Surgical Endoscopy (2022) 36:7863–7876
https://doi.org/10.1007/s00464-022-09662-4

GUIDELINES

EAES rapid guideline: updated systematic review, network meta-analysis, CINeMA and GRADE assessment, and evidence-informed European recommendations on the management of common bile duct stones

Luigi Boni[1] · Bright Huo[2] · Laura Alberici[3] · Claudio Ricci[3,4] · Sofia Tsokani[5] · Dimitris Mavridis[5,6] · Yasser Sami Amer[7,8,9,10] · Alexandros Andreou[11] · Thomas Berriman[12] · Gianfranco Donatelli[13,14] · Nauzer Forbes[15,16] · Stylianos Kapiris[17] · Cüneyt Kayaalp[18] · Leena Kylänpää[19] · Pablo Parra-Membrives[20,21] · Peter D. Siersema[22] · George F. Black[23] · Stavros A. Antoniou[24,25]

Received: 8 July 2022 / Accepted: 18 September 2022 / Published online: 13 October 2022

Abstract

Background Choledocholithiasis presents in a considerable proportion of patients with gallbladder disease. There are several management options, including preoperative or intraoperative endoscopic cholangiopancreatography (ERCP), and laparoscopic common bile duct exploration (LCBDE).

Objective To develop evidence-informed, interdisciplinary, European recommendations on the management of common bile duct stones in the context of intact gallbladder with a clinical decision to intervene to both the gallbladder and the common bile duct stones.

Methods We updated a systematic review and network meta-analysis of LCBDE, preoperative, intraoperative, and postoperative ERCP. We formed evidence summaries using the GRADE and the CINeMA methodology, and a panel of general surgeons, gastroenterologists, and a patient representative contributed to the development of a GRADE evidence-to-decision framework to select among multiple interventions.

Results The panel reached unanimous consensus on the first Delphi round. We suggest LCBDE over preoperative, intraoperative, or postoperative ERCP, when surgical experience and expertise are available; intraoperative ERCP over LCBDE, preoperative or postoperative ERCP, when this is logistically feasible in a given healthcare setting; and preoperative ERCP over LCBDE or postoperative ERCP, when intraoperative ERCP is not feasible and there is insufficient experience or expertise with LCBDE (weak recommendation). The evidence summaries and decision aids are available on the platform MAGICapp (https://app.magicapp.org/#/guideline/nJ5zyL).

Conclusion We developed a rapid guideline on the management of common bile duct stones in line with latest methodological standards. It can be used by healthcare professionals and other stakeholders to inform clinical and policy decisions.

Guideline registration number IPGRP-2022CN170.

Keywords Choledocholithiasis · Common bile duct stones · ERCP · Laparoscopic common bile duct exploration · Guidelines · AGREE-S

Common bile duct stones are present in about 15% of patients with gallbladder disease [1]. Choledocholithiasis will not become clinically apparent in a proportion of patients, however it may result in obstructive jaundice, ascending cholangitis, pancreatitis, or cystic stump leak following cholecystectomy [2, 3]. Laparoscopic surgery and other advances in surgical and endoscopic technology have introduced a number of options for the management of choledocholithiasis.

Nevertheless, such options as laparoscopic common bile duct exploration (LCBDE) and intraoperative endoscopic retrograde cholangiopancreatography (ERCP) have not

✉ Stavros A. Antoniou
guidelines@eaes.eu

Extended author information available on the last page of the article

seen widespread use [4], which may be due to the need of advanced laparoscopic and endoscopic skills, coordination between surgeons and gastroenterologists, and limited summary evidence of relative benefits and harms.

In an annual survey of the European Association for Endoscopic Surgery (EAES) Research Committee/Guidelines Subcommittee, members prioritized the management of common bile duct stones to be addressed by a clinical practice guideline [5].

The aim of this rapid guideline is to assist upper gastrointestinal, endoscopic, and general surgeons, gastroenterologists and other healthcare professionals, and patients in selecting the most appropriate option(s) for the management of common bile duct stones. This guideline is limited to interventions for the management of common bile duct stones in the context of intact gallbladder with a clinical decision to intervene to both the gallbladder and the common bile duct stones. The objective is to reduce perioperative morbidity and the need for long-term reinterventions, and to improve patients' experience and health-related quality of life. This guideline applies primarily to healthcare professionals, policy makers, patients, and other stakeholders in the European region.

Methods

This rapid guideline was registered in the International Practice Guideline Registry Platform (registration number IPGRP-2022CN170). It follows AGREE-S, GRADE, Institute of Medicine, Guidelines International Network (GIN) and Cochrane Rapid Reviews Methods Group development and reporting standards [6–10]. An AGREE-S reporting checklist is available in Supplementary file 2. GRADE guidance published in a series of articles in the *Journal of Clinical Epidemiology* was consulted for up-to-date information. The development of this guideline was informed by the GRADE methodology to appraise the certainty of the evidence from a network meta-analysis (NMA), the Confidence in Network Meta-Analysis (CINeMA) methodology, and the GRADE evidence-to-decision framework to choose from multiple interventions [11–14]. This process was facilitated by the use of MAGICapp, an online authoring and publication platform.

Steering group

The steering group consisted of two general surgeons (SAA, LB). A member of the steering group is a certified guideline methodologist (INGUIDE certificate number 2021-L2-V1-00001) with vast experience in evidence outreach, synthesis, assessment and guideline development (SAA). Both members of the steering group were free from direct and indirect conflicts [15]. A Guidelines International Network lead member served as external auditor and co-methodologist, overseeing the project from the outset, receiving all email communications of the steering group and the guideline development group, contributing to the development of the evidence tables and co-leading the discussions pertaining to the evidence-to-decision framework (YSA). A gastroenterologist with experience in the GRADE methodology served as external content auditor (NF).

Guideline panel

The guideline panel consisted of 4 general surgeons and 4 gastroenterologists. Despite our efforts, we could not recruit any patient representatives at the outset. However, we received post hoc input on the evidence-to-decision framework from a patient representative, a former patient located in a rural area of the USA, who experienced acute gangrenous cholecystitis with choledocholithiasis 7 years ago, and had preoperative ERCP and laparoscopic cholecystectomy. Panel members watched a short video tutorial outlining the guideline development methodology. The composition of panel members aimed to represent regional diversity in practice across Europe. Panel members disclosed no direct nor indirect conflicts [15].

Health question

Which intervention should be used among preoperative ERCP, intraoperative ERCP, LCBDE, and postoperative ERCP for adult patients with common bile duct stones in the acute or elective setting?

Protocol

A protocol was developed a priori by the steering group [16]. The protocol draft was made publicly available through the EAES website, and EAES members were invited through email to comment on the content. The guideline question and outcomes of interest were refined in collaboration with the panel members. Amendments to the protocol with justifications are provided under *Amendments to the protocol*.

Rating the importance of outcomes

The importance of outcomes was rated by panel members using the GRADE scale [17]. The classification of outcomes into each of the three categories (not important, important, critical) was made by the steering group under consideration of panel members' ratings available online [15]. The rating of importance was the median of ratings provided by panel members for each outcome.

We considered the importance of outcomes as follows:

(1) 30-Day complications Clavien-Dindo ≥ 3: critical
(2) 30-Day complications Clavien-Dindo ≤ 2: important
(3) Reintervention for common bile duct stones up to 6 months post primary intervention: important
(4) Quality of life: critical (decided post hoc, see *Amendments to the protocol*)

In addition, we considered conversion to open surgery as an important outcome, because it is not captured by perioperative complications classified according to Clavien-Dindo, although it may contribute to postoperative complications (e.g., wound infection). Panel members approved the consideration of this outcome, which was included before data collection and analysis, and they were made aware of this potential overlap between conversion and perioperative complications, although it is likely of small magnitude.

