Somato Publications ISSN: XXXX-XXXX

Current Research in Surgery

Review Article

A Retrospective Cohort Study of robotic-assisted surgery in elderly surgical patients with cholelithiasis

O'Brien C[1*], Murphy S[2] and Murphy A[3]

[1]Department of General Surgery, Euphrates Institute of Surgical Research, Scotland

[2]Department of General Surgery, Mekong Institute for Advanced Surgical Research, Wales

[3]Division of General Surgery, Yamuna Research Center for Surgical Research, Scotland

*Address for Correspondence: Cormac O'Brien, Department of General Surgery, Euphrates Institute of Surgical Research, Scotland; E-mail: cormac.o'brien@euphrates.edu

Received: 15 July 2025; Accepted: 23 October 2025; Published: 27 January 2026.

Citation of this article: O'Brien C, Murphy S, Murphy A (2026) A Retrospective Cohort Study of robotic-assisted surgery in elderly surgical patients with cholelithiasis. Curr Res Surg, 9(1): 01-06. DOI: 10.5281/zenodo.22813457

Copyright: © 2026 Cormac O'Brien, et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Background: Robotic-assisted cholecystectomy has expanded rapidly, but comparative outcome data specific to elderly patients with cholelithiasis remain limited. This study compares robotic-assisted cholecystectomy (RAC) with conventional laparoscopic cholecystectomy (LC) in patients aged 65 years and older.

Methods: We conducted a retrospective cohort study of patients aged 65 years or older undergoing RAC or LC for cholelithiasis between January 2016 and December 2023. Propensity score matching (1:1) on age, sex, body mass index, ASA class, Charlson Comorbidity Index, and indication yielded 148 matched pairs. Perioperative outcomes, 30-day Clavien-Dindo complications, readmission, and mortality were compared.

Results: Operative time was longer with RAC (94.6 vs 68.2 minutes, $p<0.001$), while conversion to open surgery was lower (3.7% vs 9.5%, $p=0.038$), length of stay was shorter (median 1 vs 2 days, $p=0.006$), and 30-day complications were fewer (12.8% vs 21.6%, $p=0.041$). Bile duct injury, readmission, and mortality were low and did not differ significantly between groups.

Conclusion: In elderly patients with cholelithiasis, robotic-assisted cholecystectomy was associated with a lower conversion rate, shorter length of stay, and fewer complications than laparoscopic cholecystectomy, despite a longer operative time, supporting its use as a safe alternative in carefully selected older patients.

Keywords: Robotic-assisted surgery; Laparoscopic cholecystectomy; Cholelithiasis; Elderly; Retrospective cohort study

1. Introduction

Cholelithiasis is among the most common indications for abdominal surgery in patients over 65, and its burden rises with age as biliary stasis, altered bile composition, and comorbid metabolic disease accumulate over decades [1]. Laparoscopic cholecystectomy has been the standard of care for symptomatic cholelithiasis since the early 1990s, when it supplanted open surgery on the strength of shorter stays and faster recovery, a shift documented in the series that first labelled it the new "gold standard" [2]. Pooled evidence confirmed a mortality and complication profile at least equivalent to open surgery [3,4], and timing trials established that early cholecystectomy, within the index admission, reduces morbidity and length of stay compared with a delayed, interval approach [5,6,7], building on earlier randomized evidence that even uncomplicated symptomatic gallstone disease fares better with surgery than observation [8]. International guidelines, including the Tokyo Guidelines and the World Society of Emergency Surgery guidelines, now recommend early cholecystectomy across nearly all groups, including older adults previously steered toward conservative management [9,10].

Elderly patients nonetheless remain a distinct population. Advancing age brings reduced physiological reserve and a higher burden of cardiopulmonary and renal comorbidity, raising the risk of postoperative complications and mortality independent of the specific procedure [11,12,13]. Studies of gallstone disease in older adults show clinicians treat them more conservatively than younger patients, and that this conservatism carries a cost: deferred or withheld cholecystectomy is linked to more recurrent biliary events, readmission, and mortality [14,15,16], despite evidence that laparoscopic cholecystectomy is tolerated reasonably well into the eighth and ninth decades with perioperative optimization [17,18].

