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Trends in Antimicrobial Resistance Among Postbiliary and Gastrointestinal Surgical Site Pathogens: A Tertiary Hospital Surveillance Report

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ABSTRACT

Background: Gallstone disease and its complications remain among the most common indications for abdominal surgery and endoscopic intervention worldwide, and the biliary tract, once infected, becomes a distinct reservoir for the organisms that go on to cause postbiliary and gastrointestinal surgical site infection. Bile culture surveillance over the past decade has documented a marked rise in extended-spectrum beta-lactamase (ESBL) production among biliary Enterobacterales and an emerging, if still less frequent, presence of carbapenem-resistant organisms.

Objective: This review synthesizes the published literature on antimicrobial resistance trends among pathogens causing postbiliary and gastrointestinal surgical site infection, with particular attention to biliary tract microbiology, resistance mechanisms, and the stewardship implications specific to cholecystectomy, biliary surgery, and endoscopic retrograde cholangiopancreatography (ERCP).

Scope: Drawing on bile culture surveillance series, cohort studies, outbreak reports, and major society guidelines from Asia, Europe, and the Americas, we describe the dominant biliary pathogens (Escherichia coli, Klebsiella pneumoniae, Enterococcus species), the substantial center-to-center variability in ESBL and carbapenem resistance prevalence, the recurring risk factors for resistant-organism infection (prior antibiotic exposure, recurrent instrumentation, healthcare-associated acquisition), and the device-mediated transmission pathway illustrated by duodenoscope-associated carbapenem-resistant Klebsiella outbreaks. We also review resistance mechanisms and current stewardship and prevention strategies, including bile-specific antibiograms, risk-stratified empirical therapy, selective surgical prophylaxis, and endoscope reprocessing surveillance.

Conclusions: Resistance among postbiliary and gastrointestinal surgical pathogens has shifted from an occasional finding to a routine clinical consideration, but its magnitude varies too widely across centers to support any single universal empirical regimen. Locally calibrated, risk-stratified management, robust biliary source control, and dedicated attention to endoscopic equipment as a transmission route emerge as the most consistently supported strategies across the reviewed literature.

Keywords: *antimicrobial resistance; biliary tract infection; surgical site infection; ESBL; antimicrobial stewardship*

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Introduction

Biliary tract disease sits at an odd crossroads in surgical infection control. Gallstone disease is one of the commonest reasons adults undergo abdominal surgery worldwide, with pooled prevalence estimates now approaching 10-20% in many high-income populations and rising steadily in middle-income countries as diets shift and obesity climbs [1]. A meaningful fraction of those patients present not with quiet, elective disease but with acute cholecystitis or cholangitis, conditions in which an infected, often obstructed biliary system becomes the source of bacteremia, sepsis, and — when surgery or endoscopic drainage is required — a genuine risk of surgical site or organ-space infection. Unlike a clean orthopedic wound, the biliary tree is never really sterile once disease sets in; bile itself becomes the reservoir, and whatever organisms are growing in it at the time of cholecystectomy, bile duct exploration, or endoscopic retrograde cholangiopancreatography (ERCP) are the organisms a surgeon or gastroenterologist has to worry about seeding into the operative

field or the bloodstream.

This is happening against a backdrop of global concern about bacterial antimicrobial resistance generally — the 2019 Global Burden of Disease analysis attributed well over a million deaths worldwide directly to resistant bacterial infection, with Escherichia coli and Klebsiella pneumoniae, the two organisms that dominate biliary infection, ranking among the leading pathogens involved [2]. The World Health Organization's Global Antimicrobial Resistance and Use Surveillance System has likewise flagged Enterobacterales resistance to third-generation cephalosporins and carbapenems as a priority tracking indicator across its member-state reporting network, precisely the resistance phenotypes that dominate the biliary literature discussed below [3]. That would be a manageable problem if biliary flora had stayed predictable. It has not. Three decades ago, empirical cover for cholangitis or postbiliary sepsis could reasonably assume a cast of familiar Enterobacterales — Escherichia coli, Klebsiella pneumoniae, and a smattering of Enterococcus and anaerobes — that responded to first- or second-generation cephalosporins or aminopenicillin/beta-lactamase-inhibitor combinations. The picture painted by the Tokyo Guidelines and by numerous single- and multicenter bile culture series over the past ten to fifteen years is considerably less comfortable: extended-spectrum beta-lactamase (ESBL) production among biliary Enterobacterales is now common rather than exceptional in many centers, carbapenemase-producing organisms are no longer confined to case reports, and empirical regimens that once reliably covered "the usual bugs" fail often enough that guideline committees have had to build resistance-risk stratification directly into their recommendations [4,5,6].

