ADVANCEMENTS IN HEALTH RESEARCH

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SUPPLEMENTARY MATERIAL

Gallbladder and common bile duct actinomycosis: a comprehensive systematic review of literature

Shewaz Tariq Latif,[1] Berun A. Abdalla,[2,3] Suhaib H. Kakamad,[4] Sasan M. Ahmed,[2,5,6] Dahat A. Hussein,[2,7] Dilan Hikmat,[8] Shvan H. Mohammed[2,9]

[1]Shaheed Dr. Aso Eye Hospital, Sulaymaniyah, Iraq

[2]Kscien Organization for Scientific Research (Middle East Office), Sulaymaniyah, Iraq

[3]Department of Scientific Affairs, Smart Health Tower, Sulaymaniyah, Iraq

[4]Research Center, Qaiwan International University, Sulaymaniyah, Kurdistan Region, Iraq

[5]Green Apple Organization for Health Awareness, Sulaymaniyah, Kurdistan Region, Iraq

[6]College of Medicine, Department of Clinical Sciences, University of Sulaimani, Sulaymaniyah

[7]Department of Laboratory, Smart Health Tower, Sulaymaniyah, Iraq

[8]Department of Internal Medicine, Sparrow Hospital-Michigan State University, Lansing, MI, USA

[9]Xzmat Polyclinic, Rizgari, Kalar, Sulaymaniyah, Iraq

Corresponding author: Berun A. Abdalla, Zargatay Taza, Madam Mitterrand Stree, House 54, 46001, Sulaymaniyah, Iraq. E-mail: berun.anwer95@gmail.com

Table S1. Demographic data of the included studies.

Author/Reference	Year	Case No.	Country	Sex	Age	PMH	Presentation/symptoms							White cell count	Neutrophils	C-reactive protein	Erythrocyte Sedimentation Rate
							Fever	Rigors / chills	RUQ pain	Other pain-site	Jaundice	Nausea / vomiting	Weight loss				
Robson et al. [14]	1905	1	UK	Male	47	N/A	N/A	N/A	N/A	Yes	No	No	Yes	N/A	N/A	N/A	N/A
Hansen et al. [12]	1979	1	Belgium	Female	84	Negative	Yes	N/A	Yes	Yes	N/A	N/A	N/A	12.3 × 10^9/L (range N/A)	85%	N/A	40 mm/h
Freland et al. [7]	I987	2	France	Female	72	N/A	Yes	N/A	Yes	No	N/A	N/A	N/A	11.5 × 10^9/L (range N/A)	N/A	N/A	N/A
			France	Male	60	No	No	No	Yes	No	No	N/A	N/A	11.0 × 10^9/L (range N/A)	N/A	N/A	N/A
Sullivan et al. [25]	1939	1	USA	Female	N/A	N/A	Yes	N/A	Yes	Yes	N/A	N/A	N/A	22.75 × 10^9/L (range N/A)	N/A	N/A	N/A
Ormsby et al. [19]	1998	1	USA	Male	80	Chronic cholecystitis	Yes	N/A	No	Yes	N/A	N/A	Yes	N/A	N/A	N/A	N/A
Potti et al. [13]	1999	1	USA	Male	76	Coronary disease	Yes	N/A	Yes	Yes	N/A	N/A	No	17.0 × 10^9/L (range N/A)	N/A	N/A	N/A
Hefny et al. [16]	2005	1	UAE	Male	50	DM, HTN	Yes	Yes	Yes	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Al-Sindi et al. [24]	2006	1	Bahrain	Male	48	DM	Yes	N/A	Yes	No	No	Yes	N/A	10.0 × 10^9/L (range N/A)	1.5 × 10^9/L	N/A	N/A
Lee et al. [20]	2007	1	Korea	Male	65	N/A	No	N/A	Yes	No	No	N/A	N/A	Leukocytosis is absent (value N/A)	N/A	N/A	N/A
Acevedo et al. [23]	2008	1	Chile	Female	41	N/A	N/A	N/A	Yes	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mir et al. [17]	2008	1	UK	Male	70	IHD, DM, HTN, Hypercholestrolemia	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thadani et al. [6]	2010	1	USA	Female	64	Negative	N/A	N/A	Yes	No	Yes	N/A	Yes	6.0 × 10^9/L (range N/A)	N/A	N/A	N/A
Han et al. [21]	2011	1	Korea	Male	64	DM, HTN, Cirrhosis	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bansal et al. [22]	2012	1	USA	Female	59	Negative	No	No	N/A	Yes	Yes	NR	Yes	N/A	N/A	N/A	N/A
Godbole et al. [10]	2014	1	India	Female	50	DM	No	N/A	Yes	No	No	No	No	N/A	N/A	N/A	N/A
Pereira et al. [3]	2016	1	India	Male	68	DM	N/A	N/A	Yes	Yes	N/A	N/A	N/A	Leukocytosis is present (value N/A)	N/A	N/A	N/A
Elmekkaou et al. [5]	2017	1	Morocco	Male	88	DM, HTN	Yes	N/A	Yes	No	Yes	Yes	N/A	16.0 × 10^9/L (range N/A)	N/A	56 mg/dL	N/A
Shrestha et al. [2]	2021	1	Nepal	Female	60	Negative	N/A	N/A	Yes	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Furuya et al. [9]	2022	1	Japan	Male	75	N/A	Yes	Yes	Yes	No	N/A	N/A	N/A	23.7 × 10^9/L (range N/A)	N/A	23.2 mg/dL	N/A
Garrido et al. [8]	2022	1	Portugal	Female	75	N/A	N/A	N/A	Yes	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nahal et al. [11]	2024	1	USA	Male	48	Bullous emphysema	N/A	N/A	Yes	No	N/A	N/A	N/A	23.5 × 10^9/L (range N/A)	N/A	N/A	N/A
Singh et al. [4]	2024	1	India	Female	31	Negative	No	N/A	Yes	No	N/A	No	N/A	6.9 × 10^9/L (range N/A)	N/A	N/A	N/A

