

ROBOtic Care Outcomes Project (ROBOCOP) for Acute Gallbladder

Pathology

Shannon Greenberg MD,¹ Marc Abou Assali MD,² Yanli Li PhD,³ Hannah Bossie MS,³ Chris Neighorn MBA,³ Esther Wu MD,⁴ Kaushik Mukherjee MD MSCI²

1: Department of Surgery, University of Indiana Medical Center, Indianapolis, IN.

2: Division of Acute Care Surgery, Loma Linda University Health, Loma Linda, CA

3: Intuitive Surgical Inc., Sunnyvale, CA

4: Division of Gastrointestinal and Minimally Invasive Surgery, Loma Linda University Health,
Loma Linda, CA

Corresponding Author

Kaushik Mukherjee MD MSCI FACS

Associate Professor and Chief

Vice Chair of Surgery, Finance

Division of Acute Care Surgery

Loma Linda University Health

11175 Coleman Pavilion

CP 21111

Loma Linda, CA 92350

Phone: 909-558-4286

Fax: 909-558-0236

kmukherjee@llu.edu

ORCID ID: 0000-0002-3292-0552

Email Addresses for Authors:

SG: sgreenb@iu.edu

MAA: MarcAbouAssali@llu.edu

YL: Yanli.Li@Intusurg.com

HB: Hannah.Bossie@Intusurg.com

CN: Christopher.Neighorn@Intusurg.com

EW: wyung@llu.edu

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Disclosures

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Contributions

SG, MAA, EW: manuscript critical revision

YL, HB, CN: Data analysis

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Abstract

Background: Robotic cholecystectomy is being increasingly used for patients with acute gallbladder disease who present to emergency department, but clinical evidence is limited. We aimed to compare the outcomes of emergent laparoscopic and robotic cholecystectomies in a large real-world database.

Methods: Patients who received emergent laparoscopic or robotic cholecystectomies from 2020 to 2022 were identified from the Intuitive Custom Hospital Analytics database, based on de-identified extraction of electronic health record data from US hospitals. Conversion to open or subtotal cholecystectomy and complications were defined using ICD10 and/or CPT codes. Multivariate logistic regression with inverse probability treatment weighting (IPTW) was performed to compare clinical outcomes of laparoscopic versus robotic approach after balancing covariates. Cost analysis was performed with activity-based costing and adjustment for inflation.

Results: Of 26,786 laparoscopic and 3,151 robotic emergent cholecystectomy patients being included, 64% were female, 60% were ≥ 45 years, and 24% were obese. Approximately 5.5% patients presented with pancreatitis, and 4% each presenting with sepsis and biliary obstruction. After IPTW, distributions of all baseline covariates were balanced. Robotic cholecystectomy decreased odds of conversion to open (OR 0.68 [95%CI 0.49, 0.93, $p=0.035$]), but increased odds of subtotal cholecystectomy (OR 1.64 [95% CI 1.03, 2.60, $p=0.037$]). Surgical site infection, readmission, length of stay, hospital acquired conditions, bile duct injury or leak, and hospital mortality were similar in both groups. There was no significant difference in hospital cost.

Conclusions: Robotic cholecystectomy has reduced odds of conversion to open and comparable complications, but increased odds of subtotal cholecystectomy compared to laparoscopic cholecystectomy for acute gallbladder diseases. Further work is required to assess the long-term implications of these differences.

Level of Evidence: III, Therapeutic/Care Management Case-Control (Retrospective)

Keywords: cholecystectomy, laparoscopy, robotic surgery, emergency general surgery

Introduction

Minimally invasive cholecystectomy has become almost universally adopted as the standard of care for the operative management of gallstone disease.[1] This first occurred starting almost 30 years ago with the advent of laparoscopic cholecystectomy. Several large systematic reviews and meta-analyses have shown that laparoscopic approach reduced perioperative morbidity, mortality and hospital length of stay compared to open cholecystectomy in adults, elderly patients, and children.[2–4] Despite the near-universal use of laparoscopic cholecystectomy, conversion rates even for elective cases remain as high as 4.2-6.2% and have not significantly changed over time.[5] Converted cases have been reported to have increased complications, longer length of stay and higher hospital cost than nonconverted minimally invasive cases for cholecystectomy and other common surgical procedures.[6–9]

Robotic cholecystectomy offers some potential advantages that may avert some of the challenges associated with laparoscopic cholecystectomy. These include increased manual dexterity, advanced three-dimensional visualization, tremor filtration, motion scaling, and the integration of fluorescent imaging with indocyanine green.[10,11] These advances, however, has raised concerns about increased cost, and one large systematic review did not identify outcome differences between the two techniques, albeit in single site cases.[12–14] On the other hand, a propensity score matched analysis of single hospital data by Kane demonstrated reduced length of stay and readmission rate with robotic cholecystectomy.[15]. Thus there is still clinical equipoise in this area.

There is potential that reduction in conversion to open surgery may be the piece that connects advances in technology to improved outcome. Sugrue demonstrated that conversion to open surgery is likely to be higher in acute rather than elective cholecystectomy and this is because more acute cholecystectomies tend to meet the criteria for a “difficult gallbladder” including significant inflammation making determination of anatomy difficult.[16,17] These may be the cases in which the advanced technology available with the robot enables a higher likelihood of achieving a successful minimally invasive operation. A retrospective analysis of elective cholecystectomies performed at a VA hospital reported robotics reduced conversion rate from 6.6% in laparoscopic to 0.6% in robotic approach. [18] A meta-analysis of four retrospective cohort studies totaling 917 patients indicated a significantly reduced odds ratio of conversion to open with robotic multi-port cholecystectomy (OR 0.11 [95% CI 0.04, 0.30], $p < 0.001$).[19] Three of these studies included both acute and elective patients, while the fourth included only elective cases. Gangemi demonstrated an almost ten-fold reduction in conversion for acute or gangrenous cholecystitis with robotic versus laparoscopic cholecystectomy.[20] Therefore there is still room for definitive work in this area.

The final issue to be addressed is how the use of robotics affects the approach to the “bailout” of the difficult cholecystectomy. One option is to abandon complete cholecystectomy and perform a subtotal cholecystectomy. Elshaer found that a laparoscopic subtotal cholecystectomy had reduced odds of intra-abdominal fluid collection, retained stones, wound infection, reoperation, and mortality, but a higher incidence of bile leaks.[21] Braschi found lower incidence of bile leak, intra-abdominal abscess, biloma, postoperative endoscopic retrograde cholangiopancreatography (ERCP), and readmission with total cholecystectomy

compared to subtotal.[22] Grossman compared laparoscopic subtotal cholecystectomy to attempted laparoscopic with conversion to open total cholecystectomy and found that the minimally invasive approach was associated with shorter OR time, reduced rate of ICU admission, and shorter length of stay.[23]

It is unclear how robotic surgery affects the approach to the difficult gallbladder, the need for bailout, the conversion rate, and the use of subtotal cholecystectomy in the acute cholecystectomy population. We sought to address these questions with a large, de-identified, multicenter database of patients undergoing laparoscopic and robotic cholecystectomy for acute biliary disease.

Methods

IRB Approval

This project (LLUH IRB #5230337) received a designation of non-human subjects research, and as such was considered to not require IRB review or approval. We followed the guidelines for the STROBE checklist for case-control studies (Supplemental Digital Content, <http://links.lww.com/TA/D472>).