Quality of life was prioritized by members of the panel and external advisors. They also nominated a number of outcomes, which were not prioritized: need for repeated sedation, postoperative biliary fistula and recurrent choledocholithiasis. We considered these outcomes to overlap with the primary outcomes reported previously.

Setting minimal important differences

The evidence-to-decision framework was set within a fully contextualized approach [14]. An anonymous web-based survey of panel members was performed to define minimal important differences. The results of the survey are available online [15]. The median of minimal important differences proposed by the panel members was considered.

Under consideration of panel's responses, the following minimal important differences were set:

(1) 30-Day complications Clavien-Dindo ≥ 3: 10 per 1000
(2) 30-Day complications Clavien-Dindo ≤ 2: 50 per 1000
(3) Reintervention: 25 per 1000
(4) Quality of life: (set post hoc)—5 out of 100—7.2 for Gastrointestinal Quality of Life Index
(5) Conversion: (set post hoc)—100 per 1000

Search strategy

We updated a previous systematic review on the management of choledocholithiasis [18]. We refined the search syntax and we updated the search from September 14, 2017 (date of the last search of the previous review) to January 8, 2022. We searched PubMed, Scopus, and Web of Science. The search strategies were developed by authors of the primary systematic review with input from the steering group. The search syntaxes are provided in the online appendix [15].

Study selection

Study selection was performed by an ad hoc evidence outreach team (LA, BH) using the platform Rayyan [19]. Both reviewers were blinded to each other's judgement and, after unblinding, disagreements were resolved through arbitration by the senior author. We considered randomized controlled trials only, comparing either of the interventions, or a modification, with each other. Overarching inclusion criteria were adult patients with common bile duct stones diagnosed with magnetic resonance cholangiopancreatography (MRCP), ERCP, or intraoperative cholangiography in the elective or acute setting (i.e., presenting with acute cholecystitis, biliary cholangitis, or biliary pancreatitis).

Data extraction

Outcome data were extracted in parallel by the same 2 reviewers; discrepancies were resolved by arbitration from the senior author, who also cross checked the extracted data against the study reports. The data extraction spreadsheet and detailed risk of bias assessments per outcome, or group of outcomes, with justifications are available online, also for third-party use under the Creative Commons license, after approval by the senior author [15].

Risk of bias assessment

We performed de novo risk of bias assessments using RoB 2.0 [20]. Risk of bias assessments were performed by one of the reviewers (BH) and cross checked by the senior author (SAA). For the purposes of outcome-specific risk of bias assessment, outcomes were grouped as follows: 30-day complications Clavien–Dindo and conversion; reintervention; and quality of life. We considered longest-term follow-up data for reinterventions and quality of life, although the vast majority of studies did not report on duration of follow-up, which was taken into consideration in the evidence appraisal. Risk of bias assessment and visual summarization were performed with the RoB-2 tool and the respective Excel application [21].

Statistical analysis

Network meta-analysis (NMA) is a popular statistical method that synthesizes direct and indirect evidence; it allows estimation of the relative effectiveness between any pair of interventions within a network of treatments [22, 23]. Moreover, NMA allows to generate a relative hierarchy (ranking) of interventions.

Network plots were created for each outcome to visualize the structure of intervention comparisons. The nodes correspond to the interventions and the edges display the observed intervention comparisons. Thickness of edges indicates the frequency with which each comparison occurs in the network (number of studies).

For each outcome, we conducted a random effects network meta-analysis within a frequentist framework using methods derived from graph theory, originally developed for electrical networks [24, 25]. All analyses were generated in R software, using the "netmeta" package [26].

The effect estimates (indirect or mixed) were expressed as odds ratios or mean differences for dichotomous outcomes and continuous variables, respectively, along with 95% confidence intervals. Confidence intervals including 1 for odds ratios or 0 for mean difference imply a non-statistically significant relative effect for the compared interventions.

We generated a hierarchy of treatments, using P-scores [27]. P-scores give the probability for each intervention being better than all competing interventions; the closer the P-score to 1 the better the intervention. Forest plots and league tables were used to display the results. The lower diagonal of a league table displays all the relative network effects estimates and their corresponding 95% confidence intervals, while the upper diagonal includes all direct (pairwise) estimates.

A fundamental assumption of NMA is transitivity, which suggests that the distribution of effect modifiers is similar across intervention comparisons. The statistical manifestation of transitivity is consistency (or coherence), which refers to the statistical agreement between the observed direct and indirect sources of evidence. Incoherent network meta-analysis results can be less interpretable and reliable. We applied the node-splitting approach to locally check for consistency in our networks. Also, we used the 'design-by treatment' model, proposed by Higgins et al. to check for consistency in the entire network [28]. In addition, we assessed potential reporting bias using the comparison-adjusted funnel plot, which is an extension of the funnel plot in pairwise meta-analysis [29]. We also performed a sensitivity analysis considering only studies that were published from 2011 onwards (see *Amendments to the protocol*).

Assessment of the certainty of evidence

We constructed GRADE evidence profiles of certainty for each pairwise comparison separately and for each outcome using MAGICapp. The certainty of evidence is determined by the risk of bias across studies, incoherence, indirectness, imprecision, publication bias and other parameters [30]. To inform calculations of absolute effect differences, we performed proportion meta-analyses of frequencies of baseline risks/effects provided by the source studies; these are available in the online appendix [15].

We used the CINeMA software to summarize risk of bias according to the contribution of each study to the network for the respective outcome [11, 14]. The overall risk of (within study) bias was based upon the highest proportion of risk of bias contributed to the network, as per CINeMA methodology [11]. Judgements on publication (reporting) bias were based on comparison-adjusted funnel plots. Judgements on indirectness were based on conceptual differences between the study populations, settings and interventions (which was judged to be low risk across outcomes), and the presence of direct evidence; if only indirect evidence was present (which does not allow for assessment of inconsistency), we downgraded the evidence certainty by one level. Heterogeneity judgements were based upon statistical calculations of heterogeneity and consistency. If substantial evidence of heterogeneity or inconsistency was found, we downgraded the certainty in the evidence by one or two levels. Judgements on imprecision were based upon minimal important differences that were set by majority voting of the guideline panel in advance (or in the consensus meeting, for outcomes included post hoc), according to principles of a fully contextualized approach (minimal important differences for each outcome were based upon the assumption that each outcome is the only outcome of interest) [14].

For each outcome, we stratified interventions by certainty (moderate-to-high or low-to-very low). We then grouped interventions within each stratum into 3 groups according to their statistical ranking: among the best, inferior to the best/better than the worst, and among the worst. This process facilitates assessment of both the certainty of the evidence on each intervention along with their ranking [31]. The classified rankings were considered by panel members as complementary to the GRADE evidence tables.

Evidence-to-decision framework and development of recommendations

The guideline panel reviewed the evidence tables and the stratified rankings and provided their judgements, in an in-person consensus meeting, on:

- The magnitude of benefit of each intervention
- The magnitude of harm of each intervention
- The certainty of the evidence for each intervention
- Any variability in patients' values and preferences
- Costs or savings related to each intervention
- Effect of each intervention on equity
- Acceptability of each intervention
- Feasibility of each intervention.

Panel members then participated in an online Delphi process to formulate the recommendations. A draft of the recommendations was developed by the steering group, and panel members were invited to anonymously propose modifications.

The *Values and Preferences* domain of the evidence-to-decision framework was informed by collective experience of the panel and the patient representative's input; this was provided in an online meeting with the guideline methodologist.