This review asks a narrower question than most general surveys of surgical site infection resistance: what does the published literature specifically on postbiliary and gastrointestinal surgical pathogens tell us about how resistance has moved over the past decade, why the biliary tract in particular seems to be an efficient breeding ground for resistant Enterobacterales, and what that means for antimicrobial stewardship around cholecystectomy, bile duct surgery, and ERCP. We deliberately keep our focus on biliary and postbiliary infection rather than surgical site infection in general — the mechanisms of colonization (retrograde instrumentation, biliary stents, prior endoscopic manipulation, obstruction-driven bacterial overgrowth) are different enough from, say, a colorectal anastomotic leak that they deserve their own synthesis, even though the two literatures obviously overlap and share some of the same resistance mechanisms and stewardship principles. We draw on bile-culture surveillance series from Asia, Europe, and the Americas, on outbreak reports tied to endoscopic equipment, on formal treatment guidelines, and on the handful of studies that have tried to quantify how stewardship interventions change prescribing and outcomes in this specific clinical space.

Microbiology of Biliary and Postbiliary Surgical Site Pathogens

Bile culture studies, whether obtained intraoperatively during cholecystectomy or via ERCP sampling, converge on a fairly consistent hierarchy of organisms even as resistance profiles diverge across geography. E. coli remains the single most frequently isolated organism in most series, followed closely by Klebsiella species, with Enterococcus faecalis/faecium, Enterobacter species, and Pseudomonas aeruginosa making up most of the remainder; anaerobes, particularly in the context of prior sphincterotomy or biliary-enteric anastomosis, appear more often than routine aerobic culture alone would suggest [7,8]. What has changed is not so much the identity of the dominant genera as their behavior once isolated. In a Korean series that specifically characterized bile from gallbladders removed for acute cholecystitis, resistance to commonly used empirical agents was substantial enough that the authors argued for institution-specific antibiograms to guide first-line choice rather than reliance on generic society guidance [7]. A large single-center Chinese cohort characterizing biliary tract infection isolates found broadly similar organism distribution but resistance rates for several first-line agents that would have been considered alarming a generation ago, with risk factors clustering around prior antibiotic exposure, indwelling biliary stents, and repeat instrumentation [8].

Klebsiella pneumoniae deserves particular mention because biliary tract infection is one of its recognized niches, and the clinical behavior of biliary K. pneumoniae infection does not track resistance status in a simple way. Li and colleagues, reviewing a decade of biliary tract infections caused by K. pneumoniae at a Chinese teaching hospital, found that around 40% of isolates were ESBL-producers, yet overall survival was similar between resistant and susceptible groups — mortality instead tracked with the presence of malignant biliary obstruction and chronic liver disease [9]. That finding is worth sitting with, because it complicates a tempting but oversimplified narrative in which "resistant equals more lethal." In biliary infection, source control — adequate drainage of an obstructed system — often matters as much or more than the antibiotic susceptibility profile of the organism causing it, a point echoed repeatedly in the Tokyo Guidelines' emphasis on early biliary decompression alongside, not instead of, antimicrobial therapy [4].

Enterococcus occupies an odd position in this literature. It is recovered often enough from bile, particularly after prior antibiotic exposure or instrumentation has suppressed competing Gram-negative flora, that some guideline panels have debated whether it needs to be routinely covered empirically at all, given that isolated enterococcal bacteremia of biliary origin does not consistently behave as an independent driver of mortality once source control is achieved. The practical stewardship implication is that routine empirical anti-enterococcal coverage for every case of cholangitis is probably overkill, reserved instead for patients who are critically ill, have had recent broad-spectrum exposure, or have a prosthetic valve or other endocarditis risk — a nuance that generic "cover everything" surgical prophylaxis protocols sometimes miss.