Study Population and Database Analytics

A retrospective study was conducted to evaluate nationwide perioperative outcomes of minimally invasive emergent cholecystectomies, including both robotic and standard laparoscopic techniques, using the Intuitive Custom Hospital Analytics (CHA) database (Supplemental Digital Content, <http://links.lww.com/TA/D474>). The CHA database extracted

de-identified, HIPAA-compliant patient data from hospital electronic health records (EHR) in the US under a standard non-disclosure agreement. Information documented directly by the clinical care team and medical coders and entered into the medical record is then collated by hospital personnel who audit the report for quality prior to submission into the database. Participation in the CHA database by facilities is optional. Individual hospitals conducted data validation and integrity checks prior to submitting their data to the CHA database to ensure proper metrics and diagnostic codes are provided. Should facilities not meet these specifications, the data is rejected. Any protected health information was de-identified by individual hospitals before data transmission. Data from the CHA database has been previously published in the literature with respect to diverticulitis outcomes.[24]

Adult patients who received emergent minimally invasive cholecystectomies from 2020 to 2022 were included in the study. Minimally invasive cholecystectomy was defined using the International Classification of Disease (ICD Tenth Revision, Clinical Modification (ICD-10-CM) procedure codes and Current Procedural Terminology (CPT) codes (Appendix 1). Laparoscopic and robotic cholecystectomies were differentiated by hospital provided identifiers. Patients with missing operative time or some basic demographic and clinical information (e.g., gender, emergent/elective cases, setting of care, region) were excluded.

Outcomes

Clinical outcomes being evaluated were conversion to open surgery or subtotal cholecystectomy, perioperative complications including surgical site infection, bile duct injury or leak, pancreatic leak/fistula, other postprocedural complications, and hospital acquired

conditions, blood transfusion and mortality in hospital. ICD-10-CM diagnosis codes were used to define the outcomes of interest (Appendix). Operative room (OR) time and hospital length of stay data were extracted from hospital EHR.

Covariates

Patient-level demographic and clinical characteristics included age, sex, indication for surgery, body mass index (BMI), presence of diabetes, payor type, and year of surgery. Hospital region and teaching status were also included as covariates.

Statistical Analysis

Inverse probability treatment weighting (IPTW) using stabilized weights was performed to balance distributions of covariates in laparoscopic and robotic cholecystectomy patients. IPTW was calculated as the inverse of patients' estimated probability of receiving different surgical modality using a logistic regression model including all the aforementioned baseline factors. Distributions of baseline characteristics in both the raw data and IPTW data were presented. Adequacy of IPTW to balance covariates was assessed by using absolute value of standardized mean difference (SMD) less than 0.1.[25,26] To compare the clinical outcomes of laparoscopic and robotic cholecystectomy patients, logistic regressions were performed in the raw data and IPTW data, respectively. Odds ratio (OR) and 95% confidence intervals (95% CIs) were calculated. Additionally, a multivariate logistic regression analysis was performed to identify risk factors for conversion to open surgery. We also performed a subset analysis of only the patients undergoing surgery for sepsis or obstruction.

All analyses were performed using R version 4.2.2. Two-tailed p-values less than 0.05 were considered statistically significant.

Cost Analysis

An activity-based costing (ABC) analysis was performed to estimate the costs for laparoscopic and robotic emergent cholecystectomy. Resource data from each patient including operating room time, ICU length of stay, blood transfusion,[27] conversion to open surgery,[8] 30-day readmissions,[28] and surgical site infections[29] were compiled and can be seen in Supplementary Table 1, <http://links.lww.com/TA/D473>. These were then added to supply costs for laparoscopic and robotic cases (\$1448 and \$1979 respectively) and adjusted for the Consumer Price Index (CPI). Final costs were then analyzed using standard parametric statistics.

Results

A total of 26,786 laparoscopic and 3,151 robotic emergent cholecystectomy patients were included. The age distribution, indications for surgery, body mass index (BMI) categories, year of discharge, hospital type, payor, and region of the United States in both the unadjusted and IPTW weighted data are included in **Table 1**. Two thirds of study population were female and 60% were older than 45 years at the time of surgery. Approximately 5.5% of these patients presented with pancreatitis, as well as an additional 4% presenting each with sepsis and biliary obstruction. Approximately one-quarter of the patients in the study had $BMI \geq 30 \text{ kg/m}^2$, consistent with a diagnosis of obesity. Distributions of a few variables including discharge year, hospital type, payor, and region were imbalanced in the raw data; while after applying IPTW, all

covariates were balanced ($SMD < 0.1$). The effectiveness of balancing covariates using IPTW is diagrammed in **Figure 1**, with a corresponding reduction in SMD after rebalancing.

The unadjusted outcomes in the two groups (laparoscopic and robotic) are included in **Table 2**. Robotic cholecystectomy had a lower conversion rate to open compared to laparoscopic cholecystectomy (1.1% vs. 1.9%, OR 0.60 [95% CI 0.42, 0.83], $p < 0.002$) and non-significantly higher odds of subtotal cholecystectomy (0.5% vs. 0.7%, OR 1.48 [95% CI 0.93, 2.27], $p = 0.10$). When all possible outcomes are included (minimally invasive subtotal cholecystectomy, open total cholecystectomy, and open subtotal cholecystectomy), odds of minimally invasive subtotal cholecystectomy were higher in the robotic group (0.7% vs. 0.3%, OR 1.95 [95% CI 1.18, 3.08] although odds of conversion to open subtotal cholecystectomy were similar. Rates of complications including surgical site infection, blood transfusion, bile duct injury or leak, pancreatic leak/fistula and postprocedural complications, and hospital mortality were similar between laparoscopic and robotic cholecystectomy patients in the unadjusted data, aside from lower hospital acquired conditions observed in robotic patients (4.3% laparoscopic vs. 3.6% robotic, OR 0.82 [0.67, 1.00], $p = 0.046$). Robotic and laparoscopic cholecystectomies had comparable hospital length of stay, but operative time was longer in the robotic group by 11 minutes (113 ± 45 vs. 102 ± 43 , $p < 0.001$).

The outcomes after IPTW rebalancing are included in **Table 3** and the results remained similar to the unadjusted analyses. Robotic cholecystectomy was associated with reduced conversion to open (1.3% vs. 1.9%, OR 0.68 [0.48, 0.97]) but increased the use of minimally invasive subtotal cholecystectomy (0.8% vs. 0.5%, OR 1.64 [1.03, 2.60]). Similar results were

observed when all four outcomes were considered. After IPTW rebalancing, rates for all complications including hospital acquired conditions and hospital length of stay were similar between the two groups. Operative time was 14 minutes longer in robotic group (115 ± 47 vs 101 ± 42 minutes, $p < 0.001$).

Table 4 indicates the results of a subgroup analysis in patients with sepsis and obstruction as the reason for cholecystectomy. Although limited by sample size, the data here parallels the larger paper. Robotic cases were also noted to have significantly lower odds of hospital acquired conditions (OR: 0.52, 95% CI: 0.26-0.95, p value 0.034) and other postprocedural complications (OR: 0.22, 95% CI: 0.01, 1.00, p value 0.05) in this subgroup of patients.

Figure 2 illustrates in diagram form the odds ratios and their statistical significance levels from a multivariate regression analysis to evaluate risk factors for converting to open surgery. Robotic surgery was associated with significantly reduced odds of conversion (0.63 [0.44, 0.87], $p = 0.008$) compared to the laparoscopic approach. Male patients, patients above the age of 45 years, and patients with sepsis or biliary obstruction all had 2 to 3-fold increased odds of conversion (p values < 0.001). Obesity was associated with increased rates of conversion (OR 1.49 [1.20, 1.84], $p < 0.001$). Operation at an academic/teaching hospital was associated with higher odds of conversion to open surgery (OR 3.70 [3.03, 4.55], $p < 0.001$), as was having Medicaid (OR 1.44 [1.07, 1.91], $p = 0.013$) or Medicare (OR 1.71 [1.26, 2.33] $p < 0.001$) as the primary payor; while surgery conducted in the Western states had lower odds of conversion (OR 0.71 [0.53, 0.96], $p = 0.025$).

Our ABC-based CPI-adjusted cost analysis indicated that costs were comparable between laparoscopic and robotic cholecystectomies (Laparoscopic mean \$15400 ± \$25770, median \$11274 [\$7563, \$17344], robotic mean \$16264 ± \$17091, median \$11695 [\$7762, \$17971], p=0.13).

Discussion

The present study is the largest real-world database study comparing clinical outcomes of laparoscopic and robotic cholecystectomy for acute indications after an emergency department visit. Detailed patient-level covariates and outcomes were collected, and robust inverse probability treatment weighting was performed to adjust for imbalances in covariates between the laparoscopic and robotic groups. Both community and academic medical centers in all parts of the country, and representing all payors, were included.