Amendments to the protocol

Following panel members' and advisors' input, we considered quality of life as a critical outcome. After public input, we performed sensitivity analyses of studies published from 2011 onwards. Furthermore, we considered both acute and elective cases in the question framework, after discussion with the panel.

Despite our efforts, we could not involve a patient representative from the start of the project, however, we received the input from a patient representative on the evidence-to-decision framework (see *Evidence-to-decision framework and development of recommendations*).

Results

We included 20 studies from the original review and an additional 7 studies from the update search and record screening, for a total of 27 studies [32–58]. Excluded records are provided online [15] and the PRISMA flow chart is available in the online Appendix. Risk of bias contribution charts per outcome or group of outcomes are available in the online Appendix. Detailed risk of bias assessment with justifications is provided in the online appendix [15].

Network geometry

The network geometry was similar but not identical for all outcomes, with mostly direct comparisons between interventions, except for preoperative vs postoperative ERCP, and intraoperative vs postoperative ERCP, where the evidence was only indirect across outcomes. For visual illustration of the network geometry, see network plots per outcome in the online Appendix. Node size is proportional to the number of studies; node color corresponds to the proportion of risk of bias; edge width is proportional to the inverse variance; and edge color corresponds to the average risk of bias.

Assessment of transitivity

There was no variation in baseline characteristics among studies, thus we did not identify any major challenges of transitivity in this regard. Inclusion or exclusion of patients with acute cholecystitis, cholangitis or pancreatitis was inconsistently reported. Specifically, only 2 studies reported that they included patients with acute cholecystitis [37, 53]. Seventeen of 27 studies reported on inclusion or exclusion of patients with cholangitis and/or pancreatitis. We explored the likelihood for these variables to potentially affect transitivity. Acute cholangitis and/or pancreatitis were exclusion criteria in 45%, 55%, 35%, and 33% of the preoperative ERCP, intraoperative ERCP, LCBDE, and postoperative ERCP cohorts (see data extraction sheet in online appendix) [15]. Therefore, we did not consider likely that these parameters affected transitivity. There was no substantial variation in operative and interventional techniques. Most authors attempted transcystic stone extraction before performing choledochotomy.

Evidence and evidence-to-decision framework

The evidence for the comparison between preoperative ERCP versus LCBDE is presented in Table 1. The evidence tables for other comparisons are available in the online Appendix. Sensitivity analyses of studies published from 2011 onwards corroborated the findings of the primary analysis (see online Appendix). The evidence-to-decision framework is summarized in Table 2. A decision algorithm is provided in Fig. 1.

Delphi survey

Unanimous consensus was achieved in the first Delphi round for all recommendations (responses available in the online appendix [15]).

- We suggest LCBDE over preoperative, intraoperative, or posterative ERCP, when surgical experience and expertise are available. (weak recommendation)
- We suggest intraoperative ERCP over LCBDE, preoperative, or postoperative ERCP, when this is logistically feasible in a given healthcare facility. (weak recommendation)
- We suggest preoperative ERCP over LCBDE, intraoperative, or postoperative ERCP, when intraoperative ERCP is not feasible, and when surgical experience and expertise in LCBDE are not available. (weak recommendation)
- We suggest intraoperative ERCP over preoperative ERCP, LCBDE, or postoperative ERCP, when intraoperative ERCP is logistically feasible, and when surgical

Table 1 Evidence table for the comparison LCBDE versus preoperative ERCP

Outcome Timeframe	Study results and measurements	Absolute effect estimates		Certainty of the evidence (Quality of evidence)	Plain language summary
		LCBDE	Preoperative ERCP		
Major complications[a] 30 days	Odds ratio: 1.41 (CI 95% 0.64–3.13) Based on data from 2339 participants in 18 studies Follow up 30 days or in-hospital	**30** per 1000 Difference: **12 more per 1000** (CI 95% 11 fewer—58 more)	**42** per 1000	**Low** Due to serious risk of bias, due to serious imprecision[b]	Preoperative ERCP may increase major complications
Minor complications[c] 30 days	Odds ratio: 0.99 (CI 95% 0.59–1.67) Based on data from 2339 participants in 18 studies Follow up 30 days or in-hospital	**120** per 1000 Difference: **1 fewer per 1000** (CI 95% 46 fewer—65 more)	**119** per 1000	**Low** Due to serious risk of bias, due to serious inconsistency[d]	Preoperative ERCP may have little or no difference on minor complications
Conversion to open[e]	Odds ratio: 0.79 (CI 95% 0.45–1.41) Based on data from 3139 participants in 21 studies	**50** per 1000 Difference: **10 fewer per 1000** (CI 95% 27 fewer—19 more)	**40** per 1000	**Moderate** Due to serious risk of bias[f]	Preoperative ERCP probably has little or no difference on conversion to open surgery
Reintervention[g] 6 months	Odds ratio: 1.33 (CI 95% 0.56–3.23) Based on data from 2530 participants in 18 studies Follow up 1 month to 10 years (mostly not reported)	**50** per 1000 Difference: **15 more per 1000** (CI 95% 21 fewer—95 more)	**65** per 1000	**Very low** Due to very serious risk of bias, due to serious imprecision[h]	We are uncertain whether preoperative ERCP increases or decreases reintervention
Quality of life[i]	Measured by: Gastrointestinal Quality of Life Index Scale: GIQLI – High better Based on data from 157 participants in 1 study Follow up 3 months	**131.24** Mean Difference: **MD 18.92 lower** (CI 95% 17.05 lower—20.79 lower)	**112.32** Mean	**Low** Due to serious indirectness, due to serious imprecision[j]	Preoperative ERCP may worsen quality of life

[a]Clavien-Dindo ≥ 3

[b]**Risk of Bias: serious. Imprecision: serious.** Wide confidence intervals crossing decision threshold

[c]Clavien-Dindo ≤ 2

[d]**Risk of Bias: serious. Inconsistency: serious.** Due to incoherence

[e]Conversion from laparoscopic to open cholecystectomy or common bile duct exploration

[f]**Risk of Bias: serious**

[g]Any repeat intervention besides simple laparoscopic cholecystectomy, for common bile duct clearance (includes LCBDE)

[h]**Risk of Bias: very serious. Imprecision: serious**

[i]Quality of life assessed using any validated scale

[j]**Indirectness: serious.** Insufficient follow-up. **Imprecision: serious.** Only data from one study, low number of patients

LCBDE laparoscopic common bile duct exploration, *ERCP* endoscopic cholangiopancreatography, *CI* confidence interval, *MD* mean difference, *GIQLI* Gastrointerstinal Quality of Life Index