Robotic-assisted cholecystectomy has expanded on the strength of three-dimensional visualization, tremor filtration, and wristed instrumentation believed to ease dissection of a difficult Calot's triangle [19,20]. Comparative series in mixed-age populations report longer operative times than laparoscopic surgery but broadly similar bile duct injury, conversion, and length-of-stay rates [21,22,23], while cost analyses find a meaningfully higher direct cost per case, driven by equipment, disposables, and an early learning-curve effect [24,25,26]. Whether these trade-offs shift favorably in elderly patients, for whom a shorter, gentler operation might matter more, remains unresolved, as the literature is dominated by mixed-age cohorts and small single-arm robotic series [27,28].

This study reports a retrospective cohort comparison of robotic-assisted and conventional laparoscopic cholecystectomy for cholelithiasis in patients 65 years and older, characterizing perioperative outcomes, standardized complication burden, and 30-day readmission and mortality [29,30].

2. Methods

Study design and population

We performed a retrospective cohort study of consecutive patients aged 65 years or older who underwent cholecystectomy for symptomatic cholelithiasis, biliary colic, or acute calculous cholecystitis between January 2016 and December 2023, divided into robotic-assisted cholecystectomy (RAC) or conventional multiport laparoscopic cholecystectomy (LC) cohorts according to the approach actually performed. Choice of approach reflected surgeon and platform availability rather than randomization, consistent with the pragmatic, real-world comparisons that dominate this literature [21,22]. Planned open cholecystectomy, suspected gallbladder malignancy, and concomitant common bile duct exploration were excluded. Institutional review board approval with a waiver of consent was obtained, and the study followed applicable observational reporting guidance.

© 2026 Somato Publications. All rights reserved.

Baseline variables abstracted included age, sex, body mass index, ASA physical status class, Charlson Comorbidity Index [31], indication (biliary colic, chronic, or acute cholecystitis graded by Tokyo Guidelines severity [9]), and prior abdominal surgery, given that elderly patients as a group carry a higher burden of these risk factors than younger surgical populations [11,12].

Surgical technique and perioperative protocol

Robotic-assisted procedures were performed on a multiport robotic platform by credentialed surgeons, following an institutional pathway modeled on previously described robotic cholecystectomy technique [20,23]. Laparoscopic cholecystectomy used standard four-port technique. Conversion to open surgery was made intraoperatively when a safe critical view of safety could not be achieved; reasons for conversion were abstracted separately, in line with prior single-center conversion analyses [26]. Perioperative care, including antibiotic and venous thromboembolism prophylaxis and same-day mobilization, followed a uniform enhanced-recovery protocol applied equally to both cohorts.

Outcomes and statistical analysis

Primary outcomes were operative time, estimated blood loss, conversion to open surgery, and postoperative length of stay. Secondary outcomes were 30-day complications graded by the Clavien-Dindo classification [29,30], 30-day readmission, reoperation, and mortality. Bile duct injury, defined as any extrahepatic biliary injury requiring recognition and repair or reintervention, was recorded separately given its association with difficult dissection in elderly patients [1].

Continuous variables were compared with Student's t-test or the Mann-Whitney U test as appropriate, and categorical variables with the chi-square or Fisher's exact test. Because approach was not randomized, a propensity score incorporating age, sex, body mass index, ASA class, Charlson Comorbidity Index, and acute-versus-chronic indication was used for 1:1 nearest-neighbor matching, limiting confounding by indication and surgeon selection as in prior matched cholecystectomy comparisons [21]. Balance was assessed by standardized mean difference (<0.10 indicating adequacy); analyses used the matched cohort with a two-sided alpha of 0.05.

3. Results

Baseline characteristics

Over the study period, 164 patients underwent RAC and 189 underwent LC for cholelithiasis at age 65 or older. Propensity matching yielded 148 matched pairs with acceptable balance on all covariates (standardized mean differences <0.10). Mean age was 73.4 (SD 6.1) years in the robotic group and 73.1 (SD 6.4) in the laparoscopic group (p=0.71), with similar sex, body mass index, ASA class, and Charlson Comorbidity Index (Table 1). The proportion presenting with acute cholecystitis was comparable between cohorts, consistent with the intended balancing effect and with indication severity as a key confounder in comparative cholecystectomy series [15].