We noted that robotic cholecystectomy significantly reduced the odds of conversion to open surgery in the setting of emergent cholecystectomy. As mentioned above, conversion is an important outcome as it may negate the benefits sought with a minimally invasive procedure and be associated with increased complications.[6–8] It is more important in the emergent setting as difficulty and conversion rates are likely to be higher than the elective setting.[16] Smaller single institution studies have demonstrated decreased conversion rates with robotic surgery, but either were not focused on the acute population or failed to demonstrate statistical significance.[30] Of note, a study by Gangemi included only 20-25% non-elective cholecystectomies but still reported a conversion rate of 9.6% in the laparoscopic group versus 0.76% in the robotic

group.[20] Our conclusions are validated in the subset of patients with advanced liver disease in a study of the NSQIP database, showing a statistically significant decrease in conversion rates among robotic cases (27%vs 8%, $p=0.01$) for emergent cholecystectomy in this high-risk population.[31] This study is currently the largest done in this area and does demonstrate a reduction in conversion rate to open with robotic cholecystectomy for emergent cases. In this study, although the absolute risk reduction of 0.6% may not seem significant, more than a million minimally invasive cholecystectomies are performed annually in the United States, and thus the potential benefits translate to a large number of patients.[32] Furthermore, patients exhibit a significant preference for minimally invasive surgical techniques.[33]

Several other factors have been shown to increase the risk of conversion in our current study. Male patients, age older than 45 years, and patients with sepsis or biliary obstruction all had 2 to 3-fold increased odds of conversion and obesity was associated 1.5-fold increased odds of conversion. These observed risk factors are fairly consistent with the existing literature. An analysis of the National Inpatient Sample found an increased risk of conversion with increased age, male gender, public insurance, and minority race/ethnicity groups for emergent cholecystectomy procedures.[9] A large retrospective study also showed increased risk of conversion for male patients, patients with prior upper abdominal surgery, age over 65 years, history of ERCP, and a diagnosis of acute cholecystitis; in this study robotic cholecystectomy was not studied.[34] The study by Gangemi referenced above found an increased risk of conversion for male patients and a diagnosis of acute or gangrenous cholecystitis; however these risk factors were lesser for the robotic cases in comparison to laparoscopic.[20]

In the overall setting of the approach to the difficult gallbladder, the surgeon may leverage subtotal cholecystectomy if the critical view of safety is not achievable.[21,35] Although this can be done with or without conversion to open surgery, open surgery does not guarantee that total cholecystectomy will be achieved; our data demonstrates this. The data from Elshaer and colleagues demonstrates a very high conversion rate in these difficult gallbladders; our data suggests that robotic surgery may help reduce the risk of conversion, perhaps with a higher chance of using subtotal minimally invasive cholecystectomy. As discussed above, the differences between open total cholecystectomy and minimally invasive subtotal cholecystectomy are just starting to be studied, with mixed results.[21–23] Very large studies will need to be performed to truly outline the implications of one of the more difficult choices in surgery: convert to open and risk still performing a subtotal cholecystectomy, or stay minimally invasive and definitively support subtotal cholecystectomy.

The recent manuscript by Kalata and colleagues, a retrospective study of Medicare beneficiaries undergoing laparoscopic, robotic, and open cholecystectomy from 2010 to 2019, bears discussion. In this study, it was noted that robotic cases had a higher incidence of bile duct injury requiring intervention within 1 year; of note, this is different from our results. One important variation is the rate of open cholecystectomy, which included almost 20% of the patients in the Kalata study. There was no documentation of conversion rates reported nor any information on rates of subtotal cholecystectomy. Furthermore, the data in the supplemental content indicates that the rate of bile duct injury in the open cholecystectomy group ranged from 3.1 to 4.0%; the combination of these two data points indicates that some of the open cholecystectomies with bile duct injuries may have been converted from laparoscopic surgery as

the original intention to treat. This manuscript also describes a higher rate of bile duct injuries in elective surgeries compared to emergent surgeries, which is certainly unexpected.[36] The authors do bring up an important issue regarding surgeon experience and learning curve, however. In our 3 year dataset, the penetrance of robotic surgery increased from 8.7% (1329/15358) in 2020 to 16.8% (342/2041) in 2022. Over this time period, conversion rates in both groups decreased (1.9% to 1.5% in the laparoscopic group, and 1.7% to 0.6% in the robotic surgery group). It is not likely that surgeons continue to maintain a learning curve with laparoscopic cholecystectomy; rather it may be that the incidence of subtotal cholecystectomy rather than open cholecystectomy is increasing as the preferred approach to the difficult gallbladder; Ramirez-Giraldo reported exactly this in their review.[37]

Finally, our activity-based costing and inflation-adjusted cost analysis of almost 30,000 cases indicates that there is not a statistically significant difference between laparoscopic and robotic cholecystectomy costs, even after adjusting for ICU utilization, blood products, length of stay, operating room time, readmission, conversion, and surgical site infections. This analysis diverges from some previous cost analyses and indicates that additional data may be needed in this area.[8,13,14] These previous manuscripts are older and perhaps do not reflect current cost structures; furthermore our methodology helped account for variations in costing between hospitals.

This study does have several limitations. As a deidentified database study relying on the ICD and CPT codes extracted from hospital EHR, it was not possible to individually verify data reported by individual hospitals to the CHA database, therefore the study is subject to coding

incompleteness and inaccuracies. Data validation and integrity checks performed by individual hospitals before data submission might mitigate the issue, but possible variation in coding behaviors across hospitals still cannot be excluded. There was no possible follow-up after discharge; thus, readmission or complications at other hospitals could not be assessed. Additionally, we have no perspective of surgeons' robotic experience and therefore are unable to assess where the surgeons contributing this data were in regard to their learning curve. Despite the efforts to adjust for different covariates, this study was retrospective and non-randomized, therefore residual confounding still likely to exist. Data on the use of indocyanine green fluorescent cholangiography is not submitted to the CHA database, so we are not able to indicate how often this was used in the robotic cholecystectomies. Data in our database does not reflect the time (day/night/week/weekend) that procedures were performed. [1]

It is our assessment that robotic cholecystectomy for acute gallbladder pathology carries a lower risk of conversion to open surgery, albeit with a more frequent use of subtotal cholecystectomy. This benefit persists across a broad variety of patients and disease processes and has the potential to reduce length of stay and improve other patient outcomes. This data indicates that, through the use of robotic techniques, the benefits of minimally invasive surgery can be extended to a greater number of patients. This is particularly important in the setting of emergency surgery, where we know there are existing disparities in access to minimally invasive care.

List of Supplementary Digital Content

Supplementary Table 1

CHA Code List

STROBE Checklist for Case-Control Studies

All Author Disclosure Forms

ACCEPTED

References

1. Aguayo E, Dobaria V, Nakhla M, Seo Y-J, Hadaya J, Cho NY, et al. National trends and outcomes of inpatient robotic-assisted versus laparoscopic cholecystectomy. *Surgery*. 2020;168:625–30.
2. Coccolini F, Catena F, Pisano M, Gheza F, Fagiuoli S, Saverio SD, et al. Open versus laparoscopic cholecystectomy in acute cholecystitis. Systematic review and meta-analysis. *Int J Surg*. 2015;18:196–204.
3. Antoniou SA, Antoniou GA, Koch OO, Pointner R, Granderath FA. Meta-analysis of laparoscopic vs open cholecystectomy in elderly patients. *World J Gastroenterol*. 2014;20:17626–34.
4. Steffens D, Wales K, Toms C, Yeo D, Sandroussi C, Jiwane A. What surgical approach would provide better outcomes in children and adolescents undergoing cholecystectomy? Results of a systematic review and meta-analysis. *Ann Pediatr Surg*. 2020;16:24.
5. Pucher PH, Brunt LM, Davies N, Linsk A, Munshi A, Rodriguez HA, et al. Outcome trends and safety measures after 30 years of laparoscopic cholecystectomy: a systematic review and pooled data analysis. *Surg Endosc*. 2018;32:2175–83.
6. Terho PM, Leppäniemi AK, Mentula PJ. Laparoscopic cholecystectomy for acute calculous cholecystitis: a retrospective study assessing risk factors for conversion and complications. *World J Emerg Surg*. 2016;11:54.
7. Özdemir A, Karakaya A, Pergel A. Conversion from laparoscopic cholecystectomy to open surgery reasons and possible risks: A single center experience. *J Exp Clin Med*. 2022;39:781–5.

