

An Unencumbered Acute Care Surgeon Improves Delivery of Emergent Surgical Care for Cholecystectomy Patients

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ABSTRACT

Introduction: Many patients utilize the Emergency Room (ER) for primary care, resulting in overburdened ERs, strained resources, and delays in care. To combat this, many centers have adopted a Trauma/Acute Care Surgery (TACS) service providing specialty surgeons whose primary work is the unencumbered surgical availability to emergency surgery patients. To evaluate our programs' efficacy, we investigated cholecystectomies as a common urgent procedure representative of services provided. We hypothesized that the adoption of a TACS service would result in improved access to care as evidence by decreased ER visits prior to cholecystectomy, improved time to cholecystectomy, and decreased hospital length of stay (LOS).

Methods: All patients that underwent urgent cholecystectomy from January 1, 2018 to December 31, 2018 were reviewed. The unencumbered TACS surgeon was implemented on July 1, 2018. Prior ER visits involving biliary symptoms, time from admission to cholecystectomy, and hospital LOS were compared.

Results: Of the 322 urgent cholecystectomies over the study period, 165 were performed prior and 157 following adoption of the TACS structure. The average number of ER visits for biliary symptoms prior to cholecystectomy decreased from 1.4 to 1.2 ($p=0.01$). Time from admission to cholecystectomy was 28.3 hours and 27.3 hours respectively ($p=0.74$). Average LOS decreased following the restructure (3.1 vs 2.5 days; $p=0.03$).

Conclusion: Implementation of an unencumbered TACS surgeon managing urgent surgical disease improves access to and delivery of surgical services for cholecystectomy patients in a safety net, level one trauma center. Further research is necessary to determine potential improvements in hospital cost and patient satisfaction.

Key Words: Acute care surgery, Cholecystectomy, Cholecystitis, Emergency surgery, General surgery.

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INTRODUCTION

Access to emergency medical care is a well-known barrier for patients in the United States.¹ In 2006, the Institute of Medicine cited a national crisis in emergency care, emphasizing the lack of emergency general surgery (EGS) services as a significant contributor to this crisis.² Approximately 4 million patients present to the emergency room (ER) requiring EGS evaluation, with 2 million requiring hospital admission annually.^{2,3} This results in overburdened ERs with long patient wait times, evaluation delays by consultation services, prolonged wait times for surgical intervention, and poor outcomes in this patient population.⁴⁻⁶ Admission to busy surgical services can result in a several day's wait for available operative time.⁵ In 2010, 37% of ERs reported being unequipped to provide adequate care for this patient population⁷ and with more than 80% of general surgery residents seeking specialty fellowships, there are fewer general surgeons prepared to treat the growing EGS population.⁵ In 2005,

The Committee to Develop the Reorganized Specialty of Trauma, Surgical Critical Care, and Emergency Surgery proposed a restructuring of previous EGS services under a new Acute Care Service (ACS) model. The intent was to address the upcoming shortage of general surgeons for a growing EGS population.^{8,9} This model combines the specialties of trauma, surgical critical care, and emergency general surgery into a single service prioritizing comprehensive care to urgent inpatient needs.

Most studies exploring the effects of different ACS models have focused on appendicitis as a surrogate marker of efficacy in tertiary care institutions. ACS models have been shown to result in hospital cost savings, decreased overnight resource utilization, improved patient outcomes by decreasing hospital length of stay (LOS) and complication rates, and increase elective service productivity.^{10–14} Few studies have explored the impact on patients with cholecystitis, which, unlike appendicitis does not require urgent definitive surgery.¹⁵ Recent studies have shown that early surgical intervention for acute cholecystitis is safe, effective, and cost efficient during the initial admission.^{16–18} In 2018, Denver Health, a busy, urban Level I Trauma Center, implemented a defined ACS service named the Trauma and Acute Care Surgery (TACS) Service. Denver Health Medical Center is an ACS verified Level I Trauma Center and the primary safety net hospital for Colorado, maintaining robust elective general and subspecialty surgery services while balancing over 2,700 trauma admissions annually. In 2017, a total of eight trauma surgeons managed the entire general surgery service in a hospital performing over 3,000 inpatient and 7,820 outpatient elective surgeries. We hypothesized that implementation of the TACS Service would result in improved efficiency of care for our admitted cholecystectomy patients, as evidenced by decreased number of ER visits for biliary related issues prior to cholecystectomy, decreased time from admission to cholecystectomy, and decreased hospital LOS.