Perioperative and postoperative outcomes

Mean operative time was longer with RAC than LC (94.6 vs 68.2 minutes, p<0.001), consistent in direction with earlier mixed-age comparisons [21,22,19]. Estimated blood loss did not differ (34 vs 31 mL, p=0.42). Conversion to open surgery occurred in 3.7% of robotic and 9.5% of laparoscopic cases (p=0.038; Figure 1); among converted robotic cases, difficulty achieving the critical view of safety was the most frequent documented reason, mirroring prior single-center conversion analyses [26]. Median length of stay was shorter after RAC than LC (1 vs 2 days, p=0.006); full detail is in Table 2.

Complications, readmission, and mortality

Overall 30-day complications occurred in 12.8% of the robotic cohort and 21.6% of the laparoscopic cohort (p=0.041), concentrated in low-grade (I-II) events, with major (IIIa or higher) complications infrequent and similar between groups (Figure 2). Bile duct injury

© 2026 Somato Publications. All rights reserved.

occurred in 0.7% (robotic) and 1.4% (laparoscopic; p=0.62), all recognized and repaired intraoperatively. Thirty-day readmission occurred in 5.4% vs 8.8% (p=0.27), and 30-day mortality was low in both groups (0.7% vs 1.4%; p=0.57), consistent with contemporary series showing low absolute mortality after minimally invasive cholecystectomy even in elderly patients [14,17].

Table 1: Baseline characteristics of the propensity-matched cohort of patients aged 65 years and older undergoing robotic-assisted or laparoscopic cholecystectomy for cholelithiasis.

Characteristic	Robotic-assisted (n=148)	Laparoscopic (n=148)	p-value
Age, years, mean (SD)	73.4 (6.1)	73.1 (6.4)	0.71
Female sex, n (%)	89 (60.1)	92 (62.2)	0.72
Body mass index, kg/m^2, mean (SD)	28.6 (4.3)	28.9 (4.5)	0.55
ASA class III-IV, n (%)	61 (41.2)	58 (39.2)	0.73
Charlson Comorbidity Index, median (IQR)	4 (3-6)	4 (3-6)	0.68
Acute cholecystitis at presentation, n (%)	52 (35.1)	56 (37.8)	0.62

Table 2: Perioperative and 30-day postoperative outcomes by surgical approach in the propensity-matched cohort.

Outcome	Robotic-assisted (n=148)	Laparoscopic (n=148)	p-value
Operative time, minutes, mean (SD)	94.6 (24.3)	68.2 (19.7)	<0.001
Estimated blood loss, mL, mean (SD)	34 (21)	31 (19)	0.42
Conversion to open, n (%)	6 (3.7)	14 (9.5)	0.038
Length of stay, days, median (IQR)	1 (1-2)	2 (1-3)	0.006
30-day complications, n (%)	19 (12.8)	32 (21.6)	0.041
Bile duct injury, n (%)	1 (0.7)	2 (1.4)	0.62
30-day readmission, n (%)	8 (5.4)	13 (8.8)	0.27
30-day mortality, n (%)	1 (0.7)	2 (1.4)	0.57

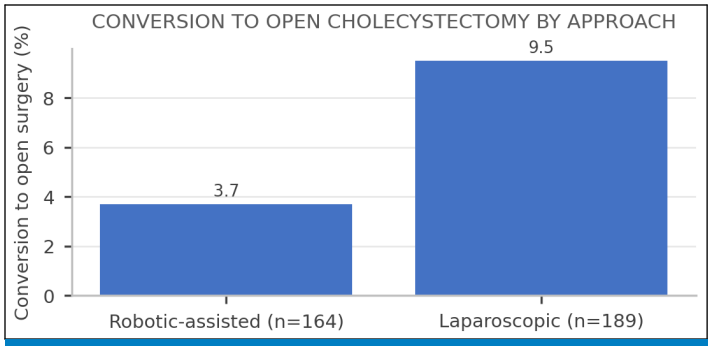

Figure 1: Conversion to open cholecystectomy by surgical approach in the propensity-matched cohort of patients aged 65 years and older, 3.7% for robotic-assisted cholecystectomy versus 9.5% for conventional laparoscopic cholecystectomy (p=0.038).