Table 2 Summary of evidence-to-decision considerations

Benefits and harms	*Research evidence* The panel considered that at least moderate benefits can be expected when intraoperative ERCP with the rendezvous technique is performed (only a minority of studies reported on the rendezvous technique), otherwise the magnitude of beneficial effect was considered to be small. The beneficial or harmful effect of LCBDE was considered to vary, depending on the anatomy of the extrahepatic biliary tree, acute/elective cases, surgeon's experience and expertise *Additional considerations* Small increase in substantial major complications (e.g., biliary tract reconstruction) could result in substantial harm for LCBDE. Rare events are ideally documented from observational studies, but no relevant data were collected here *Summary* Intraoperative ERCP with rendezvous technique was considered to provide the most favorable balance between benefits and harms, followed by preoperative ERCP. The effect of LCBDE was considered to vary depending on several factors	Small net benefit, or little difference between alternatives
Certainty of the evidence	*Research evidence* The certainty of the evidence was in general low for critical outcomes, primarily due to risk of bias and imprecision, and moderate for important outcomes. There was very limited evidence on quality of life *Summary* The panel considered that the overall certainty of the evidence was low for preoperative/intraoperative ERCP and LCBDE, and very low for postoperative ERCP	Low
Preferences and values	The guideline panel, including the patient representative, agreed that most patients would prefer a single-step management for their disease, and particularly individuals residing in rural areas, and those with time restrictions related to their work, family, or other commitments. Patients in urban areas might prefer the management options with the least risk of adverse events and the highest odds of success *Summary* The panel agreed that variation in patients' values and preferences can be anticipated	Substantial variability is expected or uncertain
Resources	*Research evidence* Three studies provided information on cost. Two found a difference in favor of LCBDE over preoperative ERCP, albeit one with no statistical significance, but a difference of over $1 K in professional fee charges in favor of LCBDE [42, 48]. Another study found that intraoperative ERCP had a lower total cost compared to preoperative ERCP [56]. A cost-effectiveness analysis suggested that LCBDE, followed by intraoperative ERCP, might be the most cost-effective among LCBDE, preoperative, intraoperative, and postoperative ERCP* These data do not derive from a systematic review on cost; therefore, the possibility of publication bias cannot be excluded, albeit unlikely *Additional considerations* Under consideration of costs and use of resources (availability of endoscopy team, coordination with surgical team, transfer of endoscopy equipment, operating room occupancy), the panel agreed that intraoperative ERCP might be associated with excessive use of resources, unless optimal coordination and resource allocation can be achieved *Summary* The panel agreed that LCBDE may be associated with the least use of resources, although intraoperative ERCP may be cost-effective with optimal operating room planning	No important issues with the recommended alternative

Table 2 (continued)

Equity	The panel suggested that either intervention might not affect equity in the elective setting, however intraoperative ERCP might reduce equity in the acute setting, due to limited availability of respective services across healthcare facilities. However, there was no consensus on LCBDE, with 4 out of 7 panel members suggesting that the effect on equity varies within and across countries, and 2 out of 7 suggesting that equity might be reduced *Summary* The panel agreed that preoperative and postoperative ERCP are associated with the least negative effect on equity	Important issues, or potential issues not investigated
Acceptability	The panel agreed that postoperative ERCP is not acceptable as a first-line strategy, rather than an acceptable intervention when choledocholithiasis is diagnosed postoperatively, or intraoperatively, when expertise in LCBDE and availability of intraoperative ERCP is lacking. Furthermore, they suggested that intraoperative ERCP might not be acceptable to key stakeholders, such as endoscopy teams and operating room staff, due to high demand in resources (availability, coordination with surgeons, transfer of endoscopy equipment) *Summary* The panel agreed that preoperative ERCP and LCBDE might be the management options with the highest acceptability to stakeholders	Important issues, or potential issues not investigated
Feasibility	The panel agreed that all management options, including intraoperative ERCP and LCBDE may be logistically feasible, however intraoperative ERCP may add substantial burden to healthcare institutions endoscopy and surgical units *Summary* The panel did not identify any issues with feasibility	No important issues with the recommended alternative

More details and a visual summary are available in https://app.magicapp.org/#/guideline/nJ5zyL

LCBDE laparoscopic common bile duct exploration, *ERCP* endoscopic cholangiopancreatography, *INR* Indian Rupee

*Morrell DJ, Pauli EM, Hollenbeak CS (2022) Inpatient choledocholithiasis management: a cost-effectiveness analysis of management algorithms. J Gastrointest Surg 26(4):837–848. https://doi.org/10.1007/s11605-022-05249-5. Epub 2022 Jan 26. PMID: 35,083,722

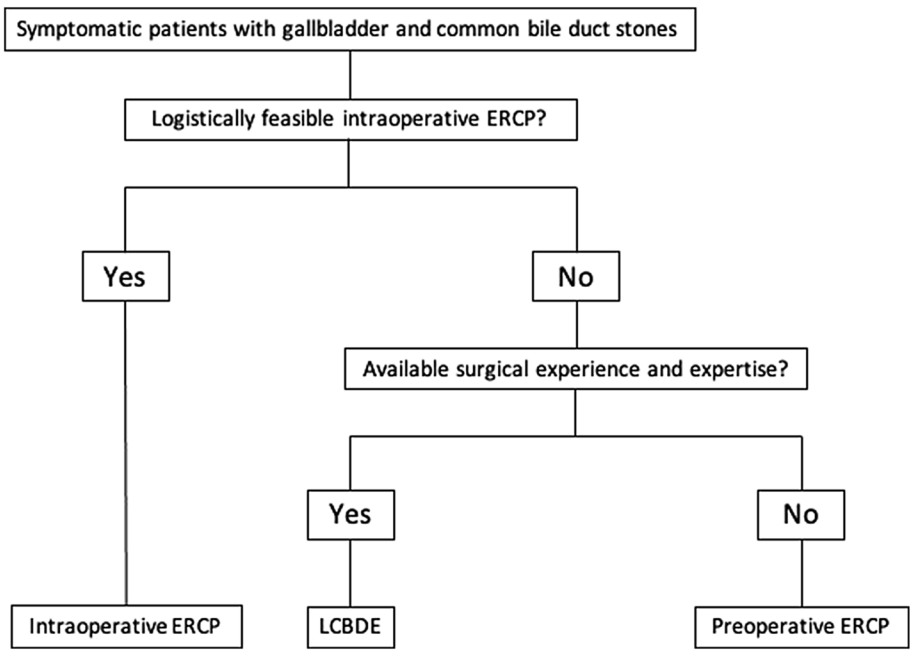

Fig. 1 Decision tree for the management of common bile duct stones. *LCBDE* laparoscopic common bile duct exploration. *ERCP* endoscopic retrograde cholangiopancreatography

experience and expertise in LCBDE are available. (weak recommendation)

Discussion

Implications for policy makers

Intraoperative ERCP and LCBDE appear to be the most effective interventions with the least harm. Some evidence suggests they may result in cost reduction compared to alternatives [42, 48, 56], once LCBDE is performed by an operating team with experience and expertise. In the absence of published evidence, we performed a survey among panel members, who estimated that LCBDE is performed in < 20% of secondary and tertiary care centers in Europe (including the UK and countries bordering the Mediterranean Sea), intraoperative ERCP in < 10% and preoperative ERCP in > 80% (majority voting; detailed survey responses available in [15]).

Policy makers may want to enhance the effectiveness and safety of healthcare services by offering LCBDE and intraoperative ERCP. When intraoperative ERCP is not feasible and expertise in LCBDE is not available, preoperative ERCP is an alternative. Healthcare institutions need to consider whether intraoperative ERCP is logistically feasible in local routine practice and are advised to remove barriers for this procedure being more frequently performed.

Further considerations are provided under *Barriers and facilitators*.

Implications for healthcare professionals

Surgeons and gastroenterologists are advised to perform intraoperative ERCP, if this is feasible at an institutional level, or LCBDE, when operating team expertise is available. We suggest auditing of outcomes and comparison to international standards, with observed risk intervals (based upon proportion meta-analysis of baseline risks in the source studies; see online Appendix):

- Major complications (Clavien-Dindo ≥ 3): LCBDE, 1–7%; preoperative ERCP, 2–7%; intraoperative ERCP, 0–5%
- Conversion to open surgery: LCBDE, 3–7%; preoperative ERCP, 2–6%; intraoperative ERCP, 0–4%
- Reintervention for common bile duct clearance within 6 months: LCBDE, 3–8%; preoperative ERCP, 3–9%; intraoperative ERCP, 0–2%

Implications for patients

Patients can be informed that preoperative ERCP is an acceptable management option. However, intraoperative ERCP or LCBDE may confer better results, depending on the availability of services and expertise. The latter alternatives may allow for a single-step treatment, whereas preoperative ERCP may require extended duration of hospital stay or management in more than one hospitalization.