Mor et al. [1]	2025	1	UK	Male	61	Right inguinal hernia	Conflicting	N/A	Yes	No	Yes	Yes	No	15.0 × 10^9/L (ref. 2.9–9.6)	N/A	229 mg/L (<5 mg/L)	N/A
Akbarzadeh-Jahromi et al. [18]	2025	1	Iran	Female	21	DM	No	N/A	Yes	No	No	Yes	N/A	12.8 × 10^9/L (range N/A)	N/A	N/A	N/A

N/A: Not Available, **PMH:** Past Medical History, **DM:** Diabetes Mellitus, **HTN:** Hypertension, **IHD:** Ischemic Heart Disease, **RUQ:** Right Upper Quadrant.

Table S2. Laboratory findings, imaging findings and radiological classification, and anatomical site of involvement.

Author/Reference	Year	LFT	Amylase	Lipase	Virology	Radiology	Radiological category*	Site
Robson et al. [14]	1905	N/A	N/A	N/A	N/A	N/A	N/A	GB
Hansen et al. [12]	1979	Elevated ALP	N/A	N/A	N/A	US: GB stones with fistula	Complicated cholecystitis	GB
Freland et al. [7]	I987	N/A	N/A	N/A	N/A	US: Enlarged GB with obstructed stones and thickened wall	Acute cholecystitis (uncomplicated)	GB
		N/A	N/A	N/A	N/A	US: GB wall thickening with multiple stones	Acute cholecystitis (uncomplicated)	GB
Sullivan et al. [25]	1939	N/A	N/A	N/A	N/A	Graham-Cole: GB visualization was negative	Abnormal, non-specific	GB
Ormsby et al. [19]	1998	Elevated	N/A	N/A	N/A	CT scan: Dilated CBD with multiple distal stones	CBD stones / obstruction	Cystic duct remnant
Potti et al. [13]	1999	Elevated	Normal	Normal	N/A	US: GB stones and soft tissue mass CT scan: GB wall papillary mass	Mass / suspected malignancy	GB
Hefny et al. [16]	2005	Normal	Normal	N/A	Negative	US: GB wall thickening and edema with multiple stones	Acute cholecystitis (uncomplicated)	GB
Al-Sindi et al. [24]	2006	Normal	N/A	N/A	Negative	US: calculous cholecystitis with 2 cm impacted stone at the GB neck	Acute cholecystitis (uncomplicated)	GB
Lee et al. [20]	2007	Elevated GGT	N/A	N/A	N/A	US: Hypoechoeic mass with a stone CT scan: GB wall thickening with impacted stones	Mass / suspected malignancy	GB
Acevedo et al. [23]	2008	N/A	N/A	N/A	N/A	US: GB stones	Uncomplicated cholelithiasis	GB
Mir et al. [17]	2008	N/A	N/A	N/A	N/A	CT scan: GB thickening with stones with small out-pouching	Acute cholecystitis (uncomplicated)	GB
Thadani et al. [6]	2010	Elevated ALP	N/A	N/A	N/A	CT scan: soft tissue mass in GB extending from pancreatic head to porta hepatis	Mass / suspected malignancy	CBD
Han et al. [21]	2011	N/A	N/A	N/A	HBV positive	CT scan: marked hypo dense GB wall thickening, mucosal denudation, hepatic duct dilatation, intrahepatic biliary gas	Complicated cholecystitis	GB
Bansal et al. [22]	2012	Elevated	N/A	N/A	N/A	MRI: 4.5-cm porta hepatis mass with CBD compression and portal lymphadenopathy	Mass / suspected malignancy	CBD
Godbole et al. [10]	2014	Normal	N/A	N/A	N/A	U/S: GB wall thickening with stones, Pneumobilia	Complicated cholecystitis	GB