METHODS

Prior to the implementation of the TACS Service the trauma surgeons rotated in-house call for the care of trauma and EGS patients that presented to the emergency department. The on-call surgeon balanced new ER admissions and consultations, trauma activations, elective and urgent operations, general surgery clinic, and administrative responsibilities. Following a 24 hour on-call period, the newly admitted trauma and EGS patients would be added to the individual surgeon's inpatient hospital service for management through discharge.

On July 1, 2018, the TACS Service paradigm was created to coalesce the high-volume trauma and EGS patients into a single service. The on-call surgeon responsible for managing this TACS service is unencumbered from all elective cases and clinic requirements during the week of TACS coverage. Responsibilities include the management of all patients admitted to the TACS service prior to assuming control of the service for the week, in addition to all new trauma and EGS admissions during that week. Additionally, daily dedicated operating room block time was reserved for use by the TACS service. The goal was to create favorable conditions to allow an otherwise unencumbered surgeon the ability to provide timely surgical treatment to patients presenting to the ER.

Data Collection

Following institutional review board approval, medical records for all patients undergoing inpatient cholecystectomy from January 1, 2018 through December 31, 2018 at Denver Health Medical Center were reviewed. Elective outpatient cholecystectomies and cholecystectomies performed as part of another procedure were excluded. Demographic information including age, sex, race, ethnicity, body mass index, any prior abdominal surgeries were collected. Clinical presentation information collected included admission labs: highest white blood cell count (WBC), alkaline phosphatase (ALK), and total bilirubin (T Bili), and positive findings on admission imaging as described by clinical radiologist including presence of pericholecystic fluid, a thickened gallbladder wall, distended gallbladder, presence of gallbladder stones, and common bile duct diameter. Primary outcomes included time from ER to operating room (OR) for cholecystectomy, hospital LOS, and number of ER presentations for biliary symptoms at our institutions prior to definitive treatment. Other secondary outcomes included operative time, intraoperative findings, additional interventions required, final pathologic diagnosis, and postoperative complications up to 30 days. Postoperative complications included those identified at the index hospitalization for the cholecystectomy, as well as those identified during routine two week follow up in clinic, and any ER presentations/admissions related to the cholecystectomy procedure.

Statistical Analysis

Data was abstracted from the medical records and recorded in a Microsoft Excel database (Microsoft, Seattle, WA). The group was divided based on the implementation date for the TACS Service. The cohort admitted from

Table 1.
Patient Demographics

	Pre-TACS* (N = 165)	Post-TACS (N = 157)	P-Value
Ethnicity (Hispanic)	127 (77.0%)	115 (73.3%)	0.44
Race (White)	126 (76.4%)	109 (69.4%)	0.27
Sex (Female)	133 (80.6%)	114 (72.6%)	0.08
Uninsured/Emergency Department Insurance only	51 (15.8%)	31 (9.6%)	.02
Body Mass Index	30.7 [29.8, 31.8]	30.1 [29.0, 31.3]	0.40
Age (years)	40.6 [38.4, 42.8]	42.0 [39.5, 44.5]	0.41
Prior Abdominal Surgeries	58 (35.2%)	55 (35.03%)	0.98

*Data are presented as median (interquartile range) or n (%) as appropriate.
Abbreviation: TACS, Trauma/Acute Care Surgery.

January 1, 2018 through June 30, 2018 comprised the Pre-TACS cohort. Those admitted from July 1, 2018 through December 31, 2018 comprised the Post-TACS cohort. Statistical analyses were performed using SAS Enterprise Guide 70.1 (SAS Institute, Inc. Cary, NC). Univariate analyses between the two cohorts was performed using Students T Test for parametric continuous variables and Wilcoxon Rank Sum Test for nonparametric continuous variables (assessed using Kolmogorov-Smirnov Test for normality). χ^2 Test or Fisher's Exact Test was used to compare categorical variables. All tests were performed two-sided and with a p-value of 0.05 to indicate significance.