Implications for researchers

Further randomized trials comparing preoperative ERCP, intraoperative ERCP and/or LCBDE are desired. We suggest that future studies provide stratified complication data (e.g., Clavien-Dindo classification), data on reinterventions with at least 6-month follow-up, and data on quality of life.

Feasibility and cost analyses comparing the above interventions are of particular importance, as such data can inform policy decisions at the institutional level.

Qualitative studies on preferences and values of stakeholders (patients, surgeons, endoscopists, surgical and endoscopy staff) will further inform the acceptability of alternatives.

Barriers and facilitators

Intraoperative ERCP requires close collaboration and mutual understanding between endoscopists and surgeons. The availability of professional resources and equipment, together with the number of cases requiring common bile duct clearance, will influence the decision to establish this setting on a routine level. When considering the natural history of choledocholithiasis, an average of 2–3 cases per week would mandate a dedicated operating room for intraoperative ERCP. In centers where lower case rates are treated, centralization of care for patients with common bile duct stones might be required to implement a routine practice of intraoperative ERCP. Alternatively, use of an operating room on a case-by-case basis would become a logistical challenge and requires effective coordination of the endoscopy and surgical services, which depends on the availability of resources and the organizational culture of the institution. Reviewing the evidence presented herein may assist with making informed policy decisions.

Surgical service offering LCBDE requires technical expertise of two or more staff surgeons, that can be established through visiting fellowships, practical courses, and mentored/telementored practice to increase the experience and skills of the operating team. Evidence suggests that, when operating time is used as moderator, the learning curve is reached in between 50 (choledochotomy) and 250 (transcystic exploration or choledochotomy) cases [59, 60]. Significant reduction in perioperative morbidity is achieved after 50 cases (choledochotomy) [60]. EAES offers a hands-on course at its annual Congress and visiting fellowships through its Fellowship Program. On-site fellowships will further allow surgeons to become

acquainted with special devices for LCBDE. Networking in surgical/endoscopic congresses, support from the industry and local mentorship can further support establishment of LCBDE at the institutional level.

Institutions and operators may also wish to consider the similar learning curve between training a surgeon to perform LCBDE to training the surgeon to perform ERCP (in healthcare settings allowing this practice by surgeons), thereby significantly decreasing the requirement for redundancy in the operating team/unit.

Monitoring

Use of the guideline by EAES members will be monitored through an online survey 2 years after publication. Feedback from target users in the form of email communication, letters to the editor, and comments in social media will be documented to be addressed in future versions of this guideline.

Validity period

A scoping search of ClinicalTrials.gov ($n=2$), EU Clinical Trials Register ($n=0$), WHO International Clinical Trials Registry Platform (de-duplicated; $n=1$) and ISRCTN registry for randomized controlled trials comparing either of the alternatives identified 3 ongoing randomized trials that compare LCBDE with (preoperative) ERCP, with reported estimated completion, or completion of recruitment in 2022, 2023 and 2024 [61–63]. Under additional consideration that a median of 2 studies was published per year over the past 10 years, we do not expect substantial additional evidence to emerge within the next 7 years. The validity of the present version of this rapid guideline is set until 2029. Please read the *Disclosure* for further information regarding validity.

Update

An update of this rapid guideline is planned to take place in 2029. The EAES Research Committee/Guidelines Subcommittee will keep monitoring new evidence and update this document if substantial new data become available.

Conclusion

This rapid guideline provides up-to-date recommendations on the management of choledocholithiasis in the context of intact gallbladder with a clinical decision to intervene to both the gallbladder and the common bile duct stones. It is based upon a network meta-analysis of interventions, and a structured evidence-to-decision framework, with the input of an international panel of stakeholders.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00464-022-09662-4.

Disclaimer This clinical practice guideline has been developed under the auspice of the European Association for Endoscopic Surgery (EAES). It is intended to be used primarily by health professionals (e.g., surgeons, anaesthetists, physicians) and to assist in making informed clinical decisions on diagnostic measures and therapeutic management. It is also intended to inform individual practice of allied health professionals (e.g., surgical nurses, dieticians, physical rehabilitation therapists, psychologists); to inform strategic planning and resource management by health care authorities (e.g., regional and national authorities, health care institutions, hospital administration authorities); and to inform patients wishing to obtain an overview of the condition of interest and its management. The use of recommendations contained herein must be informed by supporting evidence accompanying each recommendation and by research evidence that might not have been published by the time of writing the present document. Users must thus base their actions informed by newly published evidence at any given point in time. The information in the guideline should not be relied upon as being complete or accurate, nor should it be considered as inclusive of all proper treatments or methods of care or as a statement of the standard of care. With the rapid development of scientific knowledge, new evidence may emerge between the time the guideline is developed and when it is published or read. The guideline is not continually updated and may not reflect the most recent evidence. The guideline addresses only the topics specifically identified therein and is not applicable to other interventions, diseases, or stages of diseases. This guideline does not mandate any particular course of medical care. Further, the guideline is not intended to substitute the independent professional judgment of the treating provider, as the guideline does not necessarily account for individual variation among patients. Even if evidence on a topic suggests a specific diagnostic and/or treatment action, users and especially health professionals may need to decide against the suggested or recommended action in view of circumstances related to patient values, preferences, co-morbidities and disease characteristics; available human, monetary, and material resources; and healthcare infrastructures. EAES provides this guideline on an "as is" basis, and makes no warranty, express or implied, regarding the guideline.

Funding This project was funded by the European Association for Endoscopic Surgery. The funding bodies had no influence on the development of this rapid guideline or its protocol. There is no grant number linked to this research.

Declarations

Disclosures Luigi Boni, Bright Huo, Laura Alberici, Claudio Ricci, Sofia Tsokani, Dimitris Mavridis, Yasser Sami Amer, Alexandros Andreou, Thomas Berriman, Gianfranco Donatelli, Nauzer Forbes, Stylianos Kapiris, Cüneyt Kayaalp, Leena Kylänpää, Pablo Parra-Membrives, Peter D. Siersema, George F. Black, Stavros A. Antoniou have no direct conflicts of interest to disclose. Indirect conflicts were documented and managed as per Guidelines International Network Standards. Detailed conflict of interest statements of all contributors can be found in https://osf.io/ncj6t/.

Ethical approval Not applicable.

Informed consent Not applicable.