						and Dilated CBD CT scan: focal hypodense lesion in liver parenchyma, cholecysto-colic fistula suspected		
Pereira et al. [3]	2016	Normal	Elevated	Elevated	Negative	Imaging: GB thickening and edema with stones	Acute cholecystitis (uncomplicated)	GB
Elmekkaou et al. [5]	2017	Elevated ALP, GGT	N/A	N/A	N/A	U/S: acute calculous cholecystitis with GB lesion CT scan: mass mimicking GB carcinoma	Mass / suspected malignancy	GB
Shrestha et al. [2]	2021	N/A	Normal	Normal	Negative	US: GB wall thickening with stones	Acute cholecystitis (uncomplicated)	GB
Furuya et al. [9]	2022	Elevated	N/A	N/A	N/A	CT scan: Enlarged GB, intrahepatic perforation and GB abscesses with liver perforation forming liver abscesses	Complicated cholecystitis	GB
Garrido et al. [8]	2022	N/A	N/A	N/A	N/A	US: Dilated CBD	CBD stones / obstruction	CBD
Nahal et al. [11]	2024	Elevated ALP	N/A	N/A	N/A	N/A	N/A	GB, CBD
Singh et al. [4]	2024	Normal	Normal	Normal	Negative	US: GB thickening with stones	Acute cholecystitis (uncomplicated)	GB
Mor et al. [1]	2025	Elevated	N/A	N/A	N/A	CT scan: Intrahepatic and extra hepatic biliary dilatation with CBD stones	CBD stones / obstruction	GB
Akbarzadeh-Jahromi et al. [18]	2025	Normal	N/A	N/A	N/A	Imaging: Enlarged gallbladder with a single stone	Acute cholecystitis (uncomplicated)	GB

LFT: Liver Function Test, **N/A:** Not Available, **ALP:** Alkaline Phosphatase, **GGT:** Gamma-Glutamyl Transferase, **HBV:** Hepatitis B Virus, **US:** Ultrasound, **GB:** Gallbladder, **CT:** Computed Tomography, **CBD:** Common Bile Duct, **MRI:** Magnetic Resonance Imaging; * Each patient was assigned to a single radiological category, applying the following criteria in order of priority:

1. Mass / suspected malignancy — any mass, soft-tissue lesion, or lesion reported as mimicking carcinoma, irrespective of other findings.
2. Complicated cholecystitis — cholecystitis with perforation, abscess, fistula, gangrene, pneumobilia, or biliary gas.
3. CBD stones / biliary obstruction — choledocholithiasis or biliary duct dilatation in the absence of a mass or the complications above.
4. Acute cholecystitis (uncomplicated) — gallbladder wall thickening, oedema, or distension, with or without stones, and none of the above.
5. Uncomplicated cholelithiasis — stones only, with a normal gallbladder wall and no distension.
6. Abnormal, non-specific — an abnormal study not classifiable above.
7. Not available — no imaging reported.

