Supplementary Appendix S1

Artificial Intelligence Applications Along the ERCP Pathway: An Evidence Map and Relevance to Pancreatic Cancer-Related Biliary Obstruction

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S1. Review design and purpose

This review is a narrative evidence map, not a systematic review or meta-analysis. The update was designed to make study identification and classification reproducible, correct the original disease-block restriction, and document directness, taxonomy, split unit, cohort overlap, and model-level appraisal. It was not registered prospectively.

S2. Database-specific search strategies

PubMed

(("Cholangiopancreatography, Endoscopic Retrograde"[Mesh] OR ERCP[tiab] OR cholangiograph*[tiab] OR cholangioscop*[tiab] OR "biliary stent*"[tiab] OR "biliary drainage"[tiab]) AND ("Artificial Intelligence"[Mesh] OR "Machine Learning"[Mesh] OR "Deep Learning"[Mesh] OR "artificial intelligence"[tiab] OR "machine learning"[tiab] OR "deep learning"[tiab] OR "neural network*"[tiab] OR "random forest*"[tiab] OR "gradient boost*"[tiab] OR XGBoost[tiab] OR LightGBM[tiab] OR "support vector machine*"[tiab] OR radiomic*[tiab] OR "computer-aided"[tiab] OR "computer assisted"[tiab])) AND ("1900/01/01"[Date - Publication] : "2026/06/30"[Date - Publication])

Coverage: inception through the original submitted cutoff, 30 June 2026. Records returned: 224; two records carrying a coarse 2026 PubMed date were removed after exact first-publication-date adjudication.

Europe PMC

((TITLE_ABS:"ERCP" OR TITLE_ABS:"endoscopic retrograde cholangiopancreatography" OR TITLE_ABS:cholangiograph* OR TITLE_ABS:cholangioscop* OR TITLE_ABS:"biliary stent" OR TITLE_ABS:"biliary drainage") AND (TITLE_ABS:"artificial intelligence" OR TITLE_ABS:"machine learning" OR TITLE_ABS:"deep learning" OR TITLE_ABS:"neural network" OR TITLE_ABS:"random forest" OR TITLE_ABS:"gradient boosting" OR TITLE_ABS:XGBoost OR TITLE_ABS:LightGBM OR TITLE_ABS:"support vector machine" OR TITLE_ABS:radiomic* OR TITLE_ABS:"computer-aided" OR TITLE_ABS:"computer assisted") AND FIRST_PDATE:[1900-01-01 TO 2026-06-30])

Coverage: inception through the original submitted cutoff, 30 June 2026. Records returned: 176.

Scopus

TITLE-ABS-KEY((ERCP OR "endoscopic retrograde cholangiopancreatography" OR cholangiograph* OR cholangioscop* OR "biliary stent*" OR "biliary drainage") AND ("artificial intelligence" OR "machine learning" OR "deep learning" OR "neural network*" OR "random forest*" OR "gradient boost*" OR XGBoost OR LightGBM OR "support vector machine*" OR radiomic* OR "computer-aided")) AND PUBYEAR < 2027

Supplementary coverage check: 444 records assessed; records first published after 30 June 2026 were excluded.

Google Scholar

("endoscopic retrograde cholangiopancreatography" OR ERCP OR cholangioscopy OR cholangiography OR "biliary stent" OR "biliary drainage") ("artificial intelligence" OR "machine learning" OR "deep learning" OR "neural network" OR "computer-aided" OR radiomics OR "predictive model" OR nomogram)

Supplementary coverage check: the first 200 results sorted by relevance were assessed; results were limited through 2026 and records first published after 30 June 2026 were excluded.

The disease block was intentionally omitted. Disease relevance was judged after retrieval so that general-ERCP evidence could be identified and labeled indirect rather than silently excluded.

S3. Record flow

Stage	Count
PubMed records	224
Europe PMC records	176
Combined PubMed and Europe PMC records	400
Cross-database duplicates	164
Unique records after database deduplication	236
Post-cutoff records removed after exact date adjudication	2
Unique records screened	234
Excluded at title/abstract	148
Records assessed in detail (full text where available)	86
Excluded after detailed assessment	13
Evidence-map reports from the PubMed/Europe PMC flow	73
Learned-model reports from the PubMed/Europe PMC flow	67
Scopus records checked as supplementary coverage	444
Google Scholar relevance-ranked results checked	200
Supplementary reports retained	10
Total evidence-map reports	83
Total learned-model reports	77

The PubMed/Europe PMC flow reconciles to the Screening_Log and Full_Text_Exclusions sheets. The 10 retained nonduplicate additions from Scopus and Google Scholar are listed separately in Supplementary_Audit and incorporated into Included_Studies, PROBAST_AI, Figure_1_Source, and References. Reviews, guidelines, editorials, and contextual clinical studies were not counted as primary learned-model reports. SC002 is recorded as excluded because full-report availability by 30 June 2026 could not be established.