References

1. Lee YT, Sung J (2008) Choledocholithiasis. In: Baron TH, Kozarek R, Carr-Locke DL (eds) ERCP. Saunders Elsevier, Amsterdam
2. Collins C, Maguire D, Ireland A, Fitzgerald E, O'Sullivan GC (2004) A prospective study of common bile duct calculi in patients undergoing laparoscopic cholecystectomy: natural history of choledocholithiasis revisited. Ann Surg 239(1):28–33. https://doi.org/10.1097/01.sla.0000103069.00170.9c
3. Ko CW, Lee SP (2002) Epidemiology and natural history of common bile duct stones and prediction of disease. Gastrointest Endosc 56(6 Suppl):S165–S169. https://doi.org/10.1067/mge.2002.129005
4. Morino M, Baracchi F, Miglietta C, Furlan N, Ragona R, Garbarini A (2006) Preoperative endoscopic sphincterotomy versus laparoendoscopic rendezvous in patients with gallbladder and bile duct stones. Ann Surg 244(6):889–93. https://doi.org/10.1097/01.sla.0000246913.74870.fc (**discussion 893–6**)
5. Wandling MW, Hungness ES, Pavey ES, Stulberg JJ, Schwab B, Yang AD, Shapiro MB, Bilimoria KY, Ko CY, Nathens AB (2016) Nationwide assessment of trends in choledocholithiasis management in the United States From 1998 to 2013. JAMA Surg 151(12):1125–1130. https://doi.org/10.1001/jamasurg.2016.2059
6. EAES Guidelines Subcommittee: Living review of surgical guidelines. https://eaes.eu/about-eaes/committees/consensus-guideline-subcommittee-projects/#living-review. Accessed 25 Jun 2022.
7. Logullo P, Florez ID, Antoniou GA, Markar S, López-Cano M, Silecchia G, Tsokani S, Mavridis D, Brouwers M, Antoniou SA, GAP Consortium (2022) AGREE-S: AGREE II extension for surgical interventions—United European gastroenterology and European association for endoscopic surgery methodological guide. United Eur Gastroenterol J 10(4):425–434. https://doi.org/10.1002/ueg2.12231
8. Schünemann H, Brożek J, Guyatt G, Oxman A (2013) GRADE handbook for grading quality of evidence and strength of recommendations. https://gdt.gradepro.org/app/handbook/handbook.html. Accessed June 25, 2022.
9. Institute of Medicine (US) Committee on Standards for Developing Trustworthy Clinical Practice Guidelines (2011). In: Graham R, Mancher M, Miller Wolman D, Greenfield S, Steinberg E (eds) Clinical practice guidelines we can trust. National Academies Press US, Washington
10. Qaseem A, Forland F, Macbeth F, Ollenschläger G, Phillips S, van der Wees P (2012) Board of trustees of the guidelines international network. Guidelines international network: toward international standards for clinical practice guidelines. Ann Intern Med 156(7):525–31. https://doi.org/10.7326/0003-4819-156-7-201204030-00009
11. Garritty C, Gartlehner G, Nussbaumer-Streit B, King VJ, Hamel C, Kamel C, Affengruber L, Stevens A (2021) Cochrane rapid reviews methods group offers evidence-informed guidance to conduct rapid reviews. J Clin Epidemiol 130:13–22. https://doi.org/10.1016/j.jclinepi.2020.10.007
12. Nikolakopoulou A, Higgins JPT, Papakonstantinou T, Chaimani A, Del Giovane C, Egger M, Salanti G (2020) CINeMA: an approach for assessing confidence in the results of a network meta-analysis. PLoS Med 17(4):e1003082. https://doi.org/10.1371/journal.pmed.1003082
13. Brignardello-Petersen R, Bonner A, Alexander PE, Siemieniuk RA, Furukawa TA, Rochwerg B, Hazlewood GS, Alhazzani W, Mustafa RA, Murad MH, Puhan MA, Schünemann HJ, Guyatt GH, GRADE Working Group (2018) Advances in the GRADE approach to rate the certainty in estimates from a network meta-analysis. J Clin Epidemiol 93:36–44. https://doi.org/10.1016/j.jclinepi.2017.10.005
14. Yepes-Nuñez JJ, Li SA, Guyatt G, Jack SM, Brozek JL, Beyene J, Murad MH, Rochwerg B, Mbuagbaw L, Zhang Y, Flórez ID, Siemieniuk RA, Sadeghirad B, Mustafa R, Santesso N, Schünemann HJ (2019) Development of the summary of findings table for network meta-analysis. J Clin Epidemiol 115:1–13. https://doi.org/10.1016/j.jclinepi.2019.04.018
15. Papakonstantinou T, Nikolakopoulou A, Higgins JPT, Egger M (2020) Salanti G : CINeMA: software for semiautomated assessment of the confidence in the results of network meta-analysis. Campbell Syst Rev 16(1):1–15
16. Antoniou SA. Appendix Files for EAES rapid guideline: updated systematic review, network meta-analysis, CINeMA and GRADE assessment, and evidence-informed European recommendations on the management of common bile duct stones. https://osf.io/ncj6t/. Accessed June 25, 2022.
17. Antoniou SA, Christogiannis C, Mavridis D, Boni L. Protocol for EAES rapid guideline: update systematic review, network meta-analysis, CINeMA and GRADE assessment, and evidence-informed European recommendations on the management of common bile duct stones. https://eaes.eu/wp-content/uploads/2022/01/Protocol-EAES-Rapid-Guideline-Update-systematic-review-network-meta-analysis-CINeMA-and-GRADE-assessment.pdf. Accessed June 25, 2022.
18. Guyatt GH, Oxman AD, Kunz R, Atkins D, Brozek J, Vist G, Alderson P, Glasziou P, Falck-Ytter Y, Schünemann HJ (2011) GRADE guidelines: 2. Framing the question and deciding on important outcomes. J Clin Epidemiol 64(4):395–400. https://doi.org/10.1016/j.jclinepi.2010.09.012
19. Hultcrantz M, Rind D, Akl EA, Treweek S, Mustafa RA, Iorio A, Alper BS, Meerpohl JJ, Murad MH, Ansari MT, Katikireddi SV, Östlund P, Tranæus S, Christensen R, Gartlehner G, Brozek J, Izcovich A, Schünemann H, Guyatt G. The GRADE Working Group clarifies the construct of certainty of evidence. J Clin Epidemiol.87:4-13. https://doi.org/10.1016/j.jclinepi.2017.05.006 Epub 2017 May 18. PMID: 28529184; PMCID: PMC6542664
20. Ricci C, Pagano N, Taffurelli G, Pacilio CA, Migliori M, Bazzoli F, Casadei R, Minni F (2018) Comparison of efficacy and safety of 4 combinations of laparoscopic and intraoperative techniques for management of gallstone disease with biliary duct calculi: a systematic review and network meta-analysis. JAMA Surg 153(7):e181167. https://doi.org/10.1001/jamasurg.2018.1167
21. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A (2016) Rayyan-a web and mobile app for systematic reviews. Syst Rev 5(1):210. https://doi.org/10.1186/s13643-016-0384-4.PMID:27919275;PMCID:PMC5139140
22. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng HY, Corbett MS, Eldridge SM, Emberson JR, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT (2019) RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 28(366):l4898. https://doi.org/10.1136/bmj.l4898
23. Higgins JP, Savović J, Page M, Sterne JA (2022) RoB2 development group. Current version of RoB 2.
24. Salanti G (2012) Indirect and mixed-treatment comparison, network, or multiple-treatments meta-analysis: many names, many benefits, many concerns for the next generation evidence synthesis tool. Res Synth Methods 3(2):80–97. https://doi.org/10.1002/jrsm.1037
25. Mavridis D, Giannatsi M, Cipriani A, Salanti G (2015) A primer on network meta-analysis with emphasis on mental health. Evid Based Ment Health 18(2):40–46. https://doi.org/10.1136/eb-2015-102088
26. Rücker G, Schwarzer G (2014) Reduce dimension or reduce weights? Comparing two approaches to multi-arm studies in