RESULTS

Demographics and Presentation

In the one-year study period, 406 cholecystectomies were performed. Of those, 84 were performed as an elective outpatient procedure or part of a separate procedure and were excluded from analysis. A total of 322 cholecystectomies remained for analysis. 165 (51.2%) were performed Pre-TACS and 157 (48.8%) performed Post-TACS. Baseline patient demographics were similar between the Pre-TACS and Post-TACS and are presented in **Table 1**. Rates of insurance differed between groups, with significantly more uninsured or Emergency Department Medicaid Only patients being treated prior to the TACS change ($P = .02$). Further insurance breakdown of each cohort is shown in **Table 2**. Disease severity upon presentation was similar between the two groups. The clinical presentation of each cohort is summarized in **Table 3**. There were no significant differences in the highest serum alkaline phosphatase and total bilirubin levels at presentation. The mean admission WBC was 11.6 in the Pre-TACS cohort and 10.6 in

the post-TACS cohort ($p = .02$). All but four patients underwent diagnostic imaging at Denver Health, with 97% percent undergoing ultrasound (US) as the main diagnostic modality (1.5% underwent abdominal computed tomography (CT) only and 2.7% underwent both US and CT).

Primary Outcome

While the Post-TACS cohort showed a slightly shorter time to surgery, this difference was neither statistically nor clinically significant (**Table 4**). The hospital LOS was shorter in the Post-TACS group (2.5 median days compared to 3.1 days, $p = .02$). Fifty-eight (18%) patients had more than one presentation to our ER for biliary complaints prior to cholecystectomy, with 37 patients (22.4%) in the Pre-TACS cohort with a median number of 1.4 ER visits compared to 21 patients (13.4%) in the Post-TACS

Table 2.
Insurance Breakdown by Group

	Pre-TACS (N = 165)	Post-TACS (N = 157)
Colorado Indigent Care	2 (1.21%)	7 (4.46%)
Denver Health Financial	19 (11.52%)	19 (12.10%)
Private/Employer	15 (9.09%)	21 (13.38%)
Medicaid	69 (41.82%)	65 (41.40%)
Medicare	9 (5.45%)	13 (8.25%)
None	15 (9.09%)	18 (11.46%)
Emergency Department Medicaid only	36 (21.82%)	14 (8.92%)

Abbreviation: TACS, Trauma/Acute Care Surgery.

Table 3.
Clinical Presentation by Cohort

	Pre-TACS* (N = 165)	Post-TACS (N = 157)	P-Value
Highest WBC (cells/L)	11.6 (3.90)	10.6 (3.92)	0.019
Highest Alkaline phosphatase (IU/L)	99 [78, 137]	92 [75, 133]	0.24
Highest T Bili (mg/dL)	0.6 [0.4, 1.3]	0.6 [0.4, 1.2]	0.97
Presence of Pericholecystic Fluid	11 (6.67%)	7 (4.46%)	0.58
Common Bile Duct Diameter (mm)	5.18 (2.31)	5.03 (2.53)	0.65
Thickened Gallbladder Wall	56 (33.94%)	32 (20.38%)	<0.0001
Distended Gallbladder	17 (10.3%)	17 (10.8%)	0.70

*Data are presented as n (%) for categorical variables; continuous variables are presented as mean (standard deviation) or median (interquartile range) as appropriate.

Abbreviation: TACS, Trauma/Acute Care Surgery.

cohort with a median number of 1.2 ER visits ($P = .01$). Twelve patients visited the ER three or more times for biliary complaints prior to surgical intervention, and 10 of these 12 patients (83%) were in the pre-TACS cohort, while two patients (17%) visited the ER three or more times following the TACS implementation ($P = .04$).

Secondary Outcomes

There were no statistical differences in the secondary outcomes between the cohorts, shown in **Table 4**. Most patients underwent laparoscopic (93%) total (95%) cholecystectomy, with very few requiring primary open, or conversion to open, surgery (11 Pre-TACS and 10 Post-TACS, $P = .91$) or subtotal cholecystectomies (seven Pre-TACS and five Post-TACS, $P = .92$). The Pre-TACS group trended toward a higher percentage of additional operative procedures during the cholecystectomy. The most common additional procedures included lysis of adhesions (four patients in each cohort) and hernia repair (six Pre-TACS and two Post-TACS). A similar number of patients underwent endoscopic retrograde cholangiopancreatography procedures within each cohort (23 Pre-TACS compared to 18 Post-TACS, $P = .51$). The postoperative complication rate trended lower Post-TACS ($P = 0.1$) and the Pre-TACS group had a variety of complications experienced (**Table 5**). The median cost per index admission when the cholecystectomy procedure occurred for the Post-TACS group trended lower; however, the difference was not significant. The total costs for all cholecystitis related care, including the cost of previous ER visits and postoperative care visits, was unable to be calculated.