8. Shah PC, Groot A de, Cerfolio R, Huang WC, Huang K, Song C, et al. Impact of type of minimally invasive approach on open conversions across ten common procedures in different specialties. *Surg Endosc*. 2022;36:6067–75.
9. Shah AA, Bhatti UF, Petrosyan M, Washington G, Nizam W, Williams M, et al. The heavy price of conversion from laparoscopic to open procedures for emergent cholecystectomies. *Am J Surg*. 2019;217:732–8.
10. Muaddi H, Hafid ME, Choi WJ, Lillie E, Mestral C de, Nathens A, et al. Clinical Outcomes of Robotic Surgery Compared to Conventional Surgical Approaches (Laparoscopic or Open): A Systematic Overview of Reviews. *Ann Surg*. 2020;273:467–73.
11. Zaman JA, Singh TP. The emerging role for robotics in cholecystectomy: the dawn of a new era? *Hepatobiliary Surg Nutr*. 2017;7:21–8.
12. Shenoy R, Mederos MA, Ye L, Mak SS, Begashaw MM, Booth MS, et al. Intraoperative and postoperative outcomes of robot-assisted cholecystectomy: a systematic review. *Syst Rev*. 2021;10:124.
13. Singh A, Panse NS, Prasath V, Arjani S, Chokshi RJ. Cost-effectiveness analysis of robotic cholecystectomy in the treatment of benign gallbladder disease. *Surgery*. 2023;173:1323–8.
14. Khorgami Z, Li WT, Jackson TN, Howard CA, Sclabas GM. The cost of robotics: an analysis of the added costs of robotic-assisted versus laparoscopic surgery using the National Inpatient Sample. *Surg Endosc*. 2019;33:2217–21.
15. Kane WJ, Charles EJ, Mehaffey JH, Hawkins RB, Meneses KB, Tache-Leon CA, et al. Robotic compared with laparoscopic cholecystectomy: A propensity matched analysis. *Surgery*. 2020;167:432–5.

16. Sugrue M, Coccolini F, Bucholz M, Johnston A, Manatakis D, Ioannidis O, et al. Intra-operative gallbladder scoring predicts conversion of laparoscopic to open cholecystectomy: a WSES prospective collaborative study. *World J Emerg Surg.* 2019;14:12.
17. Salky BA, Edye MB. The Difficult Cholecystectomy: Problems Related to Concomitant Diseases. *Surg Innov.* 1998;5:107–14.
18. Tao Z, Emuakhabon V-S, Pham T, Augustine MM, Guzzetta A, Huerta S. Outcomes of robotic and laparoscopic cholecystectomy for benign gallbladder disease in Veteran patients. *J Robot Surg.* 2021;15:849–57.
19. Straatman J, Pucher PH, Knight BC, Carter NC, Glaysher MA, Mercer SJ, et al. Systematic review: robot-assisted versus conventional laparoscopic multiport cholecystectomy. *J Robot Surg.* 2023;1–11.
20. Gangemi A, Danilkowicz R, Elli FE, Bianco F, Masrur M, Giulianotti PC. Could ICG-aided robotic cholecystectomy reduce the rate of open conversion reported with laparoscopic approach? A head to head comparison of the largest single institution studies. *J Robot Surg.* 2017;11:77–82.
21. Elshaer M, Gravante G, Thomas K, Sorge R, Al-Hamali S, Ebdewi H. Subtotal Cholecystectomy for “Difficult Gallbladders”: Systematic Review and Meta-analysis. *JAMA Surg.* 2015;150:159–68.
22. Braschi C, Tung C, Tang A, Delgado C, Uribe L, Senekjian L, et al. Early Outcomes of Subtotal vs Total Cholecystectomy for Acute Cholecystitis. *JAMA Surg.* 2022;157:1062–4.
23. Grossman H, Holder KG, Freedle C, Dhanasekara CS, Dissanaik S. Comparing Outcomes of Sub-Total Cholecystectomy Versus Open Cholecystectomy as Bailout Procedures for the Difficult Gallbladder. *Am Surg.* 2022;000313482211483.

24. Curfman KR, Jones IF, Conner JR, Neighorn CC, Wilson RK, Rashidi L. Robotic colorectal surgery in the emergent diverticulitis setting: is it safe? A review of large national database. *Int J Color Dis.* 2023;38:142.
25. Chesnaye NC, Stel VS, Tripepi G, Dekker FW, Fu EL, Zoccali C, et al. An introduction to inverse probability of treatment weighting in observational research. *Clin Kidney J.* 2021;15:sfab158.
26. Austin PC, Stuart EA. Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. *Stat Med.* 2015;34:3661–79.
27. Shander A, Hofmann A, Ozawa S, Theusinger OM, Gombotz H, Spahn DR. Activity-based costs of blood transfusions in surgical patients at four hospitals. *Transfusion.* 2010;50:753–65.
28. AHRQ. HCUPNet [Internet]. 2022. Available from: <https://hcupnet.ahrq.gov>
29. Forrester JD, Maggio PM, Tennakoon L. Cost of Health Care–Associated Infections in the United States. *J Patient Saf.* 2022;18:e477–9.
30. Rifai AO, Rembetski EM, Stutts LC, Mazurek ZD, Yeh JL, Rifai K, et al. Retrospective analysis of operative time and time to discharge for laparoscopic vs robotic approaches to appendectomy and cholecystectomy. *J Robot Surg.* 2023;1–7.
31. Aziz H, Zeeshan M, Kaur N, Emamaullee J, Ahearn A, Kulkarni S, et al. A Potential Role for Robotic Cholecystectomy in Patients with Advanced Liver Disease: Analysis of the NSQIP Database. *Am Surg.* 2020;86:341–5.
32. Shenoy R, Kirkland P, Hadaya JE, Tranfield MW, DeVirgilio M, Russell MM, et al. Management of symptomatic cholelithiasis: a systematic review. *Syst Rev.* 2022;11:267.

33. White CA, Patel AV, Butler LR, Amakiri UO, Yeshoua BJ, Steinberger JM, et al. Comparison of Patient Preference, Understanding, and Sentiment for Minimally Invasive Versus Open Spine Surgery. *SPINE*. 2022;47:309–16.
34. Ábrahám S, Németh T, Benkő R, Matuz M, Váczi D, Tóth I, et al. Evaluation of the conversion rate as it relates to preoperative risk factors and surgeon experience: a retrospective study of 4013 patients undergoing elective laparoscopic cholecystectomy. *BMC Surg*. 2021;21:151.
35. Henneman D, Costa DW da, Vrouenraets BC, Wagensveld BA van, Lagarde SM. Laparoscopic partial cholecystectomy for the difficult gallbladder: a systematic review. *Surg Endosc*. 2013;27:351–8.
36. Kalata S, Thumma JR, Norton EC, Dimick JB, Sheetz KH. Comparative Safety of Robotic-Assisted vs Laparoscopic Cholecystectomy. *JAMA Surg*. 2023;158.
37. Ramírez-Giraldo C, Torres-Cuellar A, Van-Londoño I. State of the art in subtotal cholecystectomy: An overview. *Front Surg*. 2023;10:1142579.

Figure Legends

Figure 1. This figure diagrammatically indicates the standard mean differences for each covariate before (red dots) and after (blue triangles) rebalancing with inverse probability treatment weighting.

Figure 2. This figure indicates the odds ratios for each covariate studied with respect to conversion to open from minimally invasive surgery. Statistical significance is designated as follows: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robotic surgery (OR 0.63 [95% CI 0.44, 0.87]) and surgery at a non-academic hospital were associated with decreased rates of conversion to open surgery. Male gender (OR 2.31 [95% CI 1.93, 2.77]), any age greater than 34, presence of sepsis (OR 2.31 [95% CI 1.71, 3.06]), biliary obstruction (OR 2.93 [95% CI 2.09, 4.02]), and Medicaid or Medicare insurance were associated with increased rates of conversion to open surgery.