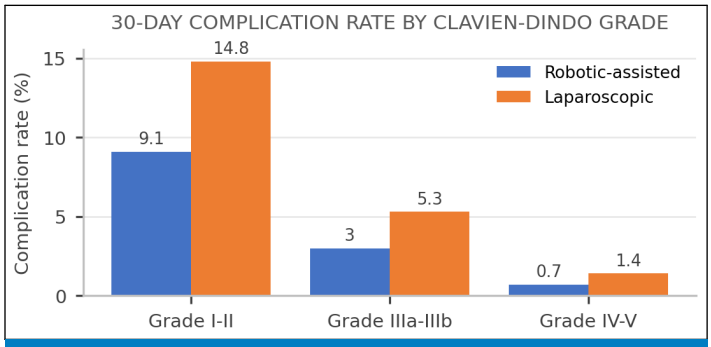

Figure 2: Thirty-day postoperative complication rate by Clavien-Dindo grade and surgical approach, showing a lower rate of low-grade (I-II) complications after robotic-assisted cholecystectomy relative to laparoscopic cholecystectomy, with similarly low rates of major (IIIa or higher) complications in both groups.

4. Discussion

In this retrospective, propensity-matched cohort of patients 65 and older, robotic-assisted cholecystectomy was associated with a longer operative time but a lower conversion rate, shorter length of stay, and lower 30-day complication rate than laparoscopic cholecystectomy, with no significant difference in bile duct injury, readmission, or mortality. These findings extend a body of evidence built largely in mixed-age or younger populations [19,21,22,23] to a cohort selected for advanced age and comorbidity burden, consistent with the hypothesis that enhanced visualization and articulated instrumentation may confer proportionally greater benefit when the anatomy is more difficult or the physiological margin for a prolonged dissection is

© 2026 Somato Publications. All rights reserved.

narrower [20,27].

The lower conversion rate is clinically important in an elderly population, where conversion to open surgery carries disproportionately higher morbidity owing to reduced pulmonary and cardiovascular reserve [11,12], consistent with prior single-center analyses identifying difficulty achieving a safe critical view as the dominant driver of robotic-to-open conversion, a difficulty the improved optics and dexterity of the robotic platform may mitigate [26,21]. The shorter length of stay likewise aligns with the broader minimally-invasive-surgery literature in older adults, where faster mobilization has been linked to shorter hospitalization [18,13].

The longer operative time replicates a near-universal finding in the robotic cholecystectomy literature, reflecting docking time and an institutional learning curve documented in prior robotic biliary series [24,25], which may narrow with cumulative volume as described for other robotic procedures [23]. Cost was not directly analyzed, but prior analyses consistently report a higher direct cost per robotic case from equipment and disposables [25,24], a trade-off that should weigh against the outcomes reported here and that mirrors the broader tension in the diffusion of robotic general surgery [27].

The low bile duct injury rate in both cohorts, together with equivalent readmission and mortality, supports that both approaches can be performed safely in selected elderly patients with a structured perioperative pathway, echoing population-level evidence that deferring cholecystectomy in older adults carries substantial risk of recurrent biliary events and mortality [14,16,15]. Guideline bodies recommend prompt cholecystectomy across most age groups rather than a delayed strategy [5,6,9,10,7], and these elderly-specific outcomes add further support regardless of platform, while suggesting robotic approach may offer incremental advantages meriting confirmation in larger, ideally multicenter or randomized, cohorts [3,4,2,32,31,30,1,17].

This study has limitations inherent to its retrospective, non-randomized design: unmeasured confounders influencing platform choice cannot be excluded despite propensity matching; the single-institution design limits generalizability; 30-day follow-up precludes assessment of longer-term outcomes such as incisional hernia; and cost, operating-room efficiency, and patient-reported outcomes were not captured, representing directions for future prospective work.

5. Conclusion

In this retrospective, propensity-matched cohort of patients aged 65 years and older undergoing cholecystectomy for cholelithiasis, robotic-assisted surgery was associated with a longer operative time but a lower conversion rate, shorter length of stay, and fewer 30-day complications than conventional laparoscopic cholecystectomy, with comparable rates of bile duct injury, readmission, and mortality. These findings suggest that robotic-assisted cholecystectomy is a safe and potentially advantageous option in carefully selected elderly patients, and support continued prompt surgical management of symptomatic cholelithiasis in this population using either minimally invasive platform, pending confirmation in larger multicenter and prospective studies.