DISCUSSION

Many institutions are transitioning from an EGS service composed of elective general surgeons to specialized ACS services combining the specialties of trauma, surgical critical care, and emergency general surgery. Academic and urban institutions are more likely to transition to the ACS model, as these institutions tend to have more patients and a larger workforce (including residents) to fuel a 24/7 ACS service. They also have a well-balanced payor mix to insure appropriate contribution margin for these ACS services.¹⁹ While ACS service implementation has been shown to improve the lag time to operation, decrease LOS, and improve complication rates, the effects on hospital finances and cost effectiveness are less clear.^{5,20–22} For trauma centers and safety net institutions with heavily unfunded populations, maintenance of trauma services, elective services, and EGS services may be a strain on financial resources.²³ For our institution, this led to the creation of the hybrid TACS Service. The ability to prioritize trauma patients, while providing efficient and high-quality healthcare for the underserved population of City and County of Denver is the cornerstone of our institution's mission. Our institution's experience in creating a TACS service produced similar outcomes to other reports, namely improved LOS for cholecystectomy patients, a trend toward reduced complication rates for cholecystectomy patients, and decreased ER visits prior to definitive surgical care. All of these lead to potential cost reduction for the management of urgent biliary disease. A recent meta-analysis reported an average decrease in LOS by 00.5 days for biliary and appendiceal disease following implementation of an ACS paradigm.²² In a nontrauma institutional setting, studies have reported a decrease of

Table 4.
Primary and Secondary Outcomes

	Pre-TACS* (N = 165)	Post-TACS (N = 157)	P-Value
# of related ER Visits Prior to Intervention	1.4 [1.2, 1.5]	1.2 [1.0, 1.2]	0.01
# of Patients with 3 or more ER visits	10 (6.1%)	2 (1.3%)	0.04
Total Days from 1 st Surgical consult to Intervention	1 [0, 3]	1 [0, 2]	0.22
Hours from Admission to Surgery	28.3 [24.3, 32.2]	27.3 [23.2, 31.5]	0.74
Scheduled Open Cholecystectomy	3 (1.8%)	1 (0.6%)	0.34
Conversion to Open Cholecystectomy	8 (4.8%)	9 (5.7%)	0.74
Laparoscopic Cholecystectomy	154 (93.3%)	147 (93.6%)	0.91
Total Cholecystectomy	158 (95.7%)	150 (95.5%)	0.92
Subtotal Cholecystectomy	7 (4.2%)	7 (4.5%)	0.92
Additional Surgical Procedures	24 (14.5%)	13 (8.28%)	0.07
Total Length of Procedure	99.5 [93.2 – 105.8]	95.0 [88.5 – 101.5]	0.3
Required ERCP during Admission	23 (13.9%)	18 (11.5%)	0.51
Pre-operative ERCP	10	8	
Post-operative ERCP	11	10	
Pre and Post-operative ERCP	2	0	
Acute on Chronic Disease	97 (60.2%)	78 (51.7%)	0.3
Length of Stay	3.1 [2.7, 3.6]	2.5 [2, 2.8]	0.02
30 Day Complication Rate	19 (11.5%)	10 (6.4%)	0.10
Cost per Admission	\$27, 927 [\$19,027, \$30,494]	\$26, 187 [\$17,967, \$29,313]	0.14

*Data are presented as n (%) for categorical variables; continuous variables are presented as mean (standard deviation) or median (interquartile range) as appropriate.

Abbreviations: TACS, Trauma/Acute Care Surgery; ERCP, endoscopic retrograde cholangiopancreatography.

cholecystectomy LOS from 5 – 6 days to 2 – 3 days after implementation of ACS services.²¹ Our result of an improved LOS by 00.6 days is in line with the reported literature and reflects the efficiency that the ACS model can add to an already efficient trauma service.