Figure 1

Figure. Balance of Covariates Before and After IPTW

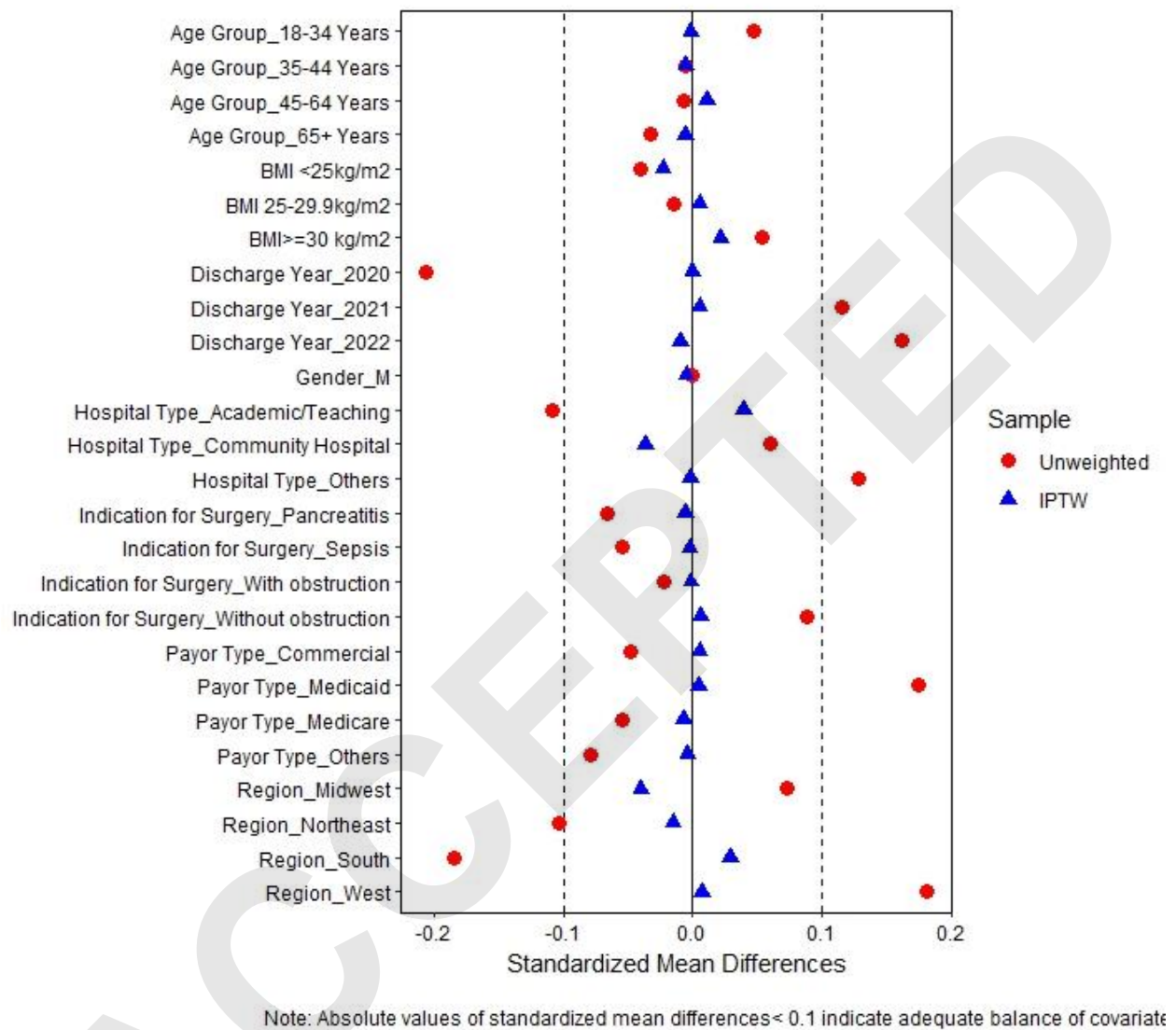


Figure 2

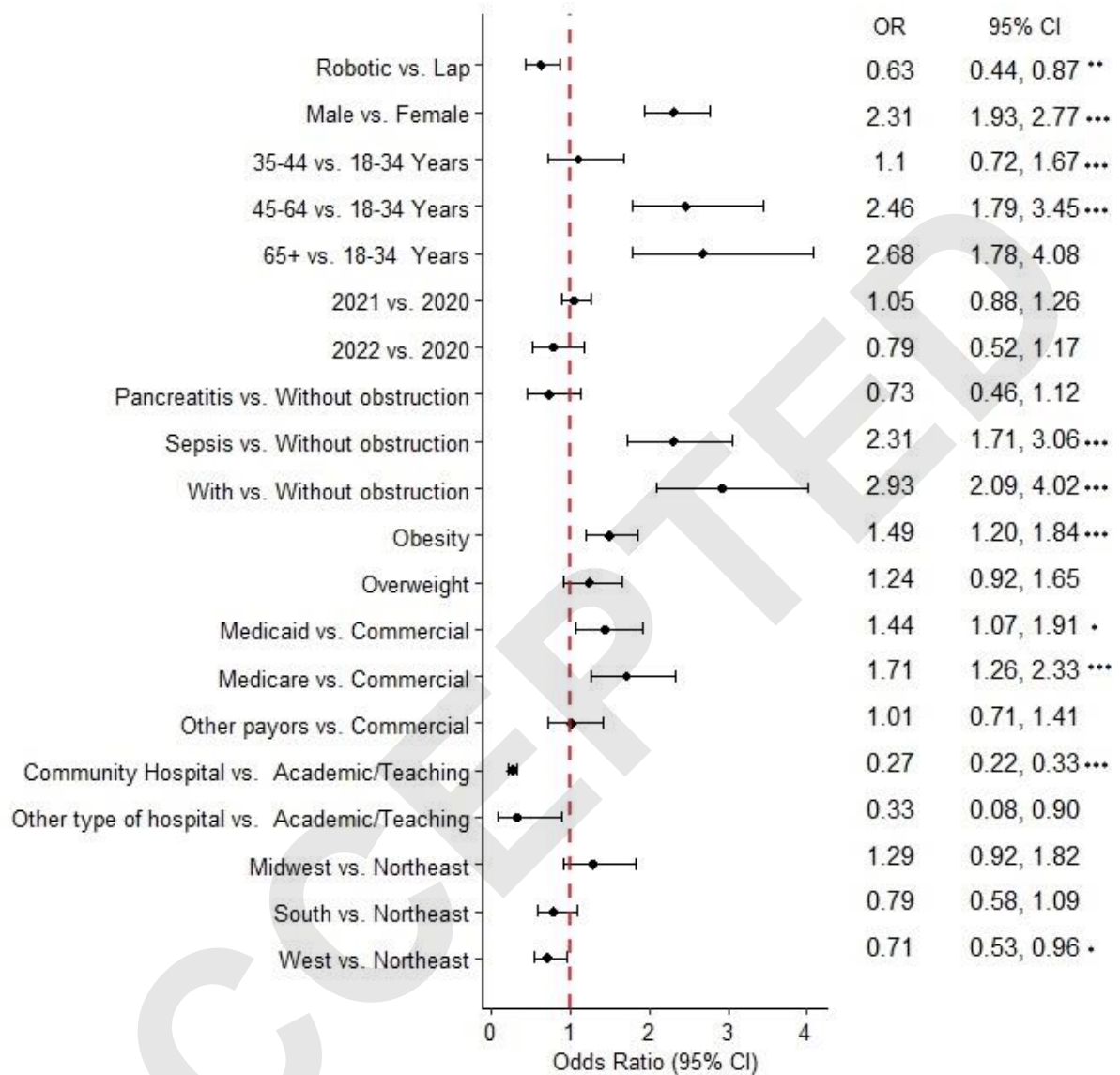


Table 1. Basic Information of Emergent Chole Patients Before and After IPTW

	Unweighted			IPTW		
	Lap, N = 26,786 ¹	Robotic, N = 3,151 ¹	SMD ²	Lap, N = 26,785 ¹	Robotic, N = 3,158 ¹	SMD ²
Gender						
Female	17,157 (64.05%)	2,019 (64.07%)	0.00	17,158 (64.06%)	2,030 (64.29%)	0.00
Male	9,629 (35.95%)	1,132 (35.93%)		9,627 (35.94%)	1,128 (35.71%)	
Age Group						
18-34 Years	6,240 (23.30%)	797 (25.29%)	0.05	6,297 (23.51%)	740 (23.44%)	0.00
35-44 Years	4,629 (17.28%)	537 (17.04%)	-0.01	4,621 (17.25%)	539 (17.06%)	-0.01
45-64 Years	8,757 (32.69%)	1,020 (32.37%)	-0.01	8,749 (32.66%)	1,048 (33.18%)	0.01
65+ Years	7,160 (26.73%)	797 (25.29%)	-0.03	7,118 (26.57%)	831 (26.32%)	-0.01
Indication for Surgery						
Pancreatitis	1,534 (5.73%)	135 (4.28%)	-0.07	1,493 (5.57%)	172 (5.44%)	-0.01
Sepsis	1,174 (4.38%)	105 (3.33%)	-0.05	1,144 (4.27%)	133 (4.23%)	0.00
With obstruction	974 (3.64%)	102 (3.24%)	-0.02	963 (3.59%)	113 (3.57%)	0.00
Without obstruction	23,104 (86.25%)	2,809 (89.15%)	0.09	23,185 (86.56%)	2,740 (86.76%)	0.01
Overweight or Obesity³						
Not overweight or obesity	18,025 (67.29%)	2,061 (65.41%)	-0.04	17,964 (67.07%)	2,084 (65.98%)	-0.02
Obesity	6,372 (23.79%)	822 (26.09%)	0.05	6,443 (24.05%)	789 (24.99%)	0.02
Overweight	2,389 (8.92%)	268 (8.51%)	-0.01	2,378 (8.88%)	285 (9.03%)	0.01
Discharge Year						
2020	14,029 (52.37%)	1,329 (42.18%)	-0.21	13,743 (51.31%)	1,620 (51.30%)	0.00
2021	11,058 (41.28%)	1,480 (46.97%)	0.11	11,218 (41.88%)	1,331 (42.15%)	0.01
2022	1,699 (6.34%)	342 (10.85%)	0.16	1,824 (6.81%)	207 (6.55%)	-0.01
Hospital Type						
Academic/Teaching	2,936 (10.96%)	246 (7.81%)	-0.11	2,850 (10.64%)	372 (11.78%)	0.04

	Unweighted			IPTW		
	Lap, N = 26,786 ¹	Robotic, N = 3,151 ¹	SMD ²	Lap, N = 26,785 ¹	Robotic, N = 3,158 ¹	SMD ²
Community Hospital	23,742 (88.64%)	2,851 (90.48%)	0.06	23,791 (88.82%)	2,769 (87.70%)	-0.04
Others	108 (0.40%)	54 (1.71%)	0.13	144 (0.54%)	16 (0.52%)	0.00
Payor Type						
Commercial	10,925 (40.79%)	1,212 (38.46%)	-0.05	10,859 (40.54%)	1,288 (40.80%)	0.01
Medicaid	5,055 (18.87%)	822 (26.09%)	0.17	5,260 (19.64%)	626 (19.82%)	0.00
Medicare	7,432 (27.75%)	799 (25.36%)	-0.05	7,362 (27.48%)	858 (27.17%)	-0.01
