</p> <p>Ranking estimates preferred ETP-GBD (EUS-GBD vs PT-GBD vs ETP-GBD: 1.81 vs 2.99 vs 1.199).</p>	
Teoh A, 2020	<p>Technical success:</p> <ul style="list-style-type: none"> EUS-GBD=97.4% (38/39) PT-GBD=100% (40/40), p=0.494 <p>Clinical success:</p> <ul style="list-style-type: none"> EUS-GBD=92.3% (36/39) PT-GBD=92.5% (37/40), p=1.00 <p>Analgesic requirements (total paracetamol in mg); mean (SD)</p> <ul style="list-style-type: none"> EUS-GBD=3,345 (5,663) PT-GBD=5,165 (5,068), p=0.034 <p>Recurrent acute cholecystitis at 1 year:</p> <ul style="list-style-type: none"> EUS-GBD=2.6% (1/39) PT-GBD=20% (8/40), p=0.029 <p>Reinterventions after 30 days:</p> <ul style="list-style-type: none"> EUS-GBD=2.6% (1/39) PT-GBD=30% (12/40), p=0.001 	<p>30-day adverse events (p=0.001):</p> <ul style="list-style-type: none"> EUS-GBD=12.8% (5/39); blocked stent (n=2), perforation (n=1), atrial fibrillation (n=1), pneumonia (n=3) PT-GBD=47.5% (19/40); tube dislodgement (n=15), multiorgan failure (n=3), pericholecystic collection (n=1), acute myocardial infarction (n=1), atrial fibrillation (n=1), pneumonia (n=1), bleeding (n=1), decompensated liver cirrhosis (n=1), urinary tract infection (n=1) <p>30-day mortality (p=1):</p> <ul style="list-style-type: none"> EUS-GBD=7.7% (3/39) PT-GBD=10% (4/40) <p>Adverse events at 1 year (including recurrent acute cholecystitis), p<0.001:</p> <ul style="list-style-type: none"> EUS-GBD=25.6% (10/39); 5 within 30 days listed above plus 1 recurrent acute cholecystitis, 1 blocked stent or tube and 3 common bile duct stones needing ERCP

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First author, date	Efficacy outcomes	Safety outcomes
		<ul style="list-style-type: none"> PT-GBD=77.5% (31/40); 19 within 30 days listed above plus 8 recurrent acute cholecystitis, 18 tube dislodgement, 2 blocked stent or tube and 1 common bile duct stones needing ERCP <p>Unplanned admissions (p=0.002):</p> <ul style="list-style-type: none"> EUS-GBD=15.4% (6/39) PT-GBD=50% (20/40)
Siddiqui A, 2019	<p>Technical success:</p> <ul style="list-style-type: none"> EUS-GBD=94% (96/102) PT-GBD=98% (143/146) ETP-GBD=88% (109/124), p=0.003 <p>Clinical success:</p> <ul style="list-style-type: none"> EUS-GBD=90% (92/102) PT-GBD=97% (141/146) ETP-GBD=80% (99/124), p<0.001 <p>After controlling for age, gender, pathology, number of sessions, and technical success, only the number of sessions variable (1 or more than 1 session) was a statistically significant predictor of clinical resolution (OR=0.036, 95% CI 0.004 to 0.353, p=0.0043).</p> <p>Need for additional surgical intervention:</p> <ul style="list-style-type: none"> EUS-GBD=0% (0/102) PT-GBD=49.7% (73/146) ETP-GBD=11.4% (14/124), p<0.001 	<p>Total procedural adverse events (p=0.07):</p> <ul style="list-style-type: none"> EUS-GBD=11.8% (12/102); 2 perforation, 5 self-limited bleeding, 1 infection, 2 bile leaks, 2 self-limited abdominal pain needing observation PT-GBD=4.1% (6/146); 3 self-limited bleeding, 1 infection, 2 bile leaks ETP-GBD=7.2% (9/124); 2 self-limited bleeding, 3 pancreatitis, 4 self-limited abdominal pain needing observation <p>There was no statistically significant difference in the severity of procedural adverse events between the 3 groups (p=0.85).</p> <p>Patients with calculous pathology were 2 times more likely to have an adverse event (OR=1.9, 95% CI 1.04 to 3.57, p=0.04), and patients who had more than 1 procedure session were almost 3 times more likely to have an adverse event (OR=2.7, 95% CI 1.23 to 6.07, p=0.0138).</p>

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First author, date	Efficacy outcomes	Safety outcomes
	<p>Surgical removal of the gallbladder was eventually needed in 24% of patients either for recurrent acute cholecystitis not amenable to non-surgical therapy or when the patient had improved medically. The timing of surgery was between 1 and 4 months after the index intervention.</p> <p>In patients that did not need a cholecystectomy, those that had ETP-GBD had a statistically significantly lower clinical success (78%) for resolution of acute cholecystitis compared to those that had PT-GBD (94%) or EUS-GBD with LAMS (92%); $p=0.002$.</p>	<p>Long-term (3 to 9 month follow up) adverse events ($p<0.001$):</p> <ul style="list-style-type: none"> EUS-GBD=1.9% (2/102); 1 catheter or stent dislodgment, 1 infection PT-GBD=19.8% (29/146); 11 catheter or stent dislodgment, 2 pain, 4 catheter or stent occlusion, 5 cellulitis, 5 infection, 2 abscess ETP-GBD=4.8% (6/124); 2 catheter or stent dislodgment, 4 catheter or stent occlusion <p>Unplanned hospital admissions ($p<0.001$):</p> <ul style="list-style-type: none"> EUS-GBD=4% (4/102) PT-GBD=19.8% (29/146) ETP-GBD=3.2% (4/124)
Teoh A, 2021	<p>Technical success:</p> <ul style="list-style-type: none"> EUS-GBD=100% (30/30) LC=100% (30/30) <p>Clinical success:</p> <ul style="list-style-type: none"> EUS-GBD=93.3% (28/30) LC=100% (30/30) <p>Mean length of hospital stay (SD):</p> <ul style="list-style-type: none"> EUS-GBD=6.8 (8.1) LC=5.5 (2.7) 	<p>30-day adverse events:</p> <ul style="list-style-type: none"> EUS-GBD=13.3% (4/30); 2 patients died (described below), 1 patient had upper gastrointestinal bleeding needing endoscopic haemostasis, and 1 had a blocked stent because of gallstones needing endoscopic insertion of an additional double-pigtail stent through the LAMS. LC=13.3% (4/30); 1 patient had intraabdominal collections needing percutaneous drainage, 1 had multiorgan failure, 1 had upper gastrointestinal

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First author, date	Efficacy outcomes	Safety outcomes
	<p>Recurrent cholecystitis:</p> <ul style="list-style-type: none"> • EUS-GBD=3.3% (1/30) • LC=0% (0/30) <p>Recurrent biliary events:</p> <ul style="list-style-type: none"> • EUS-GBD=10.0% (3/30) • LC=10.0% (3/30) <p>All were because of the presence of common bile duct stones, which were not suspected on preprocedural imaging. These events all resulted in unplanned admissions, and the stones were removed by ERCP.</p> <p>Reinterventions:</p> <ul style="list-style-type: none"> • EUS-GBD=13.3% (4/30) • LC=10.0% (3/30) 	<p>bleeding needing endoscopic haemostasis, and 1 patient had a chest infection.</p> <p>30-day mortality:</p> <ul style="list-style-type: none"> • EUS-GBD=6.7% (2/30); 1 aspiration pneumonia and 1 uncontrolled sepsis • LC=0% (0/30) <p>Unplanned readmissions:</p> <ul style="list-style-type: none"> • EUS-GBD=10.0% (3/30) • LC=10.0% (3/30)
Teoh A, 2019	<p>Technical success=95.3% of patients Clinical success=90.8% of patients Recurrent cholecystitis=2.4% (9/379)</p> <p>Unplanned procedural events=9.2% of patients (defined as any deviations of the procedure from the planned procedural steps)</p> <p>Endoscopists who had done fewer than 25 of the procedures had significantly more procedures that were longer than 30 minutes (p=0.006), more</p>	<p>30-day adverse event rate=15.3% (58/379) 30-day mortality rate=9.2% Procedure-related adverse events, n=20</p> <ul style="list-style-type: none"> • Stent obstruction, n=3 • Stent migration, n=3 • Bile leak, n=3 • Duodenal perforation, n=2 • Pneumoperitoneum, n=2 • Gastric outlet obstruction from stent, n=1 • Bleeding from puncture site, n=1

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First author, date	Efficacy outcomes	Safety outcomes
	unplanned procedural events (p=0.012) and more 30-day adverse events (p=0.031).	<ul style="list-style-type: none"> • Infected abdominal collection, n=1 • Bleeding in gallbladder, n=1 • Bleeding from cystic artery, n=1 • Infected ascites, n=1 <p>In multivariate analyses, clinical failure (p=0.014; RR 8.69, 95% CI 1.56 to 48.47) and procedure done by endoscopist with experience of fewer than 25 procedures (p=0.002; RR 4.68, 95%CI 1.79 to 12.26) were statistically significant predictors of 30-day adverse events. The only statistically significant predictor of 30-day mortality was the presence of 30-day adverse event (p<0.001; RR 103, 95%CI 11.24 to 944.04).</p>
Torres Yuste, 2019	<p>Gallstone-related hospital admissions during follow up=4.5% (1/22)</p> <p>During follow up 12 patients (54.5%) visited the emergency room 34 times with a median of 1 visit per patient (IQR 0 to 3; range 0 to 7).</p> <p>There were 36 hospital admissions during follow up, with a median of 1 admission per patient (IQR 0 to 3; range 0 to 9).</p> <p>63.6% (14/22) of patients died during follow up: 1 of them of pancreatic cancer progression, while the rest died from non-biliary causes.</p> <p>Long-term endoscopic follow up was available in 3 patients: 1 patient had a patent stent at 31 months, 1 patient had an obstructed stent because of</p>	There were no LAMS-related adverse events after the first year of follow up.