Table S3. Management and outcome.

Author/ Reference	Year	Initial Diagnosis	Pre-procedure agents (agent, dose, route, duration)	Management	Post-operative	Histopathological Examination	Microbiology	Post-procedure agents (agent, dose, route, duration)	Outcome / Follow-up
Robson et al. [14]	1905	Cholecystitis	N/A	Open cholecystectomy	Iodide of potassium	Numerous filaments, some radiating from a common centre, others broken off. At their ends they show thickenings (clubs). Rounded bodies which stain more darkly and are probably coccus bodies, Diagnosis-Actinomycosis	N/A	Potassium iodide, dose N/A, route N/A, 'some length of time'	Uneventful
Hansen et al. [12]	1979	Abdominal wall mass	N/A	Cholecystectomy	N/A	Neoplastic process with superinfection; on microscopic re-examination, foci of typical actinomycotic granules	N/A	N/A	N/A
Freland et al. [7]	I987	Acute cholecystitis	Minocycline 200 mg/day	Cholecystectomy	Minocycline (200 mg/day/for 1 week)	N/A	Smear: granulocytes and small Gram-positive organisms; culture: A. naeslundii	Minocycline 200 mg/day, route N/A, 1 week	Complete recovery
		Acute cholecystitis	N/A	Cholecystectomy	Metronidazole 500 mg and cefazolin 2 g, three times during 48 hours	Acute cholecystitis with gangrenous features	Bile: numerous intra- and extracellular Gram-positive rods;	Metronidazole 500 mg ×3, route N/A, 48 h; cefazolin 2 g ×3,	Uneventful

							culture: A. naeslundii	route N/A, 48 h	
Sullivan et al. [25]	1939	Acute cholecystitis, cholelithiasis	N/A	Cholecystectomy	N/A	Single mycelial threads of the actinomycetes in the mucosa surrounded by mononuclear cells and polymorphonuclear leukocytes	N/A	N/A	Complete recovery
Ormsby et al. [19]	1998	Choledocholithiasis, Cystic-ductolithiasis	N/A	Exploratory laparotomy	Antibiotics	Dense basophilic masses containing Gram-positive, branching filamentous bacilli and eosinophilic clubs at the granule borders, indicative of Actinomycotic granules	N/A	Penicillin 4 million units every 4 h IV, 6 weeks; amoxicillin 500 mg t.i.d. oral, at least 6 months	Uneventful
Potti et al. [13]	1999	Neoplasm	Ciprofloxacin, dose N/A; clindamycin, dose N/A	Medical treatment then Cholecystectomy	Intravenous clindamycin, ciprofloxacin after operation, oral doxycycline for 4 weeks upon discharge	Acute gangrenous cholecystitis with cholelithiasis	Gallbladder culture positive for A. meyeri	Clindamycin, dose N/A, IV, duration N/A; ciprofloxacin, dose N/A, IV, duration N/A; doxycycline, dose N/A, oral, 4 weeks	Uneventful
Hefny et al. [16]	2005	Acute cholecystitis	N/A	Medical treatment followed by laparoscopic cholecystectomy converted to open cholecystectomy after six weeks	Metronidazole and Ceftriaxone	Hemorrhagic ulceration, diffuse moderate-to-severe inflammation with micro abscess formation, and colonies of filamentous bacteria exhibiting the Splendore–Hoeppli phenomenon, consistent with actinomycetes	N/A	Metronidazole 500 mg every 8 h IV, 3 days; ceftriaxone 1 g every 12 h IV, 3 days; penicillin IV 1 week, then oral	Complete recovery