Others	3,374 (12.60%)	318 (10.09%)	-0.08	3,304 (12.34%)	386 (12.21%)	0.00
Region						
Midwest	2,929 (10.93%)	419 (13.30%)	0.07	2,984 (11.14%)	311 (9.84%)	-0.04
Northeast	2,511 (9.37%)	207 (6.57%)	-0.10	2,431 (9.07%)	274 (8.66%)	-0.02
South	9,745 (36.38%)	877 (27.83%)	-0.18	9,511 (35.51%)	1,164 (36.85%)	0.03
West	11,601 (43.31%)	1,648 (52.30%)	0.18	11,859 (44.28%)	1,410 (44.64%)	0.01

¹n (%)

² SMD: standardized mean difference. Absolute values of standardized mean differences < 0.1 indicate adequate balance.

³ Overweight: BMI 25.0 to <30; Obesity: BMI 30.0 or higher.

Table 2. Outcomes of Emergent Chole Patients by Modality in Raw Data

	Lap, N = 26,786¹	Robotic, N = 3,151¹	OR (95% CI)²	p-value
Subtotal/Chole				0.10
Cholecystectomy	26,654 (99.5%)	3,128 (99.3%)	Ref.	
Subtotals	132 (0.5%)	23 (0.7%)	1.48 (0.93, 2.27)	
Conversion to Open				0.002
Not converted to open	26,282 (98.1%)	3,115 (98.9%)	Ref.	
Converted to open	504 (1.9%)	36 (1.1%)	0.60 (0.42, 0.83)	
Conversion to open or subchole				<0.001
Non-converted	26,191 (97.8%)	3,094 (98.2%)	Ref.	
Converted to open	463 (1.7%)	34 (1.1%)	0.62 (0.43, 0.87)	
Converted to subtotal	91 (0.3%)	21 (0.7%)	1.95 (1.18, 3.08)	
Converted to open subtotal	41 (0.2%)	2 (0.1%)	0.41 (0.07, 1.34)	
Surgical Site Infection	34 (0.1%)	2 (0.1%)	0.50 (0.08, 1.64)	0.3
Blood Transfusion	157 (0.6%)	21 (0.7%)	1.14 (0.70, 1.75)	0.6
Readmission	1,042 (3.9%)	122 (3.9%)	1.00 (0.82, 1.20)	>0.9
Hospital Acquired Conditions³	1,150 (4.3%)	112 (3.6%)	0.82 (0.67, 1.00)	0.046
Bile Duct Injury or Leak	18 (0.1%)	0 (0.0%)	-	-
Other postprocedural complications	191 (0.7%)	13 (0.4%)	0.58 (0.31, 0.97)	0.038
Pancreatic Leak/Fistula	89 (0.3%)	10 (0.3%)	0.96 (0.47, 1.75)	0.9
Mortality in Hospital	56 (0.2%)	8 (0.3%)	1.21 (0.53, 2.40)	0.6
Length of Stay			-	0.10
Mean (SD)	2.98 (2.96)	3.07 (3.36)		

	Lap, N = 26,786¹	Robotic, N = 3,151¹	OR (95% CI)²	p-value
Median (IQR)	2.00 (1.00, 3.00)	2.00 (1.00, 4.00)		
Operative Time			-	<0.001
Mean (SD)	102 (43)	113 (45)		
Median (IQR)	92 (74, 120)	105 (83, 135)		

¹n (%)

²OR = Odds Ratio, CI = Confidence Interval

³Hospital acquired conditions include foreign object retained after surgery, stage III and IV pressure ulcers, deep vein thrombosis (DVT) / pulmonary embolism (PE), catheter-associated urinary tract infection (UTI), vascular catheter-associated infection and iatrogenic pneumothorax with venous catheterization.