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First author, date	Efficacy outcomes	Safety outcomes
	overgrowth at 42 months after stent deployment and 1 patient had buried-stent syndrome but with a patent fistula at 51 months follow up.	
Kim J, 2019	Both procedures were successful initially.	<p>Gastric reflux into the gallbladder</p> <p>Patient 1: frail 86-year-old with end-stage renal disease on haemodialysis, diabetes mellitus, hypertension, congestive heart failure, obstructive apnoea, and coronary artery disease who had had coronary artery stenting. She was admitted weeks after EUS-GBD with intractable right upper quadrant pain. A CT scan confirmed gastric reflux into the gallbladder. This was eventually managed with repeat endoscopic drainage on an outpatient basis, though the patient did have another hospitalisation for severe antibiotic-associated colitis.</p> <p>Patient 2: an 80-year-old woman with diabetes mellitus, hypertension, coronary artery disease, and hypothyroidism who developed a stent occlusion with recurrent cholecystitis needing a repeat endoscopic procedure, an infected biloma needing an intraperitoneal drain, and, ultimately, extraluminal free air. The patient eventually had an open cholecystectomy, partial liver resection, gastric antrectomy, and Billroth II gastrojejunostomy.</p>

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Procedure technique

Most of the procedures were done using LAMS. In the systematic review of 27 studies by Fabbri et al. (2022), 64% of procedures used a duodenal approach and LAMS were the most common type of stent used (n=654). Details of procedure technique were not reported in the systematic review by Podboy et al. (2021) but the authors noted there were wide variations in anatomic puncture location, stent size and stent type within the included studies.

Efficacy

Technical success

Technical success of EUS-GBD was reported in 6 studies and ranged from 95% to 100%. In the systematic review of 27 studies on EUS-GBD (n=1,004), the pooled rate of technical success was 98% (95% CI 96% to 99%, $I^2=24%$; Fabbri 2022). In the systematic review of 72 studies comparing EUS-GBD, ETP-GBD and PT-GBD, the pooled rates of technical success were 95% for EUS-GBD (95% CI 93% to 97%, $I^2=0%$; 14 studies, n=557), 83% for ETP-GBD (95% CI 80% to 86%, $I^2=29%$; 21 studies, n=851) and 99% for PT-GBD (95% CI 98% to 99%, $I^2=0%$; 33 studies, n=2,203; Mohan 2020). In the network meta-analysis of 10 comparative studies, PT-GBD was noted to be ranked most likely to result in technical success followed by EUS-GBD and ETP-GBD (Podboy 2021).

In the randomised controlled trial of 79 patients, technical success was 97% (38/39) for EUS-GBD and 100% (40/40) for PT-GBD ($p=0.494$, Teoh 2020). In the non-randomised comparative study of 372 patients, technical success was 94% (96/102) for EUS-GBD, 98% (143/146) for PT-GBD and 88% (109/124) for ETP-GBD ($p=0.003$; Siddiqui 2019). In the non-randomised comparative study of 60 patients, technical success was 100% (30/30) for both EUS-GBD and LC (Teoh 2021). In the registry study of 379 patients, technical success was 95% (Teoh 2019).

Clinical success

Clinical success of EUS-GBD was reported in 6 studies and ranged from 90% to 97%. In the systematic review of 27 studies on EUS-GBD (n=1,004), the pooled rate of overall clinical success was 95% (95% CI 93% to 98%, $I^2=35%$; Fabbri 2022). In the systematic review of 72 studies, the pooled rates of clinical success were 97% for EUS-GBD (95% CI 94% to 98%, $I^2=0%$; 14 studies, n=557), 88% for ETP-GBD (95% CI 84% to 91%, $I^2=50%$; 22 studies, n=1,223) and 89% for PT-GBD (95% CI 87% to 92%, $I^2=84%$; 38 studies, n=11,800; Mohan 2020). In the network meta-analysis of 10 comparative studies, the network ranking estimates closely preferred EUS-GBD for clinical success over PT-GBD and ETP-GBD (Podboy 2021).

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In the randomised controlled trial of 79 patients, clinical success was 92% (36/39) for EUS-GBD and 93% (37/40) for PT-GBD at 1 year follow up ($p=1.00$, Teoh 2020). In the non-randomised comparative study of 372 patients, clinical success was 90% (92/102) for EUS-GBD, 97% (141/146) for PT-GBD and 80% (99/124) for ETP-GBD ($p<0.001$) with a median follow up of 3 months (Siddiqui 2019). In the non-randomised comparative study of 60 patients, clinical success was 93% (28/30) for EUS-GBD and 100% (30/30) for LC, with mean follow up periods of 572 days and 264 days respectively ($p=0.002$; Teoh 2021). In the registry study of 379 patients with a mean follow up of 434 days, clinical success was 91% (Teoh 2019).

In the case series of 22 patients with a median follow up of 24 months, long-term endoscopic follow up was available in 3 patients (Torres Yuste 2019). Of these 3 patients, 1 had a patent stent at 31 months, 1 had an obstructed stent because of overgrowth at 42 months after stent deployment and 1 had buried-stent syndrome but with a patent fistula at 51 months follow up.

Recurrence of cholecystitis

Recurrence rates after EUS-GBD were reported in 5 studies and ranged from 2% to 4%. In the systematic review of 27 studies on EUS-GBD ($n=1,004$), the pooled recurrence rate was 3% (95% CI 2% to 6%, $I^2=32\%$; 21 studies, $n=965$; Fabbri 2022). In the systematic review of 72 studies, the pooled recurrence rates were 4% for EUS-GBD (95% CI 2% to 7%, $I^2=0\%$; 14 studies, $n=557$), 5% for ETP-GBD (95% CI 3% to 7%, $I^2=53\%$; 22 studies, $n=1,223$) and 11% for PT-GBD (95% CI 8% to 14%, $I^2=76\%$; 37 studies, $n=3,677$; Mohan 2020). In the network meta-analysis of 10 comparative studies, the network ranking estimates preferred EUS-GBD for recurrence rates over PT-GBD and ETP-GBD (Podboy 2021).

In the randomised controlled trial of 79 patients, rate of recurrence was 3% (1/39) for EUS-GBD and 20% (8/40) for PT-GBD at 1 year follow up ($p=0.029$, Teoh 2020). In the non-randomised comparative study of 60 patients, rate of recurrence was 3% (1/30) for EUS-GBD and 0% (0/30) for LC, with mean follow up periods of 572 days and 264 days respectively (Teoh 2021). In the registry study of 379 patients with a mean follow up of 434 days, rate of recurrence was 2% (9/379; Teoh 2019).

Recurrence of biliary events

In the randomised controlled trial of 79 patients, common bile duct stones needing ERCP was reported in 8% (3/39) of patients who had EUS-GBD and 3% (1/40) of patients who had PT-GBD at 1 year follow up (Teoh 2020). In the non-randomised comparative study of 60 patients, recurrent biliary events were reported for 10% (3/30) of patients both in the EUS-GBD and the LC group, with

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mean follow up periods of 572 days and 264 days respectively (Teoh 2021). In the case series of 22 patients, there was 1 gallstone-related hospital admission during follow up (median 24 months, Torres Yuste 2019).

Reintervention

The rate of reinterventions was reported in 3 studies. In the non-randomised comparative study of 372 patients, a need for additional surgical intervention was reported for 0% (0/102) of patients who had EUS-GBD, 50% (73/146) of patients who had PT-GBD and 11% (14/124) of patients who had ETP-GBD ($p < 0.001$) with a median follow up of 3 months (Siddiqui 2019).

In the randomised controlled trial of 79 patients, reinterventions after 30 days were reported for 3% (1/39) of patients who had EUS-GBD and 30% (12/40) of patients who had PT-GBD ($p = 0.001$, Teoh 2020). In the non-randomised comparative study of 60 patients, the reintervention rate was 13% (4/30) for EUS-GBD and 10% (3/30) for LC, with mean follow up periods of 572 days and 264 days respectively (Teoh 2021).

Hospital admissions

The rate of unplanned hospital admissions after the procedure was reported in 3 studies. In the randomised controlled trial of 79 patients, the rate of unplanned hospital admissions was 15% (6/39) of patients who had EUS-GBD and 50% (20/40) of patients who had PT-GBD ($p = 0.002$, Teoh 2020). In the non-randomised comparative study of 372 patients, the rate of unplanned hospital admissions was 4% (4/102) of patients who had EUS-GBD, 20% (29/146) of patients who had PT-GBD and 3% (4/124) of patients who had ETP-GBD ($p < 0.001$) with a median follow up of 3 months (Siddiqui 2019). In the non-randomised comparative study of 60 patients, the rate of unplanned readmissions was 10% (3/30) for EUS-GBD and 10% (3/30) for LC, with mean follow up periods of 572 days and 264 days respectively (Teoh 2021).

Safety

Mortality

Mortality was reported in 5 studies. In the systematic review of 27 studies on EUS-GBD ($n = 1,004$), the pooled procedure-related mortality was $< 1\%$ (95% CI 0% to 0.1%, $I^2 = 0\%$) and 30-day all-cause mortality was 3% (95% CI 0.5% to 7%, $I^2 = 74\%$; Fabbri 2022). In the systematic review of 72 studies, the pooled mortality rates were 26% for EUS-GBD (95% CI 17% to 38%, $I^2 = 86\%$; 9 studies, $n = 398$),

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17% for ETP-GBD (95% CI 11% to 25%, $I^2=77%$; 13 studies, $n=884$) and 11% for PT-GBD (95% CI 9% to 14%, $I^2=83%$; 37 studies, $n=3,597$; Mohan 2020).

In the randomised controlled trial of 79 patients, 30-day mortality was 8% (3/39) for EUS-GBD and 10% (4/40) of patients who had PT-GBD ($p=1$, Teoh 2020). In the non-randomised comparative study of 60 patients, the 30-day mortality was 7% (2/30) for EUS-GBD and 0% (0/30) for LC (Teoh 2021). In the registry study of 379 patients, 30-day mortality was 9% (Teoh 2019).