network meta-analysis. Stat Med 33(25):4353–4369. https://doi.org/10.1002/sim.6236
27. Rücker G (2012) Network meta-analysis, electrical networks and graph theory. Res Synth Methods 3(4):312–324. https://doi.org/10.1002/jrsm.1058
28. Rücker G, Krahn U, König J, Efthimiou O, Davies A, Papakonstantinou T, Schwarzer G. Netmeta (2022) Network meta-analysis using frequentist methods. R package version 2.0–1. https://cran.r-project.org/web/packages/netmeta/index.html. Accessed June 25, 2022.
29. Rücker G, Schwarzer G (2015) Ranking treatments in frequentist network meta-analysis works without resampling methods. BMC Med Res Methodol 31(15):58. https://doi.org/10.1186/s12874-015-0060-8.PMID:26227148;PMCID:PMC4521472
30. Higgins JP, Jackson D, Barrett JK, Lu G, Ades AE, White IR (2012) Consistency and inconsistency in network meta-analysis: concepts and models for multi-arm studies. Res Synth Methods 3(2):98–110. https://doi.org/10.1002/jrsm.1044
31. Chaimani A, Higgins JP, Mavridis D, Spyridonos P, Salanti G (2013) Graphical tools for network meta-analysis in STATA. PLoS ONE 8(10):e76654. https://doi.org/10.1371/journal.pone.0076654
32. Schünemann H, Brożek J, Guyatt G, Oxman A (2022) GRADE handbook: 5 quality of evidence. https://gdt.gradepro.org/app/handbook/handbook.html#h.9rdbelsnu4iy. Accessed June 25, 2022.
33. Florez ID, Veroniki AA, Al Khalifah R, Yepes-Nuñez JJ, Sierra JM, Vernooij RWM, Acosta-Reyes J, Granados CM, Pérez-Gaxiola G, Cuello-Garcia C, Zea AM, Zhang Y, Foroutan N, Guyatt GH, Thabane L (2018) Comparative effectiveness and safety of interventions for acute diarrhea and gastroenteritis in children: a systematic review and network meta-analysis. PLoS ONE 13(12):e0207701. https://doi.org/10.1371/journal.pone.0207701
34. Rhodes M, Sussman L, Cohen L, Lewis MP (1998) Randomised trial of laparoscopic exploration of common bile duct versus postoperative endoscopic retrograde cholangiography for common bile duct stones. Lancet 351(9097):159–161. https://doi.org/10.1016/s0140-6736(97)09175-7
35. Cuschieri A, Lezoche E, Morino M, Croce E, Lacy A, Toouli J, Faggioni A, Ribeiro VM, Jakimowicz J, Visa J, Hanna GB (1999) E.A.E.S. multicenter prospective randomized trial comparing two-stage vs single-stage management of patients with gallstone disease and ductal calculi. Surg Endosc 13(10):952–7. https://doi.org/10.1007/s004649901145
36. Sgourakis G, Karaliotas K (2002) Laparoscopic common bile duct exploration and cholecystectomy versus endoscopic stone extraction and laparoscopic cholecystectomy for choledocholithiasis. A prospective randomized study. Minerva Chir 57(4):467–474
37. Nathanson LK, O'Rourke NA, Martin IJ, Fielding GA, Cowen AE, Roberts RK, Kendall BJ, Kerlin P, Devereux BM (2005) Postoperative ERCP versus laparoscopic choledochotomy for clearance of selected bile duct calculi: a randomized trial. Ann Surg 242(2):188–192. https://doi.org/10.1097/01.sla.0000171035.57236.d7.PMID:16041208;PMCID:PMC1357723
38. Hong DF, Xin Y, Chen DW (2006) Comparison of laparoscopic cholecystectomy combined with intraoperative endoscopic sphincterotomy and laparoscopic exploration of the common bile duct for cholecystocholedocholithiasis. Surg Endosc 20(3):424–427. https://doi.org/10.1007/s00464-004-8248-8
39. Rábago LR, Vicente C, Soler F, Delgado M, Moral I, Guerra I, Castro JL, Quintanilla E, Romeo J, Llorente R, Vázquez Echarri J, Martínez-Veiga JL, Gea F (2006) Two-stage treatment with preoperative endoscopic retrograde cholangiopancreatography (ERCP) compared with single-stage treatment with intraoperative ERCP for patients with symptomatic cholelithiasis with possible choledocholithiasis. Endoscopy 38(8):779–786. https://doi.org/10.1055/s-2006-944617
40. Noble H, Tranter S, Chesworth T, Norton S, Thompson M (2009) A randomized, clinical trial to compare endoscopic sphincterotomy and subsequent laparoscopic cholecystectomy with primary laparoscopic bile duct exploration during cholecystectomy in higher risk patients with choledocholithiasis. J Laparoendosc Adv Surg Tech A 19(6):713–720. https://doi.org/10.1089/lap.2008.0428
41. Bansal VK, Misra MC, Garg P, Prabhu M (2010) A prospective randomized trial comparing two-stage versus single-stage management of patients with gallstone disease and common bile duct stones. Surg Endosc 24(8):1986–1989. https://doi.org/10.1007/s00464-010-0891-7
42. Rogers SJ, Cello JP, Horn JK, Siperstein AE, Schecter WP, Campbell AR, Mackersie RC, Rodas A, Kreuwel HT, Harris HW (2010) Prospective randomized trial of LC+LCBDE vs ERCP/S+LC for common bile duct stone disease. Arch Surg 145(1):28–33. https://doi.org/10.1001/archsurg.2009.226
43. ElGeidie AA, ElEbidy GK, Naeem YM (2011) Preoperative versus intraoperative endoscopic sphincterotomy for management of common bile duct stones. Surg Endosc 25(4):1230–1237. https://doi.org/10.1007/s00464-010-1348-8
44. ElGeidie AA, ElShobary MM, Naeem YM (2011) Laparoscopic exploration versus intraoperative endoscopic sphincterotomy for common bile duct stones: a prospective randomized trial. Dig Surg 28(5–6):424–431. https://doi.org/10.1159/000331470
45. Ferulano GP, Dilillo S, D'Ambra M, Lionetti R, Di Silverio P, Capasso S, Pelaggi D, Rutigliano M, Iancu C (2011) Laparoscopic one-stage vs endoscopic plus laparoscopic management of common bile ductstones—a prospective randomized study. Adv Endoscopic Surg 291–306. https://cdn.intechopen.com/pdfs/24334/InTech-Laparoscopic_one_stage_vs_endoscopic_plus_laparoscopic_management_of_common_bile_duct_stones_a_prospective_randomized_study.pdf
46. Tzovaras G, Baloyiannis I, Zachari E, Symeonidis D, Zacharoulis D, Kapsoritakis A, Paroutoglou G, Potamianos S (2012) Laparoendoscopic rendezvous versus preoperative ERCP and laparoscopic cholecystectomy for the management of cholecystocholedocholithiasis: interim analysis of a controlled randomized trial. Ann Surg 255(3):435–439. https://doi.org/10.1097/SLA.0b013e3182456ec0
47. Koc B, Karahan S, Adas G, Tutal F, Guven H, Ozsoy A (2013) Comparison of laparoscopic common bile duct exploration and endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for choledocholithiasis: a prospective randomized study. Am J Surg 206(4):457–463. https://doi.org/10.1016/j.amjsurg.2013.02.004
48. Bansal VK, Misra MC, Rajan K, Kilambi R, Kumar S, Krishna A, Kumar A, Pandav CS, Subramaniam R, Arora MK, Garg PK (2014) Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with concomitant gallbladder stones and common bile duct stones: a randomized controlled trial. Surg Endosc 28(3):875–885. https://doi.org/10.1007/s00464-013-3237-4
49. Ding G, Cai W, Qin M (2014) Single-stage vs. two-stage management for concomitant gallstones and common bile duct stones: a prospective randomized trial with long-term follow-up. J Gastrointest Surg. 18(5):947–51. https://doi.org/10.1007/s11605-014-2467-7
50. Sahoo MR, Kumar AT, Patnaik A (2014) Randomised study on single stage laparo-endoscopic rendezvous (intra-operative ERCP) procedure versus two stage approach (pre-operative ERCP followed by laparoscopic cholecystectomy) for the management of cholelithiasis with choledocholithiasis. J Min Access Surg 10(3):139–143. https://doi.org/10.4103/0972-9941.134877.PMID:25013330;PMCID:PMC4083546