								penicillin 6 months	
Al-Sindi et al. [24]	2006	Acute cholecystitis with sepsis	Metronidazole IV, dose N/A; cefuroxime IV, dose N/A	Medical treatment followed by laparoscopic cholecystectomy converted to open cholecystectomy	Antibiotics for 3 months	Extensive non-dysplastic mucosal ulceration with moderate to marked suppurative, neutrophil-rich transmural inflammation, multiple mural microabscesses, and focal transmural necrosis consistent with gallbladder perforation, Pleomorphic filamentous Actinomyces were identified within the microabscesses and surface exudate	N/A	Amoxicillin 375 mg three times daily oral, 3 months; clavulanate 375 mg oral, 3 months	Uneventful
Lee et al. [20]	2007	Gallbladder carcinoma	N/A	Diagnostic laparotomy and cholecystectomy	Penicillin Intravenous for 10 days, oral amoxicillin for six months	Inflammatory cell infiltration with fibrosis and intramural sulfur granules that contained tangled filamentous bacilli compatible with Actinomyces	N/A	Penicillin, dose N/A, IV, 10 days; amoxicillin, dose N/A, oral, 6 months	Uneventful
Acevedo et al. [23]	2008	N/A	N/A	Laparoscopic cholecystectomy converted to open cholecystectomy	Intravenous ceftriaxone for 4 weeks before changing to amoxicillin	Acute inflammatory process with a suppurating focus and bacterial colonies consistent with Actinomycosis	N/A	Ceftriaxone, dose N/A, IV, 4 weeks; amoxicillin, dose N/A, oral, duration N/A	Complete recovery
Mir et al. [17]	2008	Acute cholecystitis	Source states IV co-amoxiclav and metronidazole for five days, and separately	Open cholecystectomy	Antibiotics not administered	Acute and chronic inflammatory cell infiltrates that included abundant foamy macrophages. Colonies of Actinomyces, the so-	N/A	N/A	Uneventful

			that no antibiotics were given			called 'sulphur granules', with the characteristic Splendore-Hoeppli phenomenon, were present in the lumen			
Thadani et al. [6]	2010	N/A	Ceftriaxone sodium, dose N/A; doxycycline, dose N/A	Cholecystectomy,hepaticojejunostomy	N/A	EUS-FNA revealed reactive ductal hyperplasia with actinomycotic organisms and atypical ductal cells, Surgical pathology revealed acute inflammation, with a foci of papillary carcinoma in the CBD	N/A	Ceftriaxone, changed to doxycycline on development of toxic epidermal necrolysis	N/A
Han et al. [21]	2011	Gallbladder carcinoma, chronic cholecystitis, gallbladder empyema, enterobiliary fistula	N/A	Laparotomy	Intravenous antibiotics (quinolone, 200 mg /12 hours, and metronidazole, 500 mg /8 hours) for 3 days. Oral antibiotics for 6 months	Heavy infiltration of inflammatory cells with fibrosis and intramural sulfur granules that were positive on Gram stain for filamentous branching rods	N/A	IV quinolone and metronidazole 3 days, then oral antibiotics 6 months	Complete recovery
Bansal et al. [22]	2012	Klatskin tumor	N/A	Diagnostic and therapeutic upper gastrointestinal endoscopy	Intravenous penicillin, oral metronidazole and levaquin, Antifungal coverage, discharged on amoxicillin at a dose of	Acute and chronic inflammation and granulomas with gram-positive filamentous bacteria consistent with actinomycetes species	N/A	IV penicillin with oral metronidazole and levofloxacin in hospital, antifungal added, then oral amoxicillin 1 year	Complete recovery

					750 mg three times/day for 1 year				
Godbole et al. [10]	2014	N/A	N/A	Exploratory laparotomy	Oral amoxicillin for six months	Features of chronic inflammation, few sections showing actinomycotic granules with filamentous bacteria surrounded by inflammatory cells	N/A	Discharged on oral amoxicillin for 6 months	N/A
Pereira et al. [3]	2016	N/A	N/A	Open cholecystectomy after six weeks	N/A	Extensive denudation of mucosal epithelium with the gall bladder wall showing focal area of haemorrhage and encrusted biliary material. Round to ovoid colonies of radiating filamentous structures reminiscent of colonies of Actinomyces species were noted	N/A	N/A	N/A
Elmekkaou et al. [5]	2017	Gallbladder carcinoma	N/A	Cholecystectomy, choledochotomy	6-months cure of penicillin	Consistent with peri-gallbladder necrosis containing numerous bacterial colonies of Actinomyces species	N/A	Penicillin for 6 months	Uneventful
Shrestha et al. [2]	2021	Symptomatic cholelithiasis	N/A	Open cholecystectomy	N/A	Focal mucosal denudation with colonies of radiating filamentous structures containing numerous sulfur granules composed of Gram-positive filamentous rods	N/A	N/A	N/A
Furuya et al. [9]	2022	Acute cholecystitis, liver abscess	Piperacillin-tazobactam, dose NR, 1 day; ampicillin-sulbactam IV 13 days;	Medical treatment followed by laparoscopic cholecystectomy	Amoxicillin/clavulanate and linezolid for 5 weeks	N/A	Bile Gram stain: Gram-positive rods and cocci; culture: A. odontolyti	IV piperacillin-tazobactam day 1, then IV ampicillin-	Uneventful