Stent malfunction, dislodgment or migration

Stent malfunction, dislodgment or migration was reported in 4 studies. In the systematic review of 27 studies on EUS-GBD ($n=1,004$), the pooled rate of stent malfunction or dislodgment was 4% (95% CI 0.1% to 7%, $I^2=64.5%$; Fabbri 2022). In the systematic review of 72 studies, the pooled rates of stent migration were 3% for EUS-GBD (95% CI 1% to 5%, $I^2=0%$; 13 studies, $n=546$), 2% for ETP-GBD (95% CI 1% to 4%, $I^2=0%$; 20 studies, $n=1,171$) and 7% for PT-GBD (95% CI 6% to 10%, $I^2=79%$; 38 studies, $n=3,997$; Mohan 2020).

Catheter or stent dislodgment during follow up were reported in 1% (1/102) of patients who had EUS-GBD, 8% (11/146) of patients who had PT-GBD and 2% (2/124) of patients who had ETP-GBD in the non-randomised comparative study of 372 patients (Siddiqui 2019). Stent migration was reported in 1% (3/379) of patients and gastric outlet obstruction from the stent was reported in 1 patient in the registry study of 379 patients (Teoh 2019).

Stent occlusion

Stent occlusion was reported in 5 studies. In the systematic review of 72 studies, the pooled rates of stent occlusion were 3% for EUS-GBD (95% CI 1% to 6%, $I^2=0%$; 12 studies, $n=506$), 2% for ETP-GBD (95% CI 1% to 4%, $I^2=0%$; 20 studies, $n=1,171$) and 2% for PT-GBD (95% CI 1% to 3%, $I^2=56%$; 36 studies, $n=3,524$; Mohan 2020).

A blocked stent within 30 days was reported in 5% (2/39) of patients who had EUS-GBD in the randomised controlled trial of 79 patients. At 1 year, a blocked stent was reported in 1 additional patient who had EUS-GBD and 5% (2/40) of patients who had PT-GBD (Teoh 2020). Catheter or stent occlusion during follow up were reported in 0% (0/102) of patients who had EUS-GBD, 3% (4/146) of patients who had PT-GBD and 3% (4/124) of patients who had ETP-GBD in the non-randomised comparative study of 372 patients (Siddiqui 2019). A blocked stent because of gallstones was reported in 1 patient who had EUS-GBD in the non-randomised comparative study of 60 patients (Teoh 2021). Stent obstruction was reported in 1% (3/379) of patients in the registry study of 379 patients (Teoh 2019). An obstructed stent because of overgrowth at 42 months after stent

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deployment was reported in 1 patient in the case series of 22 patients (Torres Yuste 2019).

Bile leak or peritonitis

Bile leak or peritonitis was reported in 4 studies. In the systematic review of 27 studies on EUS-GBD (n=1,004), the pooled rate of bile leak or peritonitis was 2% (95% CI 0.1% to 4%, $I^2=59.5%$; Fabbri 2022). In the systematic review of 72 studies, the pooled rates of bile leak or bile peritonitis were 3% for EUS-GBD (95% CI 2% to 5%, $I^2=0%$; 13 studies, n=546), 1% for ETP-GBD (95% CI 1% to 3%, $I^2=0%$; 21 studies, n=1,209) and 3% for PT-GBD (95% CI 2% to 4%, $I^2=0%$; 37 studies, n=3,597; Mohan 2020).

Procedural bile leaks were reported in 2% (2/102) of patients who had EUS-GBD and 1% (2/146) of patients who had PT-GBD in the non-randomised comparative study of 372 patients (Siddiqui 2019). Bile leak was reported in 1% (3/379) of patients in the registry study of 379 patients (Teoh 2019).

Bleeding

Bleeding was reported in 5 studies. In the systematic review of 27 studies on EUS-GBD (n=1,004), the pooled rate of bleeding was <1% (95% CI 0.1% to 1%, $I^2=10.3%$; Fabbri 2022). In the systematic review of 72 studies, the pooled rates of bleeding were 4% for EUS-GBD (95% CI 3% to 7%, $I^2=0%$; 13 studies, n=546), 2% for ETP-GBD (95% CI 1% to 3%, $I^2=0%$; 21 studies, n=1,209) and 2% for PT-GBD (95% CI 2% to 3%, $I^2=0%$; 37 studies, n=3,597; Mohan 2020).

Procedural self-limited bleeding was reported in 5% (5/102) of patients who had EUS-GBD, 2% (3/146) of patients who had PT-GBD and 2% (2/124) of patients in the non-randomised comparative study of 372 patients (Siddiqui 2019). Upper gastrointestinal bleeding needing endoscopic haemostasis was reported in 1 patient who had EUS-GBD and 1 patient who had LC in the non-randomised comparative study of 60 patients (Teoh 2021).

Bleeding from the puncture site, bleeding in the gallbladder and bleeding from the cystic artery were each reported in 1 patient in the registry study of 379 patients (Teoh 2019).

Perforation

Perforation was reported as an adverse event in 4 studies. In the systematic review of 72 studies, the pooled rates of perforation were 4% for EUS-GBD (95% CI 2% to 6%, $I^2=0%$; 13 studies, n=546), 2% for ETP-GBD (95% CI 1% to 3%, $I^2=0%$; 21 studies, n=1,209) and 2% for PT-GBD (95% CI 1% to 3%, $I^2=0%$; 36 studies, n=3,524; Mohan 2020).

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Perforation was reported in 1 patient who had EUS-GBD in the randomised controlled trial of 79 patients (Teoh 2020). Perforation was reported in 2% (2/102) of patients who had EUS-GBD in the non-randomised comparative study of 372 patients (Siddiqui 2019). Duodenal perforation was reported in <1% (2/379) of patients in the registry study of 379 patients (Teoh 2019).

Pneumoperitoneum

Pneumoperitoneum was reported in 2 studies. In the systematic review of 27 studies on EUS-GBD (n=1,004), the pooled rate of pneumoperitoneum was <1% (95% CI 0% to 1%, $I^2=0%$; Fabbri 2022). Pneumoperitoneum was reported in <1% (2/379) of patients in the registry study of 379 patients (Teoh 2019).

Pancreatitis

In the systematic review of 72 studies, the pooled rates of pancreatitis were 1% for EUS-GBD (95% CI 1% to 3%, $I^2=0%$; 13 studies, n=546), 5% for ETP-GBD (95% CI 4% to 7%, $I^2=17%$; 21 studies, n=1,209) and 1% for PT-GBD (95% CI 1% to 2%, $I^2=0%$; 36 studies, n=3,524; Mohan 2020).

Infection

Periprocedural infection was reported in 1 patient who had EUS-GBD and 1 who had PT-GBD in the non-randomised comparative study of 372 patients (Siddiqui 2019). In the same study, infection during the follow up period (3 to 9 months) was reported in 1% (1/102) of patients who had EUS-GBD and 3% (5/146) of patients who had PT-GBD. Infected abdominal collection and infected ascites were each reported in 1 patient in the registry study of 379 patients (Teoh 2019).

Other

Gastric reflux into the gallbladder after EUS-GBD was described in 2 patients as case reports (Kim 2019). In 1 patient, this was managed with repeat endoscopic drainage. The other patient eventually had an open cholecystectomy, partial liver resection, gastric antrectomy and Billroth II gastrojejunostomy.

Anecdotal and theoretical adverse events

Expert advice was sought from consultants who have been nominated or ratified by their professional Society or Royal College. They were asked if they knew of any other adverse events for this procedure that they had heard about (anecdotal), which were not reported in the literature. They were also asked if they thought there were other adverse events that might possibly occur, even if they have never happened (theoretical).

They did not list any anecdotal adverse events.

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They listed the following theoretical adverse events:

- One theoretical adverse event is around eventual progression to surgery. This technique has been used to “bridge” an unfit patient to surgery but the effect of these stents on eventual surgery is not clear.
- The procedure involves creating a connection between the gallbladder and stomach/duodenum (a cholecystoduodenal fistula). This would likely lead to more adhesions around the gallbladder and the bowel and makes any future surgical cholecystectomy or other abdominal surgery technically more difficult. The potential risk of complications from future abdominal operation could be higher as compared to percutaneous cholecystostomy.

Three professional expert questionnaires for this procedure were submitted. Find full details of what the professional experts said about the procedure in the [specialist advice questionnaires for this procedure](#).

No professional expert questionnaires were submitted.

Validity and generalisability

- Two randomised controlled trials on EUS-GBD for acute cholecystitis were identified, the most recent of which is included in the key evidence tables and the other (Jang 2012) is included in table 5. Most of the evidence is from retrospective observational studies.
- There was evidence from Europe, North America, Asia and Australasia, but no studies based in the UK were identified for inclusion in the key evidence.
- Most of the procedures were done by experienced endoscopists in tertiary referral centres. One study reported that unplanned procedural events were statistically significantly more common when the procedure was done by endoscopists with experience of fewer than 25 procedures ($p=0.033$; Teoh 2019).