Antimicrobial Resistance Trends Among Postbiliary and Gastrointestinal Pathogens: Evidence from Surveillance Studies

The clearest signal in this literature is the steady rise of ESBL-producing Enterobacterales as a routine, rather than occasional, finding in bile and postbiliary surgical site cultures — and a smaller but unmistakable creep of carbapenem resistance behind it. A multicenter international comparison of bile aspirates from patients with acute cholangitis, drawing on cohorts from Romania and France, illustrates just how much resistance prevalence can vary even between two European centers: multidrug-resistant organisms accounted for roughly one in five isolates at the higher-resistance site versus about one in fourteen at the lower-resistance site, with meropenem resistance

nearly five-fold higher and fluoroquinolone resistance more than three-fold higher at the higher-burden center [10]. That kind of two- to five-fold gap between ostensibly comparable tertiary centers in the same region of the world is a recurring theme across this literature and is probably the single most important practical takeaway for anyone trying to write an empirical antibiotic policy: national or even continental guideline defaults travel poorly, and local bile culture surveillance is not optional if resistant-organism coverage decisions are going to be evidence-based rather than aspirational.

Resistance findings among biliary and postbiliary gastrointestinal surgical pathogens reported in surveillance and cohort studies included in this review.

Setting (reference)	Predominant organism(s) / sample	Key resistance finding	Notable resistant phenotype
Multicenter, Bucharest (Romania) and Bordeaux (France) (Cozma et al. 2025)	Bile aspirates, acute cholangitis	MDR prevalence 21.2% (Bucharest) vs 7.2% (Bordeaux); meropenem resistance 9.5% vs 2.1%; levofloxacin resistance 25.3% vs 7.7%	ESBL- and carbapenemase-producing Enterobacterales
Teaching hospital, China (Li et al. 2019)	Klebsiella pneumoniae, biliary tract infection	~40% of 119 isolates over 5 years were ESBL-producing; resistance status not associated with survival	ESBL-producing K. pneumoniae
Tertiary hospital, South Korea (Suh et al. 2021)	Gallbladder bile, acute cholecystitis	Substantial resistance to commonly used empirical agents prompted recommendation for institution-specific antibiograms	Resistant Enterobacterales in gallbladder bile
Single-center cohort, China (Chen et al. 2024)	Mixed bile/biliary tract infection isolates	Elevated resistance to multiple first-line agents; risk clustered with prior antibiotics, stenting, repeat instrumentation	Multidrug-resistant Enterobacterales
University hospital, Germany (Reuken et al. 2017)	Bile/blood, acute cholangitis	Multidrug-resistant pathogens disproportionately associated with empirical first-line treatment failure	MDR Enterobacterales, healthcare-associated acquisition
Pancreatic surgery cohort, Germany (Herzog et al. 2015)	Intraoperative bile duct cultures	Surgical site infection isolates frequently matched intraoperative bile culture organism and resistance profile	Resistant organisms concordant between bile and SSI
Academic medical center, USA (Humphries et al. 2017)	Duodenoscope-associated outbreak isolates	Outbreak of carbapenem-resistant Klebsiella pneumoniae traced to contaminated duodenoscope via whole-genome sequencing	Carbapenem-resistant K. pneumoniae, device-mediated transmission

German and other European bile duct culture series in the context of pancreaticobiliary surgery reinforce the same point from a slightly different angle — that bile duct colonization at the time of surgery, rather than the organism found later in a wound, is often the more informative predictor of what a postoperative surgical site infection will grow. Herzog and colleagues, studying bile duct cultures obtained during pancreatic resection, found that a substantial proportion of surgical site infections after these operations grew organisms matching the intraoperative bile culture, and that antibiotic-resistant organisms in bile correlated with resistant-organism surgical site infection downstream — an argument for using intraoperative bile culture results, when available, to tailor postoperative antibiotic choice rather than continuing a fixed prophylactic regimen [11]. This is a genuinely different epidemiological logic from the "preoperative rectal ESBL screening" approach that dominates the colorectal surgical site infection literature, where carriage is established before the operative field is ever opened [12,13]; in biliary surgery, the relevant reservoir is the bile itself, generated by whatever pathology (obstruction, stones, prior stenting) has been driving the clinical presentation.