6. References

1. Strasberg SM (2008) Clinical practice. Acute calculous cholecystitis. New England Journal of Medicine, 358(26): 2804-2811. DOI: 10.1056/NEJMcp0800929

2. Soper NJ, Stockmann PT, Dunnegan DL, Ashley SW (1992) Laparoscopic cholecystectomy. The new "gold standard"? Archives of Surgery, 127(8): 917-923. DOI: 10.1001/archsurg.1992.01420080051008

3. Shea JA, Healey MJ, Berlin JA, Clarke JR, Malet PF, Staroscik RN, et al. (1996) Mortality and complications associated with laparoscopic cholecystectomy: a meta-analysis. Annals of Surgery, 224(5): 609-620. DOI:

© 2026 Somato Publications. All rights reserved.

10.1097/00000658-199611000-00005

4. Keus F, de Jong JA, Gooszen HG, van Laarhoven CJ (2006) Laparoscopic versus open cholecystectomy for patients with symptomatic cholecystolithiasis. Cochrane Database of Systematic Reviews, (4): CD006231. DOI: 10.1002/14651858.CD006231

5. Gutt CN, Encke J, Koninger J, Harnoss JC, Weigand K, Kipfmuller K, et al. (2013) Acute cholecystitis: early versus delayed cholecystectomy, a multicenter randomized trial (ACDC study). Annals of Surgery, 258(3): 385-393. DOI: 10.1097/SLA.0b013e3182a1599b

6. Loozen CS, van Santvoort HC, van Duijvendijk P, Besselink MG, Gouma DJ, Nieuwenhuijzen GA, et al. (2018) Laparoscopic cholecystectomy versus percutaneous catheter drainage for acute cholecystitis in high risk patients (CHOCOLATE trial): multicentre randomised clinical trial. BMJ, 363: k3965. DOI: 10.1136/bmj.k3965

7. Gurusamy KS, Davidson C, Gluud C, Davidson BR (2013) Early versus delayed laparoscopic cholecystectomy for people with acute cholecystitis. Cochrane Database of Systematic Reviews, (6): CD005440. DOI: 10.1002/14651858.CD005440.pub3

8. Vetrhus M, Soreide O, Solhaug JH, Nesvik I, Soreide K (2002) Symptomatic, non-complicated gallbladder stone disease. Operation or observation? A randomized clinical study. Scandinavian Journal of Gastroenterology, 37(7): 834-839. DOI: 10.1080/003655202760230904

9. Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. (2018) Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis. Journal of Hepato-Biliary-Pancreatic Sciences, 25(1): 41-54. DOI: 10.1002/jhbp.515

10. Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. (2020) 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. World Journal of Emergency Surgery, 15: 61. DOI: 10.1186/s13017-020-00336-x

11. Turrentine FE, Wang H, Simpson VB, Jones RS (2006) Surgical risk factors, morbidity, and mortality in elderly patients. Journal of the American College of Surgeons, 203(6): 865-877. DOI: 10.1016/j.jamcollsurg.2006.08.026

12. Story DA (2008) Postoperative complications in elderly patients and their significance for long-term prognosis. Current Opinion in Anaesthesiology, 21(3): 375-379. DOI: 10.1097/ACO.0b013e3282f889f8

13. Etzioni DA, Liu JH, O'Connell JB, Maggard MA, Ko CY (2003) Elderly patients in surgical workloads: a population-based analysis. American Surgeon, 69(11): 961-965.

14. Riall TS, Zhang D, Townsend CM Jr, Kuo YF, Goodwin JS (2010) Failure to perform cholecystectomy for acute cholecystitis in elderly patients is associated with increased morbidity, mortality, and cost. Journal of the American College of Surgeons, 210(5): 668-679. DOI: 10.1016/j.jamcollsurg.2009.12.031

15. Bergman S, Sourial N, Vedel I, Hanna WC, Fraser SA, Newman D, et al. (2011) Gallstone disease in the elderly: are older patients managed differently? Surgical Endoscopy, 25(1): 55-61. DOI: 10.1007/s00464-010-1128-6

16. Angrisani L, Lorenzo M, De Palma G, Sivero L, Catanzano C, Tesauro B, et al. (1996) Laparoscopic cholecystectomy in geriatric patients. Surgical Laparoscopy & Endoscopy, 6(5): 357-360.