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- In the systematic review by Fabbri et al. (2022), 8 of the 27 studies reported 10 or more cases per year per centre.
- None of the studies reported quality of life outcomes.
- The longest mean or median follow up was 24 months, but this was in a small retrospective case series with only 22 patients (Torres Yuste 2019).
- There were variations in technique and stents used within and between studies. In 1 systematic review and meta-analysis, the use of anti-migrating devices was shown to reduce the rate of procedure-related adverse events and increase the overall clinical success (Fabbri 2022).
- In 1 systematic review and meta-analysis, the pooled mortality rate was higher for EUS-GBD than for ETP-GBD and PT-GBD. This result should be interpreted with caution because there was considerable heterogeneity and not all studies reported mortality data. The authors suggested that a possible explanation for the higher all-cause mortality was that most of the EUS-GBD studies were done in patients for whom the overall survival was low to begin with and the studies adequately followed up their patients to report a mortality event, unlike the ETP-GBD and PT-GBD studies (Mohan 2020).
- In the non-randomised study comparing EUS-GBD with LC, the follow up period was statistically significantly longer in the EUS-GBD group (Teoh 2021).
- None of the papers included in tables 2 and 3 reported that the study was funded by a company. Declarations of interest were reported by at least 1 author in all the papers, except the letter to the editor that described adverse safety events (Kim 2019).
- Ongoing trial
 - Efficacy and Safety of Lumen Apposing Metal Stents: a Retrospective Multicentre Study (NCT03903523); Italy; observational cohort study; n=500; estimated end date December 2023

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Existing assessments of this procedure

A guideline on the use of therapeutic endoscopic ultrasound-guided procedures was published by the ESGE in 2022 (van der Merwe 2022). The ESGE made the following recommendation regarding EUS-GBD:

- ‘ESGE recommends that, in patients at high surgical risk, EUS-guided gallbladder drainage (GBD) should be favored over percutaneous gallbladder drainage where both techniques are available, owing to the lower rates of adverse events and need for re-interventions in EUS-GBD (Strong recommendation, high quality of evidence)’.

The Tokyo Guidelines 2018 (Mori 2017) include the following recommendation:

- ‘We recommend PT-GBD as a standard drainage method for surgically high-risk patients with acute cholecystitis. (Recommendation 1, level B). However, ETP-GBD or EUS-GBD could be considered in high-volume institutes when performed by skilled endoscopists. (Level B)’

Related NICE guidance

Interventional procedures

- NICE’s interventional procedures guidance 720 (2022) on [percutaneous insertion of a cystic duct stent after cholecystostomy for acute calculous cholecystitis](#) (Recommendation: special arrangements)
- NICE’s interventional procedures guidance 508 (2014) on [single-incision laparoscopic cholecystectomy](#) (Recommendation: normal [now known as standard] arrangements)

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NICE guidelines

- NICE clinical guideline 188 (2014) on [gallstone disease: diagnosis and management](#)

Professional societies

- Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland
- British Society of Gastroenterology
- British Society of Interventional Radiology
- Royal College of Radiologists.

Company engagement

NICE asked companies who manufacture a device potentially relevant to this procedure for information on it. NICE received no completed submissions.

References

1. Fabbri C, Binda C, Sbrancia M et al. (2022) Determinants of outcomes of transmural EUS-guided gallbladder drainage: systematic review with proportion meta-analysis and meta-regression. *Surgical Endoscopy* <https://doi.org/10.1007/s00464-022-09339-y>
2. Mohan BP, Khan SR, Trakroo S et al. (2020) Endoscopic ultrasound-guided gallbladder drainage, transpapillary drainage, or percutaneous drainage in high risk acute cholecystitis patients: a systematic review and comparative meta-analysis. *Endoscopy* 52: 96–106
3. Podboy A, Yuan J, Stave CD et al. (2021) Comparison of EUS-guided endoscopic transpapillary and percutaneous gallbladder drainage for acute cholecystitis: a systematic review with network meta-analysis. *Gastrointestinal Endoscopy* 93: 797–804e1
4. Teoh AYB, Kitano M, Itoi T et al. (2020) Endosonography-guided gallbladder drainage versus percutaneous cholecystostomy in very high-risk surgical patients with acute cholecystitis: an international randomised multicentre controlled superiority trial (DRAC 1). *Gut* 69: 1085–91
5. Siddiqui A, Kunda R, Tyberg Amy et al. (2019) Three-way comparative study of endoscopic ultrasound-guided transmural gallbladder drainage using lumen-apposing metal stents versus endoscopic transpapillary

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- drainage versus percutaneous cholecystostomy for gallbladder drainage in high-risk surgical patients with acute cholecystitis: clinical outcomes and success in an International, Multicenter Study. *Surgical Endoscopy* 33: 1260–70
6. Teoh AYB, Leung CH, Tam PTH et al. (2021) EUS-guided gallbladder drainage versus laparoscopic cholecystectomy for acute cholecystitis: a propensity score analysis with 1-year follow-up data. *Gastrointestinal Endoscopy* 93: 577–83
 7. Teoh AY, Perez-Miranda M, Kunda R et al. (2019) Outcomes of an international multicenter registry on EUS-guided gallbladder drainage in patients at high risk for cholecystectomy. *Endoscopy International Open* 7: e964–e973
 8. Torres Yuste R, García-Alonso FJ, Sánchez-Ocanaa R et al. (2019) Safety and clinical outcomes of endoscopic ultrasound-guided gallbladder drainage with lumen-apposing metal stents in patients with dwell time over one year. *Annals of Gastroenterology* 32: 514–21
 9. Kim JJ, Hiotis SP, Sur MD (2019) Gastric Reflux Into the Gallbladder After EUS-guided Stenting—Letter to the Editor Regarding “EUS-guided Versus Percutaneous Gallbladder Drainage: Isn’t It Time to Convert?” *Journal of Clinical Gastroenterology* 53: 392–3
 10. van der Merwe SW, Van Wanrooij RLJ, Bronswijk M et al. (2022) Therapeutic endoscopic ultrasound: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy* 54: 185–205
 11. Mori Y, Itoi T, Baron TH et al. (2017) Tokyo Guidelines 2018: management strategies for gallbladder drainage in patients with acute cholecystitis (with videos). *Journal of Hepato-Biliary-Pancreatic Sciences* 25: 87–95

Methods

NICE identified studies and reviews relevant to endoscopic ultrasound-guided gallbladder drainage for acute cholecystitis from the medical literature. The following databases were searched between the date they started to 11 August 2022: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and other databases. Trial registries and the internet were also searched (see the [literature search strategy](#)). Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

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The following inclusion criteria were applied to the abstracts identified by the literature search.

- Publication type: clinical studies were included with emphasis on identifying good quality studies. Abstracts were excluded if they did not report clinical outcomes. Reviews, editorials, and laboratory or animal studies, were also excluded and so were conference abstracts, because of the difficulty of appraising study methodology, unless they reported specific adverse events that not available in the published literature.
- Patients with acute cholecystitis for whom surgery was not an option.
- Intervention or test: endoscopic ultrasound-guided gallbladder drainage
- Outcome: articles were retrieved if the abstract contained information relevant to the safety, efficacy, or both.

If selection criteria could not be determined from the abstracts the full paper was retrieved.

Potentially relevant studies not included in the main evidence summary are listed in the section on [other relevant studies](#).

Find out more about [how NICE selects the evidence for the committee](#).

Table 4 literature search strategy

Databases	Date searched	Version/files
MEDLINE (Ovid)	11/08/2022	1946 to August 10, 2022
MEDLINE In-Process (Ovid)	11/08/2022	1946 to August 10, 2022
MEDLINE Epubs ahead of print (Ovid)	11/08/2022	1946 to August 10, 2022
EMBASE (Ovid)	11/08/2022	1974 to 2022 August 10
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	11/08/2022	Issue 8 of 12, August 2022
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	11/08/2022	Issue 8 of 12, August 2022
International HTA database (INAHTA)	11/08/2022	

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The following search strategy was used to identify papers in MEDLINE. A similar strategy was used to identify papers in other databases.

MEDLINE search strategy

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1      exp Cholecystitis/
2      cholecystitis.tw.
3      ((gallbladder* or gall bladder*) adj4 (inflam* or empyema or infect* or irritat*)).tw.
4      biliary tract/ or bile ducts/ or cystic duct/ or gallbladder/
5      (obstruct* or block* or stenosis* or stoppage* or narrow* or impeded*).tw.
6      4 and 5
7      ((Biliary or "Bile duct*" or gallbladder* or gall bladder* or "cystic duct*") adj4
(obstruct* or block* or stenosis* or stoppage* or narrow* or impeded*).tw.
8      1 or 2 or 3 or 6 or 7
9      gallbladder/ and drainage/
10     Endoscopes/ or Endoscopy/ or Endoscopy, Digestive System/
11     Stents/
12     Ultrasonography, Interventional/
13     Endosonography/
14     (12 or 13) and 9
15     (10 or 11) and 9
16     (Endoscop* adj4 ultraso* adj4 guid* adj4 (cholecystoduodenostom* or
cholecystogastrostom* or cholecystojejunostom*)).tw.
17     (Endoscop* adj4 ultraso* adj4 guid* adj4 (Biliary or "Bile duct*" or gallbladder or
gall bladder or "cystic duct*") adj4 drain*).tw.
18     (EUS-guid* adj4 (cholecystoduodenostom* or cholecystogastrostom* or
cholecystojejunostom*)).tw.
19     (EUS-guid* adj4 (Biliary or "Bile duct*" or gallbladder or gall bladder or "cystic
duct*") adj4 drain*).tw.      220     (EUS-GBD or EUSGBD).tw.
21     "lumen-apposing metal stent*".tw.
22     LAMS.tw.
23     or/14-22
24     8 and 23
25     "Electrocautery-Enhanced Delivery System".tw.
26     "GORE VIABIL Biliary Endoprosthesis".tw.
27     "Short Wire Biliary Endoprosthesis".tw.
28     ("hot axios*" or axios*).tw.
29     or/24-28
30     animals/ not humans/
31     29 not 30

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Other relevant studies

Other potentially relevant studies to the IP overview that were not included in the main evidence summary (tables 2 and 3) are listed in table 5.

Case series with 10 or fewer patients have been excluded.