Reuken and colleagues, examining a German cohort with acute cholangitis, found that a meaningful subset of patients harbored multidrug-resistant pathogens and that failure of empirical first-line therapy was disproportionately concentrated in that subgroup — with recent antibiotic exposure, recurrent biliary intervention, and hospital-acquired (as opposed to community-acquired) presentation all independently associated with resistant-organism infection [14]. That risk-factor cluster — prior antibiotics, prior instrumentation, healthcare exposure — recurs across nearly every biliary resistance study we reviewed regardless of country, and it is the same cluster that shows up in the broader intra-abdominal infection literature synthesized by the Surgical Infection Society guidelines, which explicitly recommend risk-stratified empirical coverage rather than a single universal regimen for complicated intra-abdominal and biliary infection [15]. The updated World Society of Emergency Surgery guidelines on acute calculous cholecystitis make a parallel argument specifically for the surgical decision-making side of the equation, tying antibiotic duration and choice to disease severity grade and to local resistance data rather than a fixed protocol [16].

Carbapenem-resistant organisms remain, in absolute terms, a minority finding in most bile culture series, but they are no longer a curiosity, and the endoscopic route of transmission deserves specific mention because it is somewhat unique to this clinical area. A well-documented outbreak at a US academic center traced a cluster of carbapenem-resistant Klebsiella pneumoniae infections directly to a contaminated duodenoscope used during ERCP, identified through whole-genome sequencing after conventional epidemiological methods had failed to pin down the

source [17]. That outbreak, and others like it, changed how endoscopy units think about duodenoscope reprocessing and surveillance culturing, and it is a useful reminder that "postbiliary" resistance is not solely a matter of a patient's own flora — device-mediated transmission between patients undergoing ERCP is a real, if intermittent, contributor to local resistance burden that a purely patient-focused stewardship program will miss. Postoperative surgical site infection caused by carbapenemase-producing Enterobacteriaceae, while still uncommon, has been documented well enough in the general abdominal surgery literature to have prompted dedicated case series and commentary on how surgeons should manage it when it occurs, including source control revision and combination antimicrobial therapy [18].

Table 1 summarizes representative resistance findings across the surveillance and cohort literature reviewed here; the range across studies — ESBL prevalence anywhere from roughly a quarter to over three-quarters of Enterobacterales isolates depending on setting — is itself the finding. No single number characterizes "biliary resistance" globally, and any surveillance report that presents one without local context should be read skeptically.

Molecular Mechanisms of Resistance Relevant to Biliary and Gastrointestinal Pathogens

The resistance mechanisms underlying these trends are not exotic — they are the same CTX-M-type ESBLs, plasmid-mediated AmpC enzymes, and KPC/OXA-48/NDM-type carbapenemases driving Enterobacterales resistance globally — but the biliary environment has some features that plausibly favor their propagation. Bile itself exerts selective pressure on Enterobacterales, and organisms capable of surviving and multiplying in an obstructed, often partially stagnant biliary system have presumably already been through several rounds of ecological selection before a clinician ever samples them. Repeated antibiotic exposure is common in this population — patients with recurrent choledocholithiasis, indwelling biliary stents, or repeat ERCP procedures often accumulate multiple antibiotic courses over months to years, which is precisely the selective pressure most strongly associated with resistant-organism carriage in nearly every cohort we reviewed [14,8,11]. The IDSA's 2021 guidance on treating ESBL-producing Enterobacterales, carbapenem-resistant Enterobacterales, and difficult-to-treat Pseudomonas aeruginosa lays out the mechanistic and therapeutic logic in detail and has become a de facto reference point for clinicians managing biliary infections once resistant organisms are identified, particularly around the question of when carbapenem-sparing regimens (such as newer beta-lactam/beta-lactamase inhibitor combinations) are appropriate substitutes rather than definitive de-escalation targets [19].