Table 3. Outcomes of Emergent Chole Patients by Modality in IPTW Data

	Lap, N = 26,785¹	Robotic, N = 3,158¹	OR (95% CI)²	p-value
Subtotal/Chole				0.037
Cholecystectomy	26,652 (99.5%)	3,132 (99.2%)	Ref.	
Subtotals	132 (0.5%)	25 (0.8%)	1.64 (1.03, 2.60)	
Conversion to Open				0.035
Not converted to open	26,285 (98.1%)	3,117 (98.7%)	Ref.	
Converted to open	500 (1.9%)	41 (1.3%)	0.68 (0.48, 0.97)	
Conversion to open or subchole				0.004
Non-converted	26,193 (97.8%)	3,094 (98.0%)	Ref.	
Converted to open	459 (1.7%)	38 (1.2%)	0.70 (0.49, 1.01)	
Converted to subtotal	92 (0.3%)	23 (0.7%)	2.12 (1.29, 3.48)	
Converted to open but do subtotal	41 (0.2%)	3 (0.1%)	0.52 (0.12, 2.28)	
Surgical Site Infection	34 (0.1%)	2 (0.1%)	0.52 (0.12, 2.27)	0.4
Blood Transfusion	156 (0.6%)	24 (0.8%)	1.32 (0.82, 2.12)	0.2
Readmission	1,043 (3.9%)	127 (4.0%)	1.03 (0.84, 1.27)	0.8
Hospital Acquired Conditions³	1,138 (4.2%)	122 (3.9%)	0.91 (0.74, 1.12)	0.4
Bile Duct Injury or Leak	18 (0.1%)	0 (0.0%)	-	-
Other postprocedural complications	191 (0.7%)	14 (0.4%)	0.62 (0.34, 1.13)	0.12
Pancreatic Leak/Fistula	89 (0.3%)	11 (0.4%)	1.08 (0.55, 2.12)	0.8
Mortality in Hospital	56 (0.2%)	9 (0.3%)	1.41 (0.64, 3.13)	0.4
Length of Stay			-	0.6
Mean (SD)	2.97 (2.96)	3.19 (3.44)		

	Lap, N = 26,785¹	Robotic, N = 3,158¹	OR (95% CI)²	p-value
Median (IQR)	2.00 (1.00, 3.00)	2.00 (1.00, 4.00)		
Operative Time			-	<0.001
Mean (SD)	101 (42)	115 (47)		
Median (IQR)	92 (74, 119)	106 (84, 135)		

¹n (%)

²OR = Odds Ratio, CI = Confidence Interval

³Hospital acquired conditions include foreign object retained after surgery, stage III and IV pressure ulcers, deep vein thrombosis (DVT) / pulmonary embolism (PE), catheter-associated urinary tract infection (UTI), vascular catheter-associated infection and iatrogenic pneumothorax with venous catheterization.

****Table 4. Results of Subgroup Analysis in Patients with Sepsis and Obstruction**

	Lap, N = 2,148 ¹	Robotic, N = 207 ¹	OR (95% CI) ²	p-value
Subtotal/Chole				0.070
Cholecystectomy	2,116 (98.5%)	200 (96.6%)	Ref.	
Subtotals	32 (1.5%)	7 (3.4%)	2.31 (0.93, 5.01)	
Conversion to Open				0.11
Not converted to open	2,048 (95.3%)	202 (97.6%)	Ref.	
Converted to open	100 (4.7%)	5 (2.4%)	0.51 (0.18, 1.14)	
Conversion to open or subchole				0.028
Non-converted	2,025 (94.3%)	195 (94.2%)	Ref.	
Converted to open	91 (4.2%)	5 (2.4%)	0.57 (0.20, 1.28)	
Converted to subtotal	23 (1.1%)	7 (3.4%)	3.16 (1.24, 7.10)	
Converted to open but do subtotal	9 (0.4%)	0 (0.0%)	-	
Surgical Site Infection	5 (0.2%)	0 (0.0%)	-	0.3
Blood Transfusion	23 (1.1%)	5 (2.4%)	2.29 (0.76, 5.62)	0.13
Readmission	123 (5.7%)	14 (6.8%)	1.19 (0.65, 2.05)	0.6
Hospital Acquired Conditions	190 (8.8%)	10 (4.8%)	0.52 (0.26, 0.95)	0.034
Bile Duct Injury or Leak	0 (0.0%)	0 (0.0%)	-	
Other postprocedural complications	47 (2.2%)	1 (0.5%)	0.22 (0.01, 1.00)	0.050
Pancreatic Leak/Fistula	5 (0.2%)	1 (0.5%)	2.08 (0.11, 13.0)	0.5
Mortality in Hospital	17 (0.8%)	3 (1.4%)	1.84 (0.43, 5.54)	0.4
Length of Stay			1.01 (0.99, 1.04)	0.3
Mean (SD)	4.7 (4.6)	5.0 (4.5)		
Median (IQR)	3.0 (2.0, 5.0)	4.0 (2.0, 6.0)		
Operative Time			-	<0.001
Mean (SD)	112 (48)	131 (53)		
Median (IQR)	103 (81, 134)	122 (96, 154)		

¹n (%)

²OR = Odds Ratio, CI = Confidence Interval

Supplementary Table 1. Procedure Codes to Define Cholecystectomy and Surgical Modality

Code Type	Code	Description	Procedure	Modality	Subtotal
CPT	47562	Laparoscopic cholecystectomy	Cholecystectomy	MIS	
CPT	47563	Laparoscopic cholecystectomy w/graph	Cholecystectomy	MIS	
CPT	47564	Laparoscopic cholecystectomy explor	Cholecystectomy	MIS	
CPT	47570	Laparoscopy, surgical; cholecystoenterostomy	Cholecystectomy	MIS	
CPT	47600	Cholecystectomy	Cholecystectomy	Open	
CPT	47605	Cholecystectomy; with cholangiography	Cholecystectomy	Open	
CPT	47610	Cholecystectomy with exploration of common duct	Cholecystectomy	Open	
CPT	47612	Cholecystectomy with exploration of common duct; withcholeodochoenterostomy	Cholecystectomy	Open	
CPT	47620	Cholecystectomy with exploration of common duct; with transduodenal sphincterotomy or sphincteroplasty, with or without cholangiography	Cholecystectomy	Open	
ICD10	0FB40ZZ	Excision of Gallbladder, Open Approach	Cholecystectomy	Open	Yes
ICD10	0FB43ZZ	Excision of Gallbladder, Percutaneous Approach	Cholecystectomy	MIS	Yes
ICD10	0FB44ZZ	Excision of Gallbladder, Percutaneous Endoscopic Approach	Cholecystectomy	MIS	Yes
ICD10	0FB48ZZ	Excision of Gallbladder, Via Natural or Artificial Opening Endoscopic	Cholecystectomy	Open	Yes
ICD10	0FT40ZZ	Resection of Gallbladder, Open Approach	Cholecystectomy	Open	
ICD10	0FT44ZZ	Resection of Gallbladder, Percutaneous Endoscopic Approach	Cholecystectomy	MIS	
ICD10	0FT90ZZ	Resection of Common Bile Duct, Open Approach	Cholecystectomy	Open	
ICD10	0FT94ZZ	Resection of Common Bile Duct, Percutaneous Endoscopic Approach	Cholecystectomy	MIS	
ICD10	0FT97ZZ	Resection of Common Bile Duct, Via Natural or Artificial Opening	Cholecystectomy	Open	
ICD10	0FT98ZZ	Resection of Common Bile Duct, Via Natural or Artificial Opening Endoscopic	Cholecystectomy	Open	

Supplemental Table 1. Raw data for Activity Based Cost Analysis with Adjustment for Consumer Price Index (CPI)

Metric	Cost Input (and Year)	Initial CPI	Final CPI	Resulting/Used Value	Source
Length of stay	\$3,123 (2019)	203.4 (June 2019)	221.8 (March 2022)	\$3,405	Premier 2019 data, Intuitive data on file
ICU Length of stay	\$5,717 (2019)	203.4 (June 2019)	221.8 (March 2022)	\$6,234	Premier, 2019 data, Intuitive data on file
Blood transfusion	\$1,183 (2010)	173 (June 2010)	221.8 (March 2022)	\$1,517	Shander, 2010
Conversion	\$4,012 (2015)	189.1 (June 2015)	221.8 (March 2022)	\$4,706	Shah, 2022
30-Day Readmissions	\$12,328	194.5 (June 2017)	221.8 (March 2022)	\$14,059	AHRQ/HCUP, 2017 data
OR Time	\$27 (2019)	203.4 (June 2019)	221.8 (March 2022)	\$29	Premier, 2019 data, Intuitive data on file
Surgical Site Infection (SSI)	\$28,220 (2016)	191.2 (June 2016)	221.8 (March 2022)	\$32,736	Forrester, 2022

STROBE Statement—Checklist of items that should be included in reports of **case-control studies**

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(a) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	2
		(b) For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2-3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2
Bias	9	Describe any efforts to address potential sources of bias	2-3
Study size	10	Explain how the study size was arrived at	2-3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-3
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	3
		(b) Describe any methods used to examine subgroups and interactions	3
		(c) Explain how missing data were addressed	2
		(d) If applicable, explain how matching of cases and controls was addressed	N/A

(e) Describe any sensitivity analyses			N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3-4
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	3-4, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	3-4, Table 1,
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	3-4, Table 3
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	3-4
Discussion			
Key results	18	Summarise key results with reference to study objectives	5-7
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	5-7
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title Page

*Give information separately for cases and controls.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

ACCEPTED

CONFLICT OF INTEREST DISCLOSURE FORM

Based on ICMJE Form

Date:	9/17/23
Your Name:	Shannon Greenberg, MD
Manuscript Title:	ROBOtic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology
Manuscript Number (if known):	Click or tap here to enter text.