Table 5 additional studies identified

Article	Number of patients and follow up	Direction of conclusions	Reason study was not included in main evidence summary
Ahmed O, Rogers AC, Bolger JC et al. (2018) Meta-analysis of outcomes of endoscopic ultrasound-guided gallbladder drainage versus percutaneous cholecystostomy for the management of acute cholecystitis. <i>Surgical Endoscopy</i> 32: 1627–35	Systematic review and meta-analysis n=495 (5 studies)	Acute cholecystoenterostomy is a promising alternative to percutaneous cholecystostomy in high-risk patients with acute cholecystitis, with equivalent success rates, improved pain scores and lower re-intervention rates, without the morbidities associated with external drainage.	A more recent systematic review and meta-analysis is included.
Ahmed O, Ogura T, Eldahrouy A et al. (2018) Endoscopic ultrasound-guided gallbladder drainage: Results of long-term follow-up. <i>Saudi Journal of Gastroenterology</i> 24: 183–88	Case series n=13 Follow up: median 240 days	The rates of technical success, functional success, and adverse events were 100%, 92% and 8%, respectively. Recurrence of cholecystitis was observed in 1 patient (8%).	Studies with more patients or longer follow up are included.
Anderloni A, Buda A, Vieceli F et al. (2016) Endoscopic ultrasound-guided transmural stenting for gallbladder drainage in high-risk patients with acute	Systematic review n=166 (21 studies)	Endoscopic ultrasound-guided transmural stenting for gallbladder drainage appears to be feasible, safe, and effective. LAMSs seem to have high potential in	A more recent systematic review and meta-analysis is included.

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cholecystitis: a systematic review and pooled analysis. <i>Surgical Endoscopy</i> 30: 5200–8		terms of efficacy and safety, although further prospective studies are needed.	
Auriemma F, Fugazza A, Colombo M et al. (2022) Safety issues in endoscopy ultrasound-guided interventions using lumen apposing metal stents. <i>Minerva Gastroenterol (Torino)</i> . 68:177-185	Review	Early recognition and management of adverse events associated with LAMS is critical to improve outcomes.	Only cites 3 studies on EUS-GBD, all of which are included in the overview.
Chan SM, Teoh AYW, Yip HC et al. (2017) Feasibility of per-oral cholecystoscopy and advanced gallbladder interventions after EUS-guided gallbladder stenting (with video). <i>Gastrointestinal Endoscopy</i> 85: 1225–32	Cohort study n=25	The recent development of EUS-GBD with a lumen-apposing stent has made endoscopic assessment and advanced gallbladder interventions via the stent possible. Per-oral cholecystoscopy and advanced gallbladder interventions were feasible and safe.	Study describes interventions that can be done after EUS-GBD.
Cho DH, Jo SJ, Lee JH et al. (2019) Feasibility and safety of endoscopic ultrasound-guided gallbladder drainage using a newly designed lumen-apposing metal stent. <i>Surgical Endoscopy</i> 33: 2135–41	Case series n=22 Follow up: median 318 days	EUS-GBD with newly designed LAMS is feasible and shows acceptable safety profiles for both the urgent drainage of acute cholecystitis and elective internalisation following PT-GBD in patients with high surgical risk.	Studies with more patients or longer follow up are included.
Choi JH, Kim HW, Lee J-C et al. (2017) Percutaneous transhepatic versus EUS-guided gallbladder drainage for malignant cystic duct obstruction. <i>Gastrointestinal Endoscopy</i> 85: 357–64	Non-randomised comparative study n=33	EUS-GBD is a feasible, safe, and effective modality for the treatment of malignant cystic duct obstruction in patients who are not indicated for surgery. It enables improved long-term quality of life in patients with advanced-stage cancer.	Small study focusing on acute cholecystitis caused by malignant cystic duct obstruction. Study is included in the systematic review by

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			Podboy et al. (2022).
Choi J-H, Lee SS, Choi JH et al. (2014) Long-term outcomes after endoscopic ultrasonography-guided gallbladder drainage for acute cholecystitis. <i>Endoscopy</i> 46: 656–61	Case series n=63 Follow up: median 275 days	Technical and clinical success=98% Procedural adverse events included duodenal perforation (n=1) and self-limiting pneumoperitoneum (n=2, 3%), all of which resolved with conservative treatment. Late adverse events developed in 4 patients (7%; 95% CI 6% to 8%), including asymptomatic distal stent migration (n=2), and acute cholecystitis due to stent occlusion (n=2). Two patients with occluded stent were successfully treated endoscopically (reintervention rate of 4%). 96% of patients had no recurrence of acute cholecystitis during follow-up.	Studies with more patients or longer follow up are included. Study is included in the systematic review by Mohan et al. (2020) and Fabbri et al. (2022).
Cucchetti A, Binda C, Dajti E et al. (2022) Trial sequential analysis of EUS-guided gallbladder drainage versus percutaneous cholecystostomy in patients with acute cholecystitis. <i>Gastrointestinal Endoscopy</i> 95: 399–406	Meta-analysis and trial sequential analysis n=535 (4 studies)	PT-GBD can provide superior technical success than EUS-GBD if a very large sample size is accrued, thus limiting the single-patient benefit. Clinical success is probably equivalent. EUS-GBD decreased overall adverse events and unplanned readmissions, but more studies are needed on the need for reinterventions.	Only 4 studies were included, all of which are in the overview.
de la Serna-Higuera C, Perez-Miranda M, Gil-Simon P et al. (2013)	Case series n=13	This pilot study shows that the lumen-apposing stent may be, in the	Small case series, included in the

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<p>EUS-guided transenteric gallbladder drainage with a new fistula-forming, lumen-apposing metal stent.</p> <p>Gastrointestinal Endoscopy 77: 303–8</p>	<p>Follow up: median 100.8 days</p>	<p>future, a feasible and safe alternative to percutaneous transhepatic gallbladder drainage in patients with acute cholecystitis unsuitable for a surgical approach. However, there are many limitations to this pilot study, so the data may not be generalised. Further prospective, larger, and comparative studies between AXIOS gallbladder drainage and percutaneous transhepatic gallbladder drainage are needed to assess the real efficacy and safety of this novel stent.</p>	<p>systematic reviews by Mohan et al. (2020) and Fabbri et al. (2022).</p>
<p>Dollhopf M, Larghi A, Will U et al. (2017) EUS-guided gallbladder drainage in patients with acute cholecystitis and high surgical risk using an electrocautery-enhanced lumen-apposing metal stent device. Gastrointestinal Endoscopy 86: 636–43</p>	<p>Case series n=75 Follow up: mean 201 days</p>	<p>The novel lumen-apposing metal stent with an electrocautery (ECE-LAMS) on the tip for high-risk surgical patients with acute cholecystitis is safe, with a high technical and clinical success rate. Future multicentre studies comparing EUS-GBD versus PT-GBD are warranted to determine which procedure is safer and clinically more effective for patients with high surgical risk acute cholecystitis.</p>	<p>Case series, which is included in the systematic reviews by Mohan et al. (2020) and Fabbri et al. (2022).</p>
<p>Fugazza A, Colombo M, Repici A et al. (2020) Endoscopic ultrasound-guided gallbladder drainage: Current perspectives. Clinical and Experimental</p>	<p>Review</p>	<p>EUS-GBD is now considered a well-established alternative treatment to surgery in case of acute cholecystitis. The data propose EUS-GBD as a</p>	<p>No meta-analysis.</p>

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Gastroenterology 13: 193–201		valuable safe and efficient procedure in the long-term follow-up, reducing the risk of further biliary events for fragile patients who do not have cholecystectomy, carrying low rates of adverse events.	
Garcia-Alonso FJ, Sanchez-Ocana R, Penas-Herrero I et al. (2018) Cumulative risks of stent migration and gastrointestinal bleeding in patients with lumen-apposing metal stents. Endoscopy 50: 386–95	Cohort study n=250 Follow up: median 75 days	LAMSs placed for longer durations (such as enteral anastomoses, biliary and gallbladder drainage) presented an 8% cumulative risk of migration at 2 years. Migration was most common when treating pancreatic fluid collections. There were 13 LAMS-related gastrointestinal haemorrhages (5%), 2 of them fatal, presenting a median of 3 days after deployment. The cumulative risk of bleeding at 12 months was 7%.	Mixed indications.
Han D, Inamdar S, Lee CW et al. (2018) Lumen apposing metal stents (LAMSs) for drainage of pancreatic and gallbladder collections: a meta-analysis. Journal of Clinical Gastroenterology 52: 835–44	Systematic review and meta-analysis n=993 (20 trials); 181 gallbladder drainage	Pooled technical success for gallbladder drainage was 95% (95% CI 91% to 99%) and clinical success was 93% (95% CI 90% to 97%).	A more recent systematic review and meta-analysis is included.
Higa JT, Sahar N, Kozarek RA et al. (2019) EUS-guided gallbladder drainage with a lumen-apposing metal stent versus endoscopic transpapillary gallbladder drainage for the	Non-randomised comparative study n=78	EUS-GBD has a higher clinical success rate than transpapillary drainage and may be associated with a lower recurrence rate of cholecystitis. However, transpapillary drainage	Small retrospective non-randomised comparative study that is included in systematic reviews by

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treatment of acute cholecystitis (with videos). <i>Gastrointestinal Endoscopy</i> 90: 483–92		should be considered as the first-line treatment for patients who are surgical candidates but need temporising measures or need an ERCP for other reasons.	Podboy et al. (2021) and Mohan et al. (2020).
Imai M, Takahashi Y, Sato T et al. (2021) Long-term outcomes of elective EUS-guided gallbladder drainage after percutaneous transhepatic gallbladder drainage. <i>Techniques and Innovations in Gastrointestinal Endoscopy</i> 23: 1–7	Case series n=15	Both the technical and clinical success rates were 93% (14/15). Two patients (13%) developed adverse events, with distal stent migration in 1 patient and asymptomatic pneumoperitoneum in the other patient. Cholecystitis recurred only in patients who had stent migration. The median duration of stent patency was 544 days (18 to 1,006 days), without any deaths. The overall stent patency rate was 87% (13/15).	Studies with more patients are included.
Inoue T, Yoshida M, Suzuki Y et al. (2021) Long-term outcomes of endoscopic gallbladder drainage for cholecystitis in poor surgical candidates: An updated comprehensive review. <i>Journal of Clinical Medicine</i> 10: 4842	Review	Long-term stent placement with endoscopic gallbladder stenting and EUS-GBD is a therapeutic method that may be a useful option for the prevention of recurrent cholecystitis. It is expected that the efficacy and safety of these procedures will be better established by future studies.	No meta-analysis.
Irani S, Ngamruengphong S, Teoh A et al. (2017) Similar efficacies of endoscopic ultrasound gallbladder drainage with a lumen-apposing metal	Non-randomised comparative study n=90	EUS-GBD has similar technical and clinical success compared with PT-GBD and should be considered an alternative for patients who are not candidates	Small retrospective non-randomised comparative study that is included in systematic