			vancomycin IV 13 days				cus and MRSA	sulbactam and vancomycin to day 20, then oral amoxicillin-clavulanate and linezolid	
Garrido et al. [8]	2022	N/A	N/A	ERCP	Intravenous penicillin for 2 weeks, amoxicillin 1g 8 hourly for 12 months	Fragments of duodenal mucosa with abundant inflammatory infiltrate and identification of colonies of microorganisms with characteristics compatible with Actinomyces species	N/A	IV penicillin 2 weeks, then amoxicillin 1 g every 8 h for 12 months	Uneventful
Nahal et al. [11]	2024	Pancreatic adenocarcinoma	Vancomycin; cefepime; metronidazole; piperacillin-tazobactam, doses N/A	Exploratory laparotomy, subtotal cholecystectomy	Piperacillin/tazobactam, vancomycin	N/A	Intra-abdominal fluid culture: A. odontolyticus, S. anginosus, P. denticola	Micafungin with piperacillin-tazobactam, vancomycin added on postoperative day 5	Died
Singh et al. [4]	2024	Chronic cholecystitis ,cholelithiasis	N/A	Laparoscopic cholecystectomy	Intravenous penicillin for 1 week, followed by oral penicillin therapy for 6 months	Chronic cholecystitis along with spherical colonies of actinomycosis composed of radiating filaments	N/A	IV penicillin 1 week, then oral penicillin 6 months	N/A
Mor et al. [1]	2025	Acute cholangitis	Piperacillin-tazobactam IV, dose N/A; co-amoxiclav,	Medical Treatment, ERCP and Laparoscopic cholesyctectomy	No prolonged antibiotics course	Chronic cholecystitis with focal suppurative inflammation and a single intraluminal cluster of	N/A	Piperacillin-tazobactam then co-	Uneventful

			dose and route N/A - 10 days in total			microorganisms consistent with Actinomyces		amoxiclav to complete 10 days; no prolonged course thereafter	
Akbarzadeh-Jahromi et al. [18]	2025	Acute cholecystitis	N/A	Cholecystectomy	Six months of penicillin therapy	Acute cholecystitis and numerous filamentous, gram-positive bacteria, consistent with actinomycosis	N/A	Discharged on penicillin for 6 months	Uneventful

N/A: Not Available, **ERCP:** Endoscopic Retrograde Cholangiopancreatography, **EUS-FNA:** Endoscopic Ultrasound–Guided Fine Needle Aspiration, **CBD:** Common Bile Duct.

Table S4. Summary of patient-level variables.

Variables	**Frequency/Percentage**
Mean Age (years)	60.7
Sex	
Male	14 (56%)
Female	11 (44%)
Country of the Study	
USA	6 (24%)
UK	3 (12.5%)
India	3 (12.5%)
Korea	2 (8.3%)
France	1 (4.2%)
Belgium	1 (4.2%)
UAE	1 (4.2%)
Bahrain	1 (4.2%)
Chile	1 (4.2%)
Morocco	1 (4.2%)
Nepal	1 (4.2%)
Japan	1 (4.2%)
Portugal	1 (4.2%)
Iran	1 (4.2%)
Past Medical History	
Unknown (not available)	8 (32%)
Negative	5 (20%)
Diabetes Mellitus	8 (32%)
Hypertension	4 (16%)
Heart disease	2 (8%)
Cirrhosis	1 (4%)
Chronic cholecystitis	1 (4%)
Hypercholesterolemia	1 (4%)
Bullous emphysema	1 (4%)
Right inguinal hernia	1 (4%)
Presentation	
Isolated Right upper quadrant pain	9 (36%)
Right upper quadrant pain with other symptoms	7 (28%)
Non-Right upper quadrant presentations	9 (36%)
Liver Function Test	
Not available	9 (36%)
Normal	6 (24%)
Elevated	5 (20%)
Elevated Alkaline Phosphatase	3 (12%)
Elevated Gamma-Glutamyl Transferase	2 (8%)
Serum Amylase	
Not available	20 (80%)
Normal	4 (16%)
Elevated	1 (4%)
Serum Lipase	
Not available	21 (84%)
Normal	3 (12%)
Elevated	1 (4%)
Virology	