17. Csikesz NG, Tseng JF, Shah SA (2008) Trends in surgical management for acute cholecystitis. Surgical Endoscopy, 22(5): 1191-1196. DOI: 10.1007/s00464-007-9660-9

18. Fried GM, Clas D, Meakins JL (1994) Minimally invasive surgery in the elderly patient. Surgical Clinics of North America, 74(2): 375-387.

19. Novitsky YW, Czerniach DR, Kercher KW, Kaban GK, Gallagher-Dorval KA, Litwin DE (2007) Advantages of robotic cholecystectomy compared with standard

© 2026 Somato Publications. All rights reserved.

laparoscopic cholecystectomy: results of a prospective randomized trial. Archives of Surgery, 142(1): 40-44. DOI: 10.1001/archsurg.142.1.40

20. Giulianotti PC, Coratti A, Angelini M, Sbrana F, Cecconi S, Balestracci T, et al. (2003) Robotics in general surgery: personal experience in a large community hospital. Archives of Surgery, 138(7): 777-784. DOI: 10.1001/archsurg.138.7.777

21. Breitenstein S, Nocito A, Puhan M, Held U, Weber M, Clavien PA (2008) Robotic-assisted versus laparoscopic cholecystectomy: outcome and cost analyses of a case-matched control study. Annals of Surgery, 247(6): 987-993. DOI: 10.1097/SLA.0b013e318172501f

22. Strosberg DS, Nguyen MC, Muscarella P, Narula VK (2017) A retrospective comparison of robotic cholecystectomy versus laparoscopic cholecystectomy: operative outcomes and cost analysis. Surgical Endoscopy, 31(3): 1436-1441. DOI: 10.1007/s00464-016-5134-0

23. Spinoglio G, Lenti LM, Maglione V, Lucido FS, Priora F, Bianchi PP, et al. (2012) Single-site robotic cholecystectomy (SSRC) versus single-incision laparoscopic cholecystectomy (SILC): comparison of learning curves. First European experience. Surgical Endoscopy, 26(6): 1648-1655. DOI: 10.1007/s00464-011-2087-2

24. Vidovszky TJ, Smith W, Ghosh J, Ali MR (2006) Robotic cholecystectomy: learning curve and cost. Journal of Surgical Research, 136(2): 172-178. DOI: 10.1016/j.jss.2006.03.021

25. Kudsi OY, Castellanos A, Kaza S, McCarty J, Dickens E, Martin D, et al. (2017) Cost analysis comparing robotic and laparoscopic cholecystectomy. Journal of Robotic Surgery, 11(4): 343-349.

26. Buchs NC, Pugin F, Volonte F, Hagen ME, Morel P (2013) Reasons for conversion from laparoscopic to robotic cholecystectomy: a retrospective analysis. Journal of Robotic Surgery, 7(3): 271-275. DOI: 10.1007/s11701-012-0367-4

27. Antoniou SA, Antoniou GA, Koch OO, Pointner R, Granderath FA (2011) Robot-assisted laparoscopic surgery of the biliary tract. Journal of the Society of Laparoendoscopic Surgeons, 15(2): 177-185. DOI: 10.4293/108680811X13022985132074

28. Ambe PC, Weber SA, Christ H, Wassenberg D (2014) Cholecystectomy for acute cholecystitis. How time-critical are the so-called "golden 72 hours"? A case control study. World Journal of Emergency Surgery, 9: 60. DOI: 10.1186/1749-7922-9-60

29. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. (2009) The Clavien-Dindo classification of surgical complications: five-year experience. Annals of Surgery, 250(2): 187-196. DOI: 10.1097/SLA.0b013e3181b13ca2

30. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Annals of Surgery, 240(2): 205-213. DOI: 10.1097/01.sla.0000133083.54934.ae

31. Charlson ME, Pompei P, Ales KL, MacKenzie CR (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of Chronic Diseases, 40(5): 373-383. DOI: 10.1016/0021-9681(87)90171-8

32. Glasgow RE, Cho M, Hutter MM, Mulvihill SJ (2000) The spectrum and cost of complicated gallstone disease in California. Archives of Surgery, 135(9): 1021-1027. DOI: 10.1001/archsurg.135.9.1021

© 2026 Somato Publications. All rights reserved.