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stent versus percutaneous transhepatic gallbladder drainage for acute cholecystitis. <i>Clinical Gastroenterology and Hepatology</i> 15: 738–45		for surgery. Patients who have EUS-GBD seem to have shorter hospital stays, lower pain scores, and fewer repeated interventions, with a trend toward fewer adverse events. A prospective, comparative study is needed to confirm these results.	reviews by Fabbri et al. (2022), Podboy et al. (2021) and Mohan et al. (2020).
Irani S, Baron TH, Grimm IS et al. (2015) EUS-guided gallbladder drainage with a lumen-apposing metal stent (with video). <i>Gastrointestinal Endoscopy</i> 82: 1110–5	Case series n=15 Follow up: median 160 days	EUS-GBD with a LAMS is technically safe and effective for decompressing the gallbladder for cholecystitis and biliary or cystic duct obstruction in patients who are poor surgical candidates.	Studies with more patients or longer follow up are included.
Itoi T, Coelho-Prabhu N, Baron TH (2010) Endoscopic gallbladder drainage for management of acute cholecystitis. <i>Gastrointestinal Endoscopy</i> 71: 1038–45	Systematic review n=321 (endoscopic drainage or stenting)	Although there are now several gallbladder drainage methods to treat acute cholecystitis, the optimal minimally invasive, safe, and reliable treatment method needs to be determined.	A more recent systematic review and meta-analysis is included.
Jain D, Bhandari BS, Agrawal N et al. (2018) Endoscopic ultrasound-guided gallbladder drainage using a lumen-apposing metal stent for acute cholecystitis: a systematic review. <i>Clinical Endoscopy</i> 51: 450–62	Review n=189 (10 studies)	The absence of an external drainage tube and widespread applicability in patients with coagulopathy or ascites make EUS-GBD using LAMS an attractive option for patients with acute cholecystitis in whom surgery is contraindicated.	More recent systematic reviews are included.
James T, Baron T (2019) EUS-guided gallbladder drainage: A review of current practices and	Review	EUS-GBD is a promising development in the management of cholecystitis, both acute	No meta-analysis.

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procedures. Endoscopic Ultrasound 8: 28-s34		and chronic, in patients unable to have cholecystectomy. Larger comparative studies between percutaneous drain placement and EUS-GBD are required to determine the optimal strategy based on patient characteristics. Long-term care of patients who have had EUS-GBD as destination therapy is not well known and additional work is needed to determine the optimal stent exchange interval.	
James TW, Krafft M, Croglia M et al. (2019) EUS-guided gallbladder drainage in patients with cirrhosis: Results of a multicenter retrospective study. Endoscopy International Open 7: e1099-e1104	Case series n=15 Follow up: mean 373 days	Technical and clinical success=93% There were 2 adverse events. EUS-GBD is safe and efficacious in managing cholecystitis in patients with Child-Pugh A and B cirrhosis who are non-operative candidates.	Small case series, focusing on EUS-GBD in patients with cirrhosis.
Jang JW, Lee SS, Song TJ et al. (2012) Endoscopic ultrasound-guided transmural and percutaneous transhepatic gallbladder drainage are comparable for acute cholecystitis. Gastroenterology 142: 805–11	Randomised controlled trial n=59	EUS-GBD is comparable with PT-GBD in terms of the technical feasibility and efficacy; there were no statistically significant differences in the safety. EUS-GBD is a good alternative for high-risk patients with acute cholecystitis who cannot have an emergency cholecystectomy.	Studies with more patients or longer follow up are included. This study is included in the systematic reviews by Podboy et al. (2021) and Mohan et al. (2020).
Jang JW, Lee SS, Park DH et al. (2011) Feasibility and safety of EUS-guided transgastric/transduodenal	Case series n=15	Placement of a modified covered self-expandable metal stent after EUS-guided transgastric or transduodenal	Studies with more patients or longer follow up are included.

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gallbladder drainage with single-step placement of a modified covered self-expandable metal stent in patients unsuitable for cholecystectomy. <i>Gastrointestinal endoscopy</i> 74: 176–81	Follow up: median 145 days	gallbladder drainage may be a feasible and safe alternative to treatments such as percutaneous cholecystostomy in patients with acute cholecystitis who are unsuitable for cholecystectomy.	Study is included in systematic review by Fabbri et al. (2022).
Kalva NR, Vanar V, Forcione D et al. (2018) Efficacy and safety of lumen apposing self-expandable metal stents for EUS guided cholecystostomy: a meta-analysis and systematic review. <i>Canadian Journal of Gastroenterology & Hepatology</i> : 7070961	Systematic review and meta-analysis n=233 (13 studies)	Pooled proportion of technical success was 94% (95% CI 91 to 97%) and clinical success was 93% (95% CI 89 to 95%). Overall complication rate was 18% (95% CI 14% to 24%) and stent related complication rate was 8% (95% CI 4 to 15%) in the pooled percentage of patients. Pooled proportion for perforation was 7% (95% CI 4 to 11%) and recurrent cholangitis or cholecystitis was noted in 4% (95% CI 2 to 8%).	A more recent systematic review and meta-analysis is included.
Kahaleh M, Perez-Miranda M, Artifon EL et al. (2016) International collaborative study on EUS-guided gallbladder drainage: Are we ready for prime time? <i>Digestive and Liver Disease</i> 48: 1054–7	Registry n=35 Follow up: median 91.5 days	EUS-GBD appears to be feasible, safe, and effective. Prospective studies are needed to confirm these findings and identify the best technique to use	Studies with more patients or longer follow up are included. Study is included in systematic review by Fabbri et al. (2022).
Kalva NR, Vanar V, Forcione D et al. (2018) Efficacy and safety of lumen apposing self-expandable metal stents for EUS guided cholecystostomy: a meta-analysis and systematic review.	Systematic review and meta-analysis n=233 (13 studies)	EUS-GBD with LAMS is a safe and alternative treatment for patients needing gallbladder drainage, with acceptable intraprocedural and postprocedural complications. However,	A more recent systematic review and meta-analysis is included.

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Canadian Journal of Gastroenterology & Hepatology 2018: 7070961		further controlled trials are necessary to estimate the overall efficacy and safety and the role of EUS-GBD with LAMS in management of nonoperative patients with acute cholecystitis.	
Kamata K, Takenaka M, Kitano M et al. (2017) Endoscopic ultrasound-guided gallbladder drainage for acute cholecystitis: Long-term outcomes after removal of a self-expandable metal stent. World Journal of Gastroenterology 23: 661–7	Case series n=12 Follow up: median 304 days	Long-term outcomes after removal of the self-expandable metal stent were excellent. Removal of the stents 4 weeks after placement and improvement of symptoms might avoid migration of the stent and recurrence of cholecystitis due to food impaction.	Studies with more patients or longer follow up are included. Study is included in systematic review by Fabbri et al. (2022).
Kanno Y, Kozakai F, Koshita S et al. (2019) Technical issues stemming from endoscopic-ultrasound-guided gallbladder drainage: A single center experience. The Turkish Journal of Gastroenterology 30: 1055–61	Case series n=18	The rates of technical success, clinical effectiveness, severe adverse event occurrence, and recurrence of acute cholecystitis were 94% (17/18), 88% (15/17), 6% (1/18, massive bile leakage), and 27% (4/15), respectively. Distal gastrectomy causing scope instability, the non-swollen gallbladder, and double pigtail stent use caused technical difficulties.	Studies with more patients or longer follow up are included. Study is included in systematic review by Fabbri et al. (2022).
Khan MA, Atiq O, Kubiliun N et al. (2017) Efficacy and safety of endoscopic gallbladder drainage in acute cholecystitis: Is it better than percutaneous gallbladder drainage?	Systematic review and meta-analysis n=809 (23 studies)	Endoscopic gallbladder drainage is an efficacious and safe therapeutic modality for treatment of patients with acute cholecystitis who cannot undergo surgery. It shows a	A more recent systematic review and meta-analysis is included.

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Gastrointestinal Endoscopy 85: 76–87		similar technical success as PT-GBD but appears to be safer.	
Kozakai F, Kanno Y, Ito K et al. (2019) Endoscopic ultrasonography-guided gallbladder drainage as a treatment option for acute cholecystitis after metal stent placement in malignant biliary strictures. Clinical Endoscopy 52: 262–8	Non-randomised comparative study n=48	EUS-GBD after metal stent placement was a feasible option for treating acute cholecystitis.	Studies with more patients or longer follow up are included.
Krishnamoorthi R, Jayaraj M, Thoguluva C V (2020) EUS-guided versus endoscopic transpapillary gallbladder drainage in high-risk surgical patients with acute cholecystitis: a systematic review and meta-analysis. Surgical Endoscopy 34: 1904–13	Systematic review and meta-analysis n=857 (5 studies); 259 endoscopic ultrasound-guided	EUS-GBD has higher rate of technical and clinical success compared to endoscopic transpapillary GBD. While the rates of overall adverse events are statistically similar, EUS-GBD has a lower rate of recurrent cholecystitis.	A more recent systematic review and meta-analysis is included.
Lisotti A, Napoleon B, Fabbri C et al. (2022) Treatment of acute cholecystitis in high-risk surgical patients. Minerva Gastroenterology 68: 154–61	Systematic review 175 papers	The levels of evidence in the literature have evolved from initial descriptive studies to recent randomised controlled trials and meta-analysis of cohort studies. While several articles addressed the comparison among different techniques, some topics and questions are still debated.	No meta-analysis.
Lisotti A, Linguerra R, Bacchilega I et al. (2022) EUS-guided gallbladder drainage in high-risk surgical patients with acute cholecystitis- procedure outcomes and evaluation of mortality	Case series n=25	Technical, clinical success rate and adverse events rate were 92%, 88%, and 16%, respectively. 30-day and 1-year mortality were 12% and 32%. Severe comorbidities	Studies with more patients or longer follow up are included.