The ability to not only expediently treat and discharge cholecystectomy patients during their admission, but also to perform definitive treatment at the first ER visit is paramount to not only preventing overburdened ERs,²⁴ but also allows for cost-efficient management of “unfavorable” payer groups for safety net, cash poor hospitals. Following our TACS implementation we identified a decrease in the number of patients who had multiple ER visits for cholecystitis complaints from 22.4% to 13.4%. Of the 58 patients who had multiple ER visits prior to cholecystectomy, 86% of these patients had government insurance or no insurance. Additionally, of the 12 patients who presented to our ER three or more times prior to surgery, all were either uninsured, or insured by Medicaid or ED

Medicaid. While this repeat ER group is small, it represents a significant financial burden on safety net hospitals and the reduction in cholecystitis related ER visits provides an additional cost-saving advantage when transitioning to an ACS model.

While implementation of our TACS service was not associated with a decrease in time to surgical intervention, the total LOS was significantly reduced. This suggests that the efficiency of our TACS service on treating cholecystectomy patients is reflected in our postoperative care, leading to earlier discharges following surgical intervention. The ability to expediently discharge patients resulting in shorter LOS should result in lower hospital costs. Even though the trend toward lower costs per surgical admission was not statistically significant between the cohorts, a difference of \$1,500 per cholecystectomy admission could amount to significant cost savings for safety net hospitals. For a busy safety net institution like Denver Health, with over 300 inpatient cholecystectomies per year, this could

Table 5.
Surgical Complications by Cohort

	Pre-TACS (N = 19)	Post-TACS (N = 10)
Abscess	1 (5.56%)	1 (10%)
Bile Leak	2 (11.11%)	0
Bowel Perforation	1 (5.56%)	0
Emergency Department readmission for Abdominal Pain	5 (27.78%)	6 (60%)
Post-operative AKI	1 (5.56%)	0
Post-operative Pancreatitis	1 (5.56%)	0
Post-operative Bleeding Hematoma	2 (11.11%)	0
Readmission for ERCP	2 (11.11%)	3 (30%)
Surgical Site Infection	1 (5.56%)	0
Stroke Alert	1 (5.56%)	0
Post-operative Sepsis	1 (5.56%)	0

Abbreviations: TACS, Trauma/Acute Care Surgery; ERCP, Endoscopic retrograde cholangiopancreatography; AKI, acute kidney injury.

amount to half a million dollars in decreased patient care costs for this population alone.

This study is retrospective and limited to medical record review from a single institution. Complications were broadly defined prior to medical record review; however, given the nature of retrospective reviews a risk of missing complications for patients exists. Additionally, the study team was limited to capture patients readmitted to the study hospital, which may have resulted in higher ER presentation rates, complication rates, and cholecystectomies than documented. Admission costs were used as a surrogate for hospital reimbursement and may not accurately reflect profit collections. Additionally, number of ER visit prior to cholecystectomy was used to represent the number of patients who were not offered cholecystectomy at their first ER visit; this number does not capture patients who presented to the ER for cholecystitis and ultimately did not receive a cholecystectomy, which would be another valuable marker for cholecystectomy efficiency of an EGS service.

Lastly, evaluating cholecystectomy efficiency and outcomes by our TACS service is a single, isolated marker of how the ACS model has affected EGS care in our institution. This study is not intended to report the impact of an ACS model transition on the entire general surgery service. While private university-based institutions with larger

workforces tend to have separate divisions of elective surgeons from EGS surgeons, EGS from Trauma services, and critical care teams from other inpatient management services,^{9,13} safety net hospitals such as Denver Health may not have such division of workflow. At our institution, the TACS service, elective procedures, and critical care management are all performed by the same group of surgeons. When evaluating the benefits of an ACS transition in smaller workforce hospitals such as ours, future studies should focus on the change to the elective caseload of surgeons who share the ACS/Trauma duties. The effect of the TACS service on each surgeon's post-call elective caseload compared to previous elective caseloads was outside the scope of the study but is an important factors in evaluating productivity. Additionally, in institutions with resident services, service disparity between ACS services and elective surgery-based services should be explored with respect to resident experience and satisfaction.

The next steps in evaluating the benefits and sustainability of our TACS model is to prospectively compare changes across the entire department of general surgery focusing on all EGS patients, surgeon satisfaction, resident and midlevel satisfaction, elective case load changes, and financial impact.

CONCLUSIONS

Safety net trauma hospitals can effectively create an ACS service that incorporates a well-developed, mature trauma model that also maintains a robust EGS service. Under this model emergent cholecystectomy patients benefit from improvements in operative wait time, length of stay, and cost. Institutions should continue to research reimbursement changes that occur with an ACS model that maximizes care for their underserved populations relying on ED Medicaid Only or self-pay.

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