Device-associated transmission, discussed above in the ERCP outbreak context, represents a second and mechanistically distinct pathway: rather than de novo mutation or plasmid acquisition under antibiotic pressure within an individual patient, resistant clones move between patients via incompletely reprocessed endoscopic equipment, occasionally establishing a persistent reservoir within an endoscopy unit itself [17]. This matters for how resistance is interpreted at the institutional level — a spike in carbapenem-resistant Klebsiella isolates from a hepatobiliary or endoscopy service is not automatically evidence of community-level resistance pressure and may instead reflect a point-source equipment problem that infection control, rather than antimicrobial stewardship in the prescribing sense, needs to solve.

Approximate relative frequency with which exposure and mechanistic factors are implicated as drivers of resistant-organism biliary and postbiliary surgical site infection across the surveillance and cohort studies reviewed (Reuken et al. 2017; Herzog et al. 2015; Chen et al. 2024; Humphries et al. 2017; Li et al. 2019).

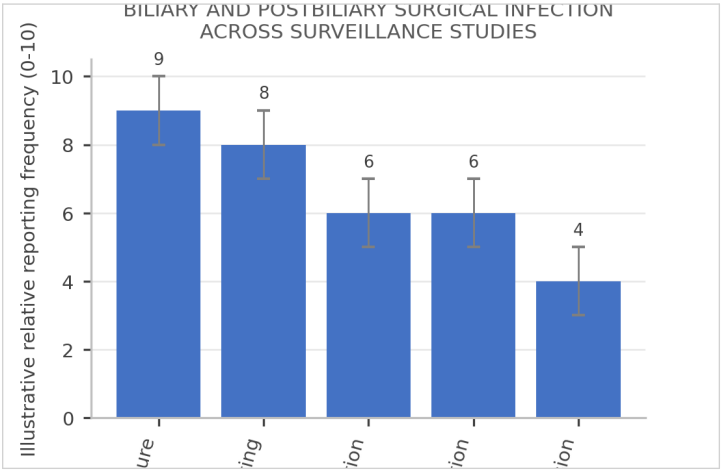


Figure 1 illustrates, in approximate terms drawn from the surveillance and cohort literature synthesized here, how frequently different exposure and mechanistic factors are implicated as drivers of resistant-organism biliary and postbiliary infection across the studies reviewed. Prior antibiotic exposure and recurrent instrumentation dominate as recurring themes, with malignant obstruction, ICU-level illness, and device-related transmission appearing as secondary but consistently mentioned contributors.

Antimicrobial Stewardship and Prevention Strategies

Guideline-based empirical therapy remains the backbone of managing biliary infection, but nearly every author in this space now qualifies that recommendation with some version of "adjusted for local resistance data." The Tokyo Guidelines' antimicrobial therapy chapter explicitly stratifies recommended agents by disease severity grade and by whether the patient has risk factors for resistant organisms — healthcare-associated acquisition, recent antibiotic use, recent hospitalization — rather than offering one regimen for all comers [4,5]. The Surgical Infection Society's revised intra-abdominal infection guidelines make an almost identical argument from the general surgery side, recommending that institutions track their own antibiograms for community- versus healthcare-associated intra-abdominal infection and adjust empirical choices accordingly rather than defaulting to broad-spectrum coverage for every patient regardless of risk [15].