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predictors. <i>Surgical Endoscopy</i> 36: 569–78		and acute kidney injury were independent predictive factors confirming of long-term mortality after EUS-GBD.	
Luk S, Irani S, Krishnamoorthi R et al. (2019) Endoscopic ultrasound-guided gallbladder drainage versus percutaneous cholecystostomy for high risk surgical patients with acute cholecystitis: a systematic review and meta-analysis. <i>Endoscopy</i> 51: 722–32	Systematic review and meta-analysis n=495 (5 studies)	Endoscopic ultrasound guided gallbladder drainage was associated with lower rates of post-procedure adverse events, shorter hospital stays, and fewer reinterventions and readmissions compared with percutaneous cholecystostomy in patients with acute cholecystitis who could not have surgery.	A more recent systematic review and meta-analysis is included.
Luo X, Sharaiha R, Teoh AYB (2022) Endoscopic Management of Acute Cholecystitis. <i>Gastrointestinal Endoscopy Clinics of North America</i> 32: 527–43	Review	Endoscopic management of acute cholecystitis in high surgical risk patients is recommended in tertiary hospitals whereby expertise, resources, and technical support are available. In patients who cannot have surgery, PT-GBD, ETP-GBD), and EUS-GBD are effective and safe alternative procedures to cholecystectomy. EUS-GBD is preferred over PT-GBD because of similar rates of technical success and reduced rates of reintervention and unplanned readmissions. LAMS are associated with reduced risks of	No meta-analysis.

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		adverse events such as bile peritonitis and perforation compared with plastic stents and these stents should be used for EUS-GBD. EUS-GBD is associated with a steeper learning curve and should be done in high volume endoscopy centres where expertise is available.	
Lyu Y, Li T, Wang B et al. (2021) Comparison of three methods of gallbladder drainage for patients with acute cholecystitis who are at high surgical risk: a network meta-analysis and systematic review. <i>Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A</i> ; 31: 1295–1302	Systematic review and network meta-analysis 13 studies	Endoscopic ultrasound-guided bladder drainage was associated with the highest probability of clinical success (68%), and the lowest prevalence of adverse events (57%) and recurrent cholecystitis (61%).	Another systematic review and network meta-analysis with a more recent paper is included.
Lyu Y, Li T, Wang B et al. (2021) Endoscopic ultrasound-guided gallbladder drainage versus percutaneous transhepatic gallbladder drainage for acute cholecystitis with high surgical risk: an up-to-date meta-analysis and systematic review. <i>Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A</i> ; 31: 1232–240	Systematic review and meta-analysis n=801 (8 studies)	Endoscopic ultrasound-guided bladder drainage was comparable to percutaneous gallbladder drainage regarding clinical success, with less reintervention and readmission, for acute cholecystitis with high surgical risk. The cholecystitis recurrence rate was lower with EUS-GBD with LAMS.	A more recent systematic review and meta-analysis is included.
Manta R, Mutignani M, Galloro G et al. (2018) Endoscopic ultrasound-guided gallbladder	Systematic review n=226 (9 studies)	The stent was positioned successfully in 95% (215/226) of	A more recent systematic review and

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<p>drainage for acute cholecystitis with a lumen-apposing metal stent: a systematic review of case series. <i>European Journal of Gastroenterology & Hepatology</i> 30: 695–98</p>	<p>Follow up: median 6 months (range 2 to 12 months)</p>	<p>patients (95% CI 92 to 98%). Clinical success=92% (207/226) at intention-to-treat analysis and 96% at per-protocol analysis. A total of 24 (11%) adverse events occurred, including 11 during the procedure, and 13 observed at follow up.</p>	<p>meta-analysis is included.</p>
<p>Matsubara S, Isayama H, Nakai Y et al. (2020) Endoscopic ultrasound-guided gallbladder drainage with a combined internal and external drainage tubes for acute cholecystitis. <i>Journal of Gastroenterology and Hepatology</i> 35: 1821–27</p>	<p>Feasibility study n=23 Follow up: 6 months</p>	<p>EUS-GBD with a combination of double pigtail plastic stent and naso-cystic tube is considered an effective and safe technique both as bridge to surgery and palliation.</p>	<p>Studies with more patients or longer follow up are included.</p>
<p>McCarty T, Hathorn K, Bazarbashi A et al. (2021) Endoscopic gallbladder drainage for symptomatic gallbladder disease: a cumulative systematic review meta-analysis. <i>Surgical Endoscopy</i> 35: 4964–4985</p>	<p>Systematic review and meta-analysis n=1,538 (36 studies)</p>	<p>Endoscopic gallbladder drainage is a safe and effective treatment for high-risk surgical candidates with symptomatic gallbladder disease. EUS-guided transmural drainage is superior to transpapillary drainage and associated with a lower rate of reintervention compared to percutaneous transhepatic drainage.</p>	<p>A more recent systematic review is included.</p>
<p>Minaga K, Yamashita Y, Ogura T et al. (2019) Clinical efficacy and safety of endoscopic ultrasound-guided gallbladder drainage replacement of percutaneous drainage: A multicenter</p>	<p>Case series n=21</p>	<p>Where ongoing gallbladder drainage is needed, conversion from PT-GBD to EUS-GBD is a feasible, effective, and safe technique for patients who cannot have cholecystectomy.</p>	<p>Studies with more patients or longer follow up are included.</p>

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retrospective study. Digestive Endoscopy 31: 180–87			
Mohan B, Asokkumar R, Shakhathreh M et al. (2019) Adverse events with lumen-apposing metal stents in endoscopic gallbladder drainage: A systematic review and meta-analysis. Endoscopic Ultrasound 8: 241–48	Systematic review and meta-analysis n=393 (8 studies)	The overall rate of adverse events with LAMS was 13%. Early adverse event risk appeared to be 6.5% and delayed risk appeared to be 8%.	Review focuses on adverse events associated with LAMS.
Nishiguchi K, Ogura T, Okuda A et al. (2021) Endoscopic gallbladder drainage for acute cholecystitis with high-risk surgical patients between transduodenal and transpapillary stenting. Endoscopic Ultrasound 10: 448–54	Non-randomised comparative study n=54 Follow up: median 522 days	Technical success rate and procedure time were significantly superior in the EUS-GBD group than in the ETP-GBD group. Recurrent acute cholecystitis tended to be more frequent in the ETP-GBD group, and clinical success tended to be more favourable in the EUS-GBD group, although these 2 variables did not differ significantly between groups.	Studies with more patients or longer follow up are included.
Ogura T, Nishioka N, Yamada M et al. (2021) EUS-guided gallbladder drainage using an improved self-expandable covered metal stent with anti-stent migration system (with video). Digestive Diseases (Basel, Switzerland) 39: 150–5	Feasibility study n=12 Follow up: median 189 days	EUS-GBD was successfully done in all patients without any adverse events, and clinical success was achieved in all patients. In 4 patients, stents were successfully removed after 3 months. No stent migration was seen.	Studies with more patients or longer follow up are included. Study is included in the systematic review by Fabbri et al. (2022).
Ogura T, Higuchi K (2019) Endoscopic ultrasound-guided gallbladder drainage: Current status and future	Review	Compared with PT-GBD, EUS-GBD involves internal drainage. It is a technically simple procedure compared	More recent systematic reviews are included.

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prospects. Digestive endoscopy 31: 55–64		with ETP-GBD. However, the results of long-term follow up are still unclear, and there is still insufficient evidence on performance of EUS-GBD as the first-line drainage technique.	
Oh D, Song TJ, Cho DH et al. (2019) EUS-guided cholecystostomy versus endoscopic transpapillary cholecystostomy for acute cholecystitis in high-risk surgical patients. Gastrointestinal Endoscopy 89: 289–98	Non-randomised comparative study n=172 Follow up: mean 19 months (for EUS-GBD)	In patients with acute cholecystitis for whom surgery is unsuitable, EUS-GBD may be a more suitable treatment method than endoscopic transpapillary cholecystostomy.	Retrospective non-randomised comparative study that is included in systematic reviews by Fabbri et al. (2022), Podboy et al. (2021) and Mohan et al. (2020).
Park SW, Lee SS (2022) Current status of endoscopic management of cholecystitis. Digestive Endoscopy 34: 439–50	Review	Endoscopic treatments such as EUS-GBD or ETP-GBD are minimally invasive, safe, and reliable. However, they have not yet been established as standard procedures and their roles are limited to treat those who are unfit for cholecystectomy. Furthermore, although no conclusion has been reached regarding which approach is preferred, these procedures should be commonly considered by skilled endoscopists practicing in high-volume institutes.	No meta-analysis.
Penas-Herrero I, de la Serna-Higuera C, Perez-Miranda M (2015) Endoscopic ultrasound-guided gallbladder drainage for the	Systematic review n=155 (with acute cholecystitis)	Overall, technical success was 97.5% and clinical success was 99.3% in patients with acute cholecystitis. Adverse events	A more recent systematic review and meta-analysis is included.

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management of acute cholecystitis (with video). Journal of Hepato-Biliary-Pancreatic Sciences 22: 35–43		developed in less than 8% of patients, all of them managed conservatively.	
Posner H, Widmer J. (2020) EUS guided gallbladder drainage. Translational Gastroenterology and Hepatology 5: 41	Review	EUS-GBD is overall a promising technique, which is being used in increasing numbers at expert centres internationally. With impressive technical and clinical success rates with low rates of adverse events, it should be considered for non-surgical candidates with acute cholecystitis.	A more recent systematic review and meta-analysis is included.
Rajadurai A, Zorron CTPL, Cameron R et al. (2022) Endoscopic ultrasound-guided gallbladder and bile duct drainage with lumen apposing metal stent: A large multicenter cohort (with videos). Journal of Gastroenterology and Hepatology 37: 179–89	Cohort study n=49 (EUS-GBD) Follow up: median 49 days	Technical success for EUS-GBD was 96% (47/49) and clinical success was 80% (39/49). No patients needed subsequent cholecystectomy. 30-day mortality was 14.3%. The procedure-related mortality was caused by biliary sepsis (2/49, 4%) or aspiration (3/49, 6%).	Studies with more patients or longer follow up are included.
Rerknimitr R, Pham KC (2020) Practical approaches for high-risk surgical patients with acute cholecystitis: The percutaneous approach versus endoscopic alternatives. Clinical Endoscopy 53: 678–85	Review	Although EUS-GBD has the highest technical and clinical success rates over ETP-GBD and PT-GBD for gallbladder drainage especially when it is performed by experienced therapeutic endoscopists, it may not be the first option if laparoscopic cholecystectomy is planned.	No meta-analysis.