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Participants of an accredited activity must disclose all personal financial and non-financial relationships, over the previous 36 months with an ineligible company (formerly defined as a commercial interest). Financial relationships are those relationships in which the individual benefits by receiving a salary, royalty, consulting fee, honoraria, ownership interest (e.g., stocks, stock options or other ownership interest), or other financial benefits, and may affect activity content relevant to products or services of an ineligible company, defined as an entity whose primary business is producing, marketing, selling, re-selling, or distributing healthcare products used by or on patients.

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According to federal regulations approved by the US Senate, any amount equal to or above \$10 USD must be disclosed. Although disclosure of the total amount is not required on this form. Authors are encouraged to search the CMS Open Payments Database found at <https://openpaymentsdata.cms.gov> and report on the JTACS Conflict of Interest Disclosure form ALL COI, and any other conflicts related or unrelated to the manuscript being submitted to the Journal for the last 36 months/3 years.

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Name all entities with whom you have this relationship or indicate none (add rows as needed)	Specifications/Comments (e.g., if payments were made to you or to your institution)
Time frame: Since the initial planning of the work	

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1	All support for the present manuscript (e.g., funding, provision of study materials, medical writing, article processing charges, etc.) No time limit for this item.	x None Click the tab key to add additional rows.	
Time frame: past 36 months			
2	Grants or contracts from any entity (if not indicated in item #1 above).	x None	
3	Royalties or licenses	x None	
4	Consulting fees	x None	
5	Payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events	x None	
6	Payment for expert testimony	x None	

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7	Support for attending meetings and/or travel	x None	
8	Patents planned, issued or pending	x None	
9	Participation on a Data Safety Monitoring Board or Advisory Board	x None	
10	Leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid	x None	
11	Stock or stock options	x None	
12	Receipt of equipment, materials, drugs, medical writing, gifts or other services	x None	
13	Other financial or non-financial interests	x None	

		Name all entities with whom you have this relationship or indicate none (add rows as needed)	Specifications/Comments (e.g., if payments were made to you or to your institution)
14	Family Disclosure. Disclose any financial associations involving a spouse, partner, or children	x None	
Please place an "X" next to the following statement to indicate your agreement: x I certify that I have answered every question and have not altered the wording of any of the questions on this form.			

CONFLICT OF INTEREST DISCLOSURE FORM

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Your Name: CHRISTOPHER C. NEIGHORN

Manuscript Title: ROBOTic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology

Manuscript Number (if known): [Click or tap here to enter text.](#)

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Time frame: Since the initial planning of the work		
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Time frame: past 36 months									
2	Grants or contracts from any entity (if not indicated in item #1 above).	☒ None <table border="1"> <tr><td>N/A</td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </table>	N/A						
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3	Royalties or licenses	☒ None <table border="1"> <tr><td>N/A</td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </table>	N/A						
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4	Consulting fees	☒ None <table border="1"> <tr><td>N/A</td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </table>	N/A						
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8	Patents planned, issued or pending	☒ None N/A
9	Participation on a Data Safety Monitoring Board or Advisory Board	☒ None N/A
10	Leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid	☒ None N/A
11	Stock or stock options	☒ None N/A
12	Receipt of equipment, materials, drugs, medical writing, gifts or other services	☒ None
13	Other financial or non-financial interests	☒ None N/A
14	Family Disclosure. Disclose any financial associations involving a spouse, partner, or children	☒ None N/A
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CONFLICT OF INTEREST DISCLOSURE FORM

Based on ICMJE Form

Date: 9/18/2023

Your Name: Esther Wu MD

Manuscript Title: ROBOtic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology

Manuscript Number (if known): [\[click or tap here to enter text\]](#)

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9	Participation on a Data Safety Monitoring Board or Advisory Board	☒ None <table border="1"> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </table>					
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Date: 9/16/2023

Your Name: Kaushik Mukherjee MD

Manuscript Title: [ROBOtic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology |

Manuscript Number (if known): [Click or tap here to enter text.](#)

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Time frame: Since the initial planning of the work			
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Based on ICMJE Form

Date: 9/18/2023

Your Name: Marc Abou Assali MD

Manuscript Title: ROBOTic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology

Manuscript Number (if known): [Click or tap here to enter text.](#)

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CONFLICT OF INTEREST DISCLOSURE FORM

Based on ICMJE Form

Date: 9/16/2023

Your Name: Yanli Li

Manuscript Title: ROBOTic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology

Manuscript Number (if known): [Click or tap here to enter text.](#)

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Time frame: Since the initial planning of the work		
1	☐ None Intuitive Surgical	Employee and stock holder of Intuitive Surgical Click the tab key to add additional rows.

	Name all entities with whom you have this relationship or indicate none (add rows as needed)	Specifications/Comments (e.g., if payments were made to you or to your institution)								
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		Intuitive Surgical	Stock holder of Intuitive Surgical
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CONFLICT OF INTEREST DISCLOSURE FORM

Based on ICMJE Form

Date: 9/16/2023

Your Name: [Hannah Bossie]

Manuscript Title: [ROBOTic Care Outcomes Project (ROBOCOP) for Acute Gallbladder Pathology]

Manuscript Number (if known): [Click or tap here to enter text.]

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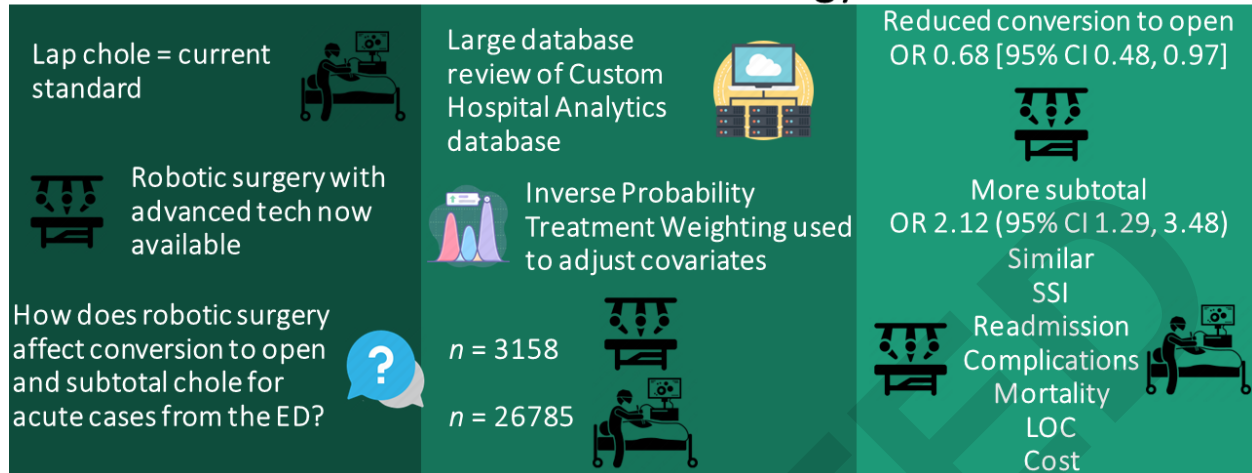
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