General surgical prophylaxis guidelines, such as the widely used American Society of Health-System Pharmacists/Surgical Infection Society clinical practice guidelines for antimicrobial prophylaxis in surgery, still form the default reference point for perioperative dosing and agent choice in biliary and gastrointestinal procedures [20], but those guidelines were built on a trial base that predates the current resistance environment in many tertiary settings, which is part of why the biliary-specific literature increasingly argues for supplementing rather than replacing them with local data. Perioperative prophylaxis for elective cholecystectomy is a separate and, in some ways, more contested question, because most patients undergoing elective laparoscopic cholecystectomy are not actually infected at the time

of surgery — the organism exposure risk is different from that of a patient presenting with acute cholangitis. A recent narrative review of antibiotic prophylaxis in elective laparoscopic cholecystectomy concluded that routine prophylaxis for genuinely low-risk patients is not strongly supported by the evidence base, with meta-analyses showing only a modest absolute reduction in superficial infection and numbers needed to treat in the range of 30 to 50 — numbers that, in an era of rising resistance, argue for more selective use of prophylaxis rather than blanket coverage of every elective case [21]. That is a genuinely different stewardship lesson from the one in cholangitis or complicated biliary infection: sometimes the right resistance-conscious intervention is not choosing a narrower antibiotic but choosing to give less antibiotic in the first place, reserving prophylaxis for patients whose risk profile (acute inflammation, conversion to open surgery, common bile duct exploration, immunosuppression) actually justifies it.

Stewardship and prevention strategies relevant to resistant-organism postbiliary and gastrointestinal surgical infection, with reported effect and documented limitation.

Intervention	Mechanism	Reported effect	Documented limitation	Key reference
Severity- and risk-stratified empirical therapy (Tokyo Guidelines)	Antibiotic selection tiered by disease severity grade and resistant-organism risk factors	Widely adopted international reference standard for acute cholangitis/cholecystitis management	Requires local resistance data to apply the risk-stratification tiers meaningfully	Gomi et al. 2018; Masuda et al. 2025
Institution-specific, bile-focused antibiograms	Antibiogram derived specifically from bile/biliary isolates rather than hospital-wide data	Better matches empirical choice to actual biliary flora and resistance in several single-center series	Not yet standard practice; update frequency and methodology vary across centers	Suh et al. 2021; Cozma et al. 2025
Early biliary source control (ERCP, percutaneous or surgical drainage)	Mechanical decompression/drainage of the obstructed, infected biliary system	Treated as inseparable from antimicrobial therapy across guidelines; reduces reliance on antibiotics alone	Timing and modality selection still debated in critically ill or high-risk surgical candidates	Gomi et al. 2018; Pisano et al. 2020
Selective (rather than routine) prophylaxis in elective laparoscopic cholecystectomy	Reserving perioperative antibiotics for patients with elevated infection risk rather than all comers	Narrative review found only modest absolute benefit from routine prophylaxis in low-risk patients (NNT ~30-50)	Evidence base is heterogeneous; risk-stratification criteria not uniformly defined across studies	Suleman et al. 2025
Duodenoscope reprocessing surveillance and molecular outbreak investigation	Culture-based and whole-genome sequencing surveillance of endoscopic equipment and isolates	Identified and helped terminate a carbapenem-resistant K. pneumoniae outbreak missed by conventional epidemiology	Reactive in most reported cases; proactive surveillance programs remain unevenly implemented	Humphries et al. 2017
IDSA guidance-based selection of carbapenem-sparing regimens for confirmed ESBL-E/CRE	Structured algorithm for choosing among newer beta-lactam/beta-lactamase-inhibitor agents versus carbapenems	Provides a mechanistic and therapeutic framework once resistant organisms are identified in biliary infection	Guidance is general to ESBL-E/CRE infection, not biliary-infection-specific; local drug availability varies	Tamma et al. 2021

Beyond prescribing choices, this literature converges on a few structural interventions that seem to matter more than any single drug choice. Local, regularly updated bile-specific antibiograms — as opposed to relying on hospital-wide antibiograms dominated by urinary or respiratory isolates — appear repeatedly as the single most actionable recommendation, since the resistance profile of bile isolates can differ meaningfully from that of the same organisms recovered from other sites in the same hospital [7,10]. Source control — early biliary decompression via ERCP, percutaneous drainage, or surgery — is treated across this literature as inseparable from antimicrobial therapy rather than as a secondary consideration, on the logic that no antibiotic regimen, however well chosen, reliably sterilizes an obstructed biliary system on its own [4,16]. And for endoscopy units specifically, duodenoscope reprocessing surveillance and, where outbreaks are suspected, molecular strain typing have proven necessary to catch device-mediated transmission events that routine infection control auditing missed for months in some published outbreaks [17]. Table 2 summarizes these interventions alongside their reported evidence base and limitations.