51. Barreras González JE, Torres Peña R, Ruiz Torres J, Martínez Alfonso MÁ, Brizuela Quintanilla R, Morera PM (2016) Endoscopic versus laparoscopic treatment for choledocholithiasis: a prospective randomized controlled trial. Endosc Int Open 4(11):E1188–E1193. https://doi.org/10.1055/s-0042-116144. PMID:27857966;PMCID:PMC5111834
52. Lv F, Zhang S, Ji M, Wang Y, Li P, Han W (2016) Single-stage management with combined tri-endoscopic approach for concomitant cholecystolithiasis and choledocholithiasis. Surg Endosc 30(12):5615–5620. https://doi.org/10.1007/s00464-016-4918-6
53. Poh BR, Ho SP, Sritharan M, Yeong CC, Swan MP, Devonshire DA, Cashin PA, Croagh DG (2016) Randomized clinical trial of intraoperative endoscopic retrograde cholangiopancreatography versus laparoscopic bile duct exploration in patients with choledocholithiasis. Br J Surg 103(9):1117–1124. https://doi.org/10.1002/bjs.10207
54. Liu Z, Zhang L, Liu Y, Gu Y, Sun T (2017) Efficiency and safety of one-step procedure combined laparoscopic cholecystectomy and eretrograde cholangiopancreatography for treatment of cholecysto-choledocholithiasis: a randomized controlled trial. Am Surg 83(11):1263–1267
55. Li KY, Shi CX, Tang KL, Huang JZ, Zhang DL (2018) Advantages of laparoscopic common bile duct exploration in common bile duct stones. Wien Klin Wochenschr 130(3–4):100–104. https://doi.org/10.1007/s00508-017-1232-9
56. Muhammedoğlu B, Kale IT (2020) Comparison of the safety and efficacy of single-stage endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy versus two-stage ERCP followed by laparoscopic cholecystectomy six-to-eight weeks later: a randomized controlled trial. Int J Surg 76:37–44. https://doi.org/10.1016/j.ijsu.2020.02.021
57. Liu S, Fang C, Tan J, Chen W (2020) A comparison of the relative safety and efficacy of laparoscopic choledochotomy with primary closure and endoscopic treatment for bile duct stones in patients with cholelithiasis. J Laparoendosc Adv Surg Tech A 30(7):742–748. https://doi.org/10.1089/lap.2019.0775
58. Li G, Pang Q, Zhai H, Zhang X, Dong Y, Li J, Jia X (2021) SpyGlass-guided laser lithotripsy versus laparoscopic common bile duct exploration for large common bile duct stones: a non-inferiority trial. Surg Endosc 35(7):3723–3731. https://doi.org/10.1007/s00464-020-07862-4
59. Zhu JG, Han W, Guo W, Su W, Bai ZG, Zhang ZT (2015) Learning curve and outcome of laparoscopic transcystic common bile duct exploration for choledocholithiasis. Br J Surg 102(13):1691–1697. https://doi.org/10.1002/bjs.9922
60. Zhu H, Wu L, Yuan R, Wang Y, Liao W, Lei J, Shao J (2018) Learning curve for performing choledochotomy bile duct exploration with primary closure after laparoscopic cholecystectomy. Surg Endosc 32(10):4263–4270. https://doi.org/10.1007/s00464-018-6175-3
61. Wang Y (2022) A multicenter randomized controlled study of 3d laparoscopy versus endoscopy in the treatment of choledocholithiasis. https://clinicaltrials.gov/ct2/show/NCT04658212?term=lcbde&recrs=abdf&cond=Choledocholithiasis&intr=laparoscopic+common+bile+duct+exploration&draw=2&rank=2. Accessed June 25, 2022.
62. Li X, Meng W (2022) Comparison of LCBDE vs ERCP + LC for Choledocholithiasis. https://clinicaltrials.gov/ct2/show/NCT02515474?term=lcbde&recrs=abdf&cond=Choledocholithiasis&intr=laparoscopic+common+bile+duct+exploration&draw=2&rank=1. Accessed June 25, 2022.
63. Zhenshun S. Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with concomitant gallbladder stones and common bile duct stones: a randomized controlled trial. http://www.chictr.org.cn/showprojen.aspx?proj=59574. Accessed June 25, 2022.

Authors and Affiliations

Luigi Boni[1] · Bright Huo[2] · Laura Alberici[3] · Claudio Ricci[3,4] · Sofia Tsokani[5] · Dimitris Mavridis[5,6] · Yasser Sami Amer[7,8,9,10] · Alexandros Andreou[11] · Thomas Berriman[12] · Gianfranco Donatelli[13,14] · Nauzer Forbes[15,16] · Stylianos Kapiris[17] · Cüneyt Kayaalp[18] · Leena Kylänpää[19] · Pablo Parra-Membrives[20,21] · Peter D. Siersema[22] · George F. Black[23] · Stavros A. Antoniou[24,25]

1 Department of Surgery, Fondazione IRCCS Ca' Granda Ospedale Maggiore, Policlinico di Milano, Milan, Italy

2 Faculty of Medicine, Dalhousie University, Halifax, NS, Canada

3 Division of Pancreatic Surgery, IRCCS, Azienda Ospedaliero-Universitaria di Bologna, Bologna, Italy

4 Department of Internal Medicine and Surgery (DIMEC), Alma Mater Studiorum, University of Bologna, Bologna, Italy

5 Department of Primary Education, School of Education, University of Ioannina, Ioannina, Greece

6 Sorbonne Paris Cité, Faculté de Médecine, Paris Descartes University, Paris, France

7 Pediatrics Department, and Clinical Practice Guidelines and Quality Research Unit, Quality Management Department, King Saud University Medical City, Riyadh, Saudi Arabia

8 Research Chair for Evidence-Based Health Care and Knowledge Translation, Deanship of Scientific Research, King Saud University, Riyadh, Saudi Arabia

9 Alexandria Center for Evidence-Based Clinical Practice Guidelines, Alexandria University, Alexandria, Egypt

10 Guidelines International Network, Perth, Scotland Department of Surgery, York Teaching Hospital NHS Foundation Trust, York, UK

11 Department of Surgery, York Teaching Hospital NHS Foundation Trust, York, UK

[12] Department of Gastroenterology, York Teaching Hospital NHS Foundation Trust, York, UK

[13] Hôpital Privé Des Peupliers, Unité d'Endoscopie Interventionnelle, Ramsay Santé, Paris, France

[14] Department of Clinical Medicine and Surgery, University of Naples "Federico II", Naples, Italy

[15] Department of Medicine, University of Calgary, Calgary, AB, Canada

[16] Department of Community Health Sciences, University of Calgary, Calgary, AB, Canada

[17] Third Department of Surgery, Evangelismos General Hospital, Athens, Greece

[18] Gastrointestinal Surgery, Yeditepe University Medical School, Istanbul, Turkey

[19] Department of Gastrointestinal Surgery, Helsinki University Hospital, Helsinki, Finland

[20] Department of General and Digestive Surgery, Valme University Hospital, Seville, Spain

[21] Department of Surgery, University of Seville, Seville, Spain

[22] Department of Gastroenterology and Hepatology, Radboud University Medical Center, Nijmegen, Netherlands

[23] Patient Representative, Siloam Springs, Arkansas, USA

[24] European University Cyprus, Nicosia, Cyprus

[25] EAES Guidelines Subcommittee, Veldhoven, The Netherlands