S4. Eligibility and evidence classification

- Primary learned-model evidence: an original report applying a learned algorithm to an ERCP, cholangiographic, cholangioscopic, stent, or post-ERCP task.
- Conventional comparator: ordinary or penalized regression and nomograms were described but not counted as AI unless a learned non-linear model was also evaluated.
- Non-learned processing: manual or rule-based reconstruction, measurement, or rendering without model learning was not counted as AI.
- Direct applicability: a cohort predominantly composed of pancreatic cancer-related distal malignant obstruction.
- Partly direct: mixed malignant obstruction with a reported pancreatic-cancer subgroup.
- Indirect: general ERCP populations, commonly stone disease, whose method might transfer but whose clinical performance cannot be assumed in pancreatic cancer.
- Adjacent: endobiliary diagnostic, selection, or technical evidence outside the target therapeutic decision.

S5. Full-text exclusions

Record	Reason for full-text exclusion
SR011	Biliary-drainage transition-care randomized trial: prediction ancillary; route/task not ERCP-specific.
SR019	Lead-apron defect model: fluoroscopy quality assurance, not a patient or endobiliary task.
SR026	Validation commentary: no original cohort.
SR034	Editorial: no original data.
SR059	Pancreaticobiliary maljunction model: not an immediate ERCP/endobiliary task.
SR065	Bile lipidomics: not an ERCP-targeted learned-model application.
SR067	ICU acute-cholangitis phenotyping: ERCP was not the modeled intervention or task.
SR102	Acute-cholangitis outcome model: not ERCP-specific.
SR118	Intraoperative cholangiography: surgical rather than ERCP setting.
SR183	MRCP primary-sclerosing-cholangitis detection: not linked to an immediate ERCP/endobiliary decision.
SR188	30-day mortality after percutaneous transhepatic biliary stenting: percutaneous, not ERCP.
SR189	Infection after percutaneous transhepatic biliary stenting: percutaneous, not ERCP.
SR243	SMART-AI preprint: superseded by the peer-reviewed report (SR028) and not counted twice.

S6. Extraction and verification

A second clinician independently verified the included-study identities, key performance data, and pancreatic-cancer applicability against primary reports, and reviewed the final corrected dataset. The author and the second clinician checked all final inclusion decisions and extracted values against primary reports. This rechecking pass was separate from screening and extraction; independent duplicate screening and extraction were not documented. Study identity, cohort composition, model taxonomy, outcome definition, split unit, validation setting, event count, and performance are recorded with primary-source links. Missing items distinguish source nonreporting from incomplete access or extraction.

Repeated images and cohort overlap

For image studies, patient grouping, repeated images, augmentation, and center separation were recorded separately. For clinical cohorts, author lists, centers, recruitment dates, sample sizes, and endpoint definitions were compared. Exact or probable overlap was flagged, and later reports were not treated as independent replication without clear new-patient evidence.

PROBAST+AI

Patient-prediction and clinically diagnostic studies receive structured critical appraisal informed by the four PROBAST+AI domains. The supplied record lacks a completed signaling-question assessment, so the workbook does not present formal domain or overall grades. Pure device classification, segmentation, and measurement receive technical split-unit and validation notes. Retrospective design, multicenter recruitment, and procedural predictor timing are not treated as automatic risk-of-bias grades. Human completion of a full PROBAST+AI assessment would be required before describing the appraisal as formal.

S7. Data files

Supplementary Data provides the complete screening log, included-study extraction, cohort-overlap audit, domain-informed critical-appraisal notes, and source data for Figures 1 and 2. The figure-source sheets preserve evaluation sizes and units, event counts, validation type, point estimates, confidence intervals where reported, thresholds, and missingness as 'not reported' only when source nonreporting was checked, or 'not verified' when access or extraction was incomplete.

S8. AI assistance and human source checking

Claude (Anthropic; Opus 5) assisted with language editing, proofreading, search-query development, and identification of relevant papers. Claude use ended 25 July 2026, one week before the ASIDE Gastroenterology submission confirmed on 1 August 2026. The start date was not recorded. It was not used for screening, eligibility decisions, or study-data extraction. OpenAI Codex (OpenAI; GPT-6) assisted with figure formatting. The current source audit is separate from the historical search and does not recreate historical Scopus or Google Scholar screening. The author and the independent verifier checked all final inclusion decisions and extracted values against primary reports. The author retains responsibility.

S9. Cutoff adjudication and source access

The historical cutoff remains 30 June 2026. The author confirmed the supplied historical retrieval and screening counts. SC002, Wang et al. AE-GNN conference report, was excluded from the cutoff-defined map because no earlier full copy was known and its confirmed IEEE Xplore added date is 6 August 2026. Its May conference presentation does not establish pre-cutoff full-report availability. The supplementary retained count therefore falls from 11 to 10, and the total from 84 to 83. The excluded record and reason remain in Supplementary_Audit. Publication type and access are distinct: a full-length published report may be eligible even when only its abstract is available for extraction, but unsupported extracted items must be recorded as not verified.