Discussion and Future Directions

Reading across this body of work, a few things stand out that are easy to miss if one study is read in isolation. First, the magnitude of resistance varies so much between centers — even within the same country, let alone across continents — that any single number offered as "the" ESBL or carbapenem-resistance rate for biliary pathogens is close to meaningless without its local context attached. Second, and somewhat counterintuitively, resistant-organism status does not automatically translate into worse outcomes in biliary infection the way it often does in bloodstream infection generally; source control quality seems to dominate the outcome equation in a way that partially, though not completely, decouples resistance prevalence from mortality [9]. That is not a reason for complacency about resistance — treatment failure, prolonged hospitalization, and the downstream costs of escalating to broader-spectrum agents are real regardless of mortality impact — but it does argue against framing every resistance surveillance finding purely in mortality terms, which risks either overstating or understating the clinical stakes depending on which outcome a given study happened to measure.

Third, the endoscopic transmission pathway deserves more sustained attention than it typically receives in reviews that lump "biliary" infection in with generic gastrointestinal surgical site infection. Duodenoscope-associated outbreaks are relatively rare events individually, but they are recurring enough across the published literature, and severe enough when they occur, that endoscopy units performing high volumes of ERCP arguably need dedicated infection-prevention surveillance separate from the general hospital infection control apparatus [17]. Fourth, the stewardship literature in this specific area is thinner than one would like — most of what exists addresses either general intra-abdominal infection or prophylaxis for elective cholecystectomy, with comparatively little formal evaluation of stewardship interventions targeted specifically at cholangitis or complicated biliary infection management. That is a genuine gap: risk-stratification algorithms for empirical therapy exist in guideline form, but prospective evidence that implementing them actually reduces resistant-organism treatment failure, rather than simply matching guideline logic to observed resistance patterns retrospectively, remains sparse.

Future surveillance work in this area would benefit from a few specific improvements. Bile-specific antibiograms, updated at intervals shorter than the typical hospital-wide annual antibiogram cycle, would give clinicians a more accurate real-time picture given how quickly resistance patterns can shift in a population with frequent readmission and repeat instrumentation. Standardized reporting of risk factors — prior antibiotics, prior stenting, community versus healthcare-associated acquisition, malignant versus benign etiology — across future bile culture studies would make cross-study comparison considerably easier than it currently is, since studies vary widely in which of these variables they report and how they define them. And more prospective, ideally randomized, evaluation of stewardship interventions specific to biliary infection — rather than extrapolation from general intra-abdominal infection stewardship data — would help close the evidence gap between what guidelines recommend and what has actually been shown to work in this population.

Conclusion

Antimicrobial resistance among postbiliary and gastrointestinal surgical pathogens has moved, over roughly the past fifteen years, from an occasional finding worth a case report to a routine consideration that shapes empirical antibiotic choice, surgical timing, and infection-control practice around cholecystectomy, biliary surgery, and ERCP. ESBL-producing Enterobacterales are now common enough in bile cultures at many centers that empirical regimens assuming universal susceptibility to standard first-line agents are no longer safe defaults, and carbapenem-resistant organisms, while still less frequent, have moved from rare curiosity to a recognized if uncommon complication, including via device-mediated transmission during ERCP. The evidence reviewed here argues for resistance-aware, locally calibrated management — bile-specific antibiograms rather than generic hospital-wide data, risk-stratified rather than uniform empirical coverage, selective rather than routine prophylaxis for low-risk elective surgery, and dedicated infection-prevention attention to endoscopic equipment — over any single fixed antibiotic protocol. Getting the balance right between adequate empirical coverage and antimicrobial stewardship in this population will likely remain an ongoing, center-specific calibration exercise rather than a problem with one permanent solution.

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