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<p>Sagami R, Hayasaka K, Nishikiori H et al. (2020) Current status in the treatment of acute cholecystitis patients receiving antithrombotic therapy: Is endoscopic drainage feasible? A systematic review. <i>Clinical Endoscopy</i> 53: 176–88</p>	<p>Systematic review 54 studies (26 on endoscopic ultrasound-guided gallbladder drainage)</p>	<p>The overall technical success, clinical success, and bleeding complication rates of endoscopic transpapillary versus EUS-GBD were 84% versus 96% ($p<0.001$), 92% versus 97% ($p<0.001$) and 0.65% versus 2.1% ($p=0.005$), respectively.</p>	<p>A more recent systematic review and meta-analysis is included.</p>
<p>Sagami R, Hayasaka K, Ujihara T et al. (2020) Feasibility of endoscopic ultrasound-guided gallbladder drainage for acute cholecystitis patients receiving antithrombotic therapy. <i>Annals of Gastroenterology</i> 33: 391–97</p>	<p>Case series n=12 Follow up: mean 261 days</p>	<p>EUS-GBD yielded high technical and clinical success rates and a low recurrence rate. No patients on antithrombotic therapy developed bleeding complications.</p>	<p>Small case series, focusing on patients who are on antithrombotic therapy.</p>
<p>Saumoy M, Yang J, Bhatt A et al. (2021) Endoscopic therapies for gallbladder drainage. <i>Gastrointestinal Endoscopy</i> 94: 671–84</p>	<p>Review</p>	<p>Nonsurgical gallbladder drainage is recommended for management of acute cholecystitis in patients deemed high risk for surgical cholecystectomy. Selection of the optimal technique (PT-GBD, ETP-GBD, or EUS-GBD) should be individualised and determined using a multidisciplinary approach based on clinical determinants and available procedural expertise.</p>	<p>No meta-analysis.</p>
<p>Saumoy M, Tyberg A, Brown E et al. (2019) Successful cholecystectomy after endoscopic ultrasound</p>	<p>Cohort study n=34</p>	<p>Surgical cholecystectomy after EUS-GBD with lumen apposing metal stent is safe and feasible for the</p>	<p>Small study focusing on the feasibility of cholecystectomy after EUS-GBD.</p>

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gallbladder drainage compared with percutaneous cholecystostomy, can it be done? <i>Journal of Clinical Gastroenterology</i> 53: 231–35		management of cholecystitis. If patient's underlying medical conditions improve, previous EUS-GBD should not preclude patients from undergoing cholecystectomy as part of standard of care.	
Small AJ, Irani S (2018) EUS-guided gallbladder drainage vs. percutaneous gallbladder drainage. <i>Endoscopic Ultrasound</i> 7: 89–92	Review	EUS-guided GBD is a viable alternative for patients with cholecystitis needing nonsurgical drainage. Transmural placement of LAMSs can permit permanent drainage with minimal adverse events and has several reported advantages over percutaneous cholecystostomy tubes. EUS internal GBD should be reserved for poor operative candidates and done by highly experienced therapeutic echoendosonographers until additional evidence is accrued.	No meta-analysis.
Sobani ZA, Ling C, Rustagi T (2021) Endoscopic ultrasound-guided gallbladder drainage. <i>Digestive Diseases and Sciences</i> 66: 2154–61	Review	With multiple available options the method of gallbladder decompression in non-surgical candidates should be carefully evaluated and tailored to individual patient. When done by skilled endoscopists at high-volume centres, EUS-GBD is an effective and safe alternative therapy for gallbladder drainage with high technical success rate and better	No meta-analysis.

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		long-term clinical outcomes compared to PT-GBD.	
Takagi W, Ogura T, Sano T et al. (2016) EUS-guided cholecystoduodenostomy for acute cholecystitis with an anti-stent migration and anti-food impaction system; A pilot study. Therapeutic Advances in Gastroenterology 9: 19–25	Case series n=16 Follow up: median 181.5 days	Technical and clinical success were 100%. There were no recurrences of acute cholecystitis. Pneumoperitoneum was seen in one patient.	Studies with more patients or longer follow up are included. Study is included in the systematic reviews by Fabbri et al. (2022) and Mohan et al. (2020).
Teoh AYB, Kongkam P, Bapaye A et al. (2021) Use of a novel lumen apposing metallic stent for drainage of the bile duct and gallbladder: Long term outcomes of a prospective international trial. Digestive Endoscopy 33: 1139–45	Cohort study n=27 (EUS-GBD) Follow up: mean 197 days	The self-approximating LAMS with lower lumen apposing force was effective and safe with a low risk of buried stent syndrome and bleeding in the longer term.	Studies with more patients or longer follow up are included.
Teoh A (2019) Outcomes and limitations in EUS-guided gallbladder drainage. Endoscopic Ultrasound 8: 40-s43	Review	EUS-GBD is a safe and effective procedure for the treatment of acute cholecystitis in patients that are at high-risk for cholecystectomy. It also opens up new windows for endoscopic intervention to the gallbladder that was previously impossible. Data from large scale randomised studies are awaited to confirm the efficacy of the procedure.	No meta-analysis.
Teoh AYB, Serna C, Penas I et al. (2017) Endoscopic ultrasound-guided gallbladder drainage reduces adverse events	Non-randomised comparative study n=118	EUS-GBD and percutaneous cholecystostomy were both effective means of achieving gallbladder drainage. EUS-GBD	Studies with more patients or longer follow up are included. Study is included in

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compared with percutaneous cholecystostomy in patients who are unfit for cholecystectomy. <i>Endoscopy</i> 49: 130–8		may be a promising alternative to percutaneous cholecystostomy for treating acute cholecystitis in patients for whom surgery is unsuitable, provided that experienced endosonographers are available.	systematic reviews by Fabbri et al. (2022), Podboy et al. (2021) and Mohan et al. (2020).
Torres Yuste R, Garcia-Alonso FJ, Sanchez-Ocana R et al. (2020) Safety and efficacy of EUS-guided gallbladder drainage combined with ERCP in the same session. <i>Digestive Endoscopy</i> 32: 608–15	Cohort study n=71	Single-session EUS-GBD combined with ERCP has comparable rates of technical and clinical success to EUS-GBD alone. A combined EUS-GBD and ERCP procedure does not appear to increase adverse events and makes possible comprehensive treatment of gallstone disease by purely endoscopic means.	Study assesses outcomes when the procedure is combined with ERCP.
Toy G, Adler DG (2022) Nonsurgical gallbladder drainage: percutaneous and endoscopic approaches. <i>Techniques and Innovations in Gastrointestinal Endoscopy</i> 24: 90–97	Review	Technical and clinical success rates are similar between the percutaneous and transmural approaches which are higher than those in the transpapillary approach. Taken together, the endoscopic approaches are associated with shorter hospital stays and readmissions. Mortality rates are similar in all the approaches.	Systematic reviews with meta-analyses are included.
Tyberg A, Jha K, Shah S et al. (2020) EUS-guided gallbladder drainage: A learning curve modified by technical progress.	Case series n=48 Follow up: mean 5.4 months	Endoscopists experienced in EUS-GBD are expected to achieve a reduction in procedure time over	Studies with more patients or longer follow up are included.

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Endoscopy International Open 8: e92-e96		successive cases, with efficiency reached at 41 minutes and a learning rate of 19 cases. Continued improvement is demonstrated with additional experience.	
Tyberg A, Saumoy M, Sequeiros EV et al. (2017) EUS-guided versus percutaneous gallbladder drainage. Journal of Clinical Gastroenterology 52: 79–84	Non-randomised comparative study n=155	EUS-GBD is safe and efficacious, with comparable technical and clinical success rates and no difference in adverse events to PT-GBD. In addition, EUS-GLB offers a potential cost-saving benefit and morbidity benefit by demonstrating fewer repeat interventions.	Retrospective non-randomised comparative study that is included in systematic reviews by Podboy et al. (2021) and Mohan et al. (2020).
Walter D, Teoh AY, Itoi T et al. (2016) EUS-guided gall bladder drainage with a lumen-apposing metal stent: a prospective long-term evaluation. Gut 65: 6–8	Case series n=30 Follow up: mean 298 days	Technical success=90% (27/30) and clinical success=96% (26/27). 7% (2/27) of patients (7%) developed recurrent cholecystitis due to LAMS obstruction. Successful LAMS removal was done in 50% (15/30) of patients after a mean of 91 days. In 15 patients, no LAMS removal was done because of death (n=5), significant tissue overgrowth (n=2) or other causes (n=8). 15 serious adverse events were reported, including 4 that were possibly stent-related or procedure-related (13%). Overall mortality was 23% (7/30), with 30-day mortality of 17% (5/30).	Studies with more patients or longer follow up are included. Study is included in the systematic review by Mohan et al. (2020).
Yoo HW, Moon JH, Jo SJ et al. (2021) A novel	Case series n=17	Technical success=94% Clinical success=100%	Studies with more patients or

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electrocautery-enhanced delivery system for one-step endoscopic ultrasound-guided drainage of the gallbladder and bile duct using a lumen-apposing metal stent: a feasibility study. Endoscopy 53: 922–26		Overall adverse event rate=18%	longer follow up are included.
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