Not available	19 (76%)
Negative	5 (20%)
Hepatitis B Virus positive	1 (4%)
Radiology	
Acute cholecystitis (uncomplicated)	9 (36%)
Gallbladder mass / suspected carcinoma	5 (20%)
Complicated cholecystitis	4 (16%)
Common bile duct stones / biliary obstruction	3 (12%)
Not available	2 (8%)
Uncomplicated cholelithiasis	1 (4%)
Abnormal, non-specific	1 (4%)
Site	
Gallbladder	20 (80%)
Common bile duct	3 (12%)
Gallbladder + common bile duct	1 (4%)
Cystic duct remnant	1 (4%)
Initial Diagnosis	
Acute cholecystitis	9 (36%)
Not available	5 (20%)
Gallbladder carcinoma	3 (12%)
Cholangiopathy	2 (8%)
Chronic cholecystitis	1 (4%)
Biliary tract malignancy (Klatskin tumor)	1 (4%)
Pancreatic adenocarcinoma	1 (4%)
Other	3 (12%)
Management	
Surgical ± medical management:	23 (92%)
Medical management alone	0 (0%)
Interventional alone	2 (8%)
Surgical approaches	
Cholecystectomy (approach not specified)	6 (26.1%) of total surgical cases
Open cholecystectomy	4 (17.4%)
Laparoscopic cholecystectomy → open conversion	3 (13%)
Exploratory / diagnostic laparotomy	4 (17.4%)
Laparoscopic cholecystectomy	3 (13%)
Subtotal cholecystectomy	1 (4.3%)
Cholecystectomy + choledochotomy	1 (4.3%)
Cholecystectomy + hepaticojejunostomy	1 (4.3%)
Post-operative treatment	
βeta-lactam–based therapy (βeta-lactam alone or in combination)	12 (48%)
Non-βeta-lactam therapy only	4 (16%)
No antibiotics or not available	8 (32%)
Antibiotic duration among patients receiving antibiotic therapy	
Antibiotics ≤ 1 week	2 (11.8%)
Antibiotics 2–5 weeks	2 (11.8%)
Antibiotics 3 months	1 (5.9%)
Antibiotics 6 months	6 (35.3%)
Antibiotics ≥ 12 months	2 (11.8%)
Unknown duration	4 (23.5%)
Histopathological Examination (HPE)	
HPE performed	22 (88%)
HPE not performed	3 (12%)
Organism morphology on HPE (n = 22, one category per patient)	
Filamentous, Gram-positive bacilli (branching stated in 2)	5 (22.7%)

Filamentous organisms, Gram status not stated	8 (36.4%)
Colonies / granules only, no filament or Gram description	7 (31.8%)
No organism described; identified by culture	2 (9.1%)
Associated HPE features (n = 22, not mutually exclusive)	
Sulfur / actinomycotic granules (term used explicitly)	7 (31.8%)
Organism colonies or clusters, granule term not used	7 (31.8%)
Radiating filaments	4 (18.2%)
Club-shaped filament ends	2 (9.1%)
Splendore–Hoeppli phenomenon	2 (9.1%)
Inflammatory pattern on HPE (n = 22, not mutually exclusive)	
Acute inflammatory infiltrate	9 (40.9%)
Chronic inflammation ± fibrosis	7 (31.8%)
Suppurative inflammation / microabscesses	4 (18.2%)
Granulomatous inflammation	2 (9.1%)
Follow-up	
Uneventful	12 (48%)
Complete Recovery	6 (24%)
Not available	6 (24%)
Passed	1 (4%)