Weekend vs. Weekday Admissions for Cholangitis Requiring an ERCP: Comparison of Outcomes in a National Cohort

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OBJECTIVES: **There has been increasing medical literature showing worse outcomes in patients admitted for medical and surgical conditions on the weekend. This has been termed the weekend effect. Little is known whether this weekend effect occurs for patients with cholangitis who require endoscopic retrograde cholangiopancreatography (ERCP), a procedure that requires many resources from the nursing staff, anesthesia, and the endoscopist.**

METHODS: **Retrospective analysis from the National Inpatient Sample (NIS) database from 2009 through 2012. Patient data were abstracted from the database for patients admitted on the weekend and weekday with cholangitis who underwent ERCP. Time to ERCP, length of stay, total cost, and mortality were compared in patients admitted with cholangitis on the weekend vs. weekday who required ERCP. ERCP adverse events were recorded from the weekend vs. weekday as well.**

RESULTS: **Twenty-three thousand six-hundred sixty-one patients were identified in the NIS database who were admitted for cholangitis who required ERCP in the study period, of which 18,106 (76.5%) patients were admitted on the weekday, whereas 5,555 (23.5%) were admitted on the weekend. By 24 h, the weekday group had undergone ERCP more frequently than the weekend group (54.6 vs. 43%; *P*<0.001). By 48 h, the weekday group had undergone ERCP more frequently than the weekend group (70 vs. 65.4%; *P*<0.001). By 72 h, both groups had undergone a similar rate of ERCP (79.7 vs. 78.9%; *P*=0.17). There was no statistical difference between the groups for in-hospital all-cause mortality (2.86 vs. 2.56%; *P*=0.24), length of stay (6.97 days vs. 6.88 days; *P*=0.28), or total cost of hospitalization ($71,552 vs $71,469; *P*=0.94).**

CONCLUSIONS: **Despite a delay in regard to time to ERCP for weekend admissions, there was no weekend effect observed in regard to length of stay, mortality, or total cost of hospitalization. Although biliary drainage with ERCP is important, these results suggest that other factors in the management of cholangitis (e.g., antibiotics and intravenous fluids) contribute to outcomes.**

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INTRODUCTION

There has been an increasing amount of medical literature showing worse outcomes in patients admitted for medical and surgical conditions on the weekend. This has been coined the weekend effect (1). The weekend effect was first shown in patients admitted with myocardial infraction (2). Since that study, many other studies across various disciplines have shown the same weekend effect, including patients admitted with a cerebrovascular accident, renal failure, pulmonary embolism, and atrial fibrillation (3–6). In addition, a large study looked at 351 million patients discharged from United States hospitals included from the National Inpatient Sample (NIS) and found that weekend admissions were more likely to develop non-reimbursable hospital-acquired conditions, also known as "never events" (7).

The weekend effect has also been shown in gastrointestinal (GI) disorders as well. There is literature showing that this effect occurs

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in patients admitted with inflammatory bowel disease requiring urgent surgery and in patients admitted with gastrointestinal hemorrhage (8,9). Both studies utilized the NIS to include a large sample of patients. Finally, Worni *et al* used the NIS to show that patients undergoing urgent surgery for left-sided diverticulitis on the weekend have worse outcomes than those admitted on the weekday (10).

It is unclear whether the same weekend effect could occur with patients admitted with cholangitis who require endoscopic retrograde cholangiopancreatography (ERCP), as the literature is sparse. There is one single-center study of 123 patients that showed a decreased length of stay for ERCP performed on the weekend vs. the first working day of the week (11). This study did not discriminate on the basis of cholangitis.

Patients admitted on the weekend requiring ERCP for biliary disorders often have their ERCP delayed till the weekday. This occurs as staffing for ERCP generally requires an endoscopist trained in ERCP, a technician familiar with ERCP equipment, a nurse familiar with ERCP, and an interventional endoscopy room equipped with fluoroscopy. Procedures without this staff can make a technically difficult procedure even more challenging. However, patients admitted with moderate or severe cholangitis often require urgent ERCP after stabilization with intravenous fluids and antibiotics (12). It is unclear whether these patients admitted on the weekend have these procedures delayed vs. weekday admissions.

The aim of this study was to compare outcomes of patients admitted on the weekend with cholangitis who underwent ERCP vs. patients admitted on a weekday. Outcomes measured were time to ERCP from admission, length of stay, total cost of hospitalization, all-cause in-hospital mortality, and adverse events of ERCP grouped by weekend vs. weekday admission.

METHODS

The data source for the study was the NIS database from 2009 to 2012. This is the largest all-payer, publicly available inpatient database in the United States developed for Healthcare Cost and Utilization Project (HCUP) and maintained by the Agency for Healthcare Research and Quality (AHRQ). The database consists of a 20% sample of all nonfederal US hospital discharges in all 50 states; unweighted, it contains data from more than 7 million hospital stays each year, whereas weighted it estimates more than 36 million hospitalizations nationally. Each hospitalization includes nearly 100 patient and hospital-related variables and is coded with one primary diagnosis upon discharge, up to 24 secondary diagnoses and 15 procedures associated with the hospitalization using International Classification of Diseases, ninth edition, clinical modification (ICD-9-CM) disease codes. HCUP quality control procedures on principal diagnosis and dates of hospitalization are routinely performed to confirm that data values are valid, consistent, and reliable (13). The NIS correlates well with other hospitalization databases such as National Hospital Discharge Survey (14) and has been extensively used for research including research for ERCP (15–18).

Study population

The study population was selected based on diagnostic and procedural coding in accordance with the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Patients above the age of 18 years in the NIS database (2009–2012) who were admitted with cholangitis and underwent ERCP were included in the study. We only included the cholangitis patients who underwent ERCP, as these are the moderate-to-severe cases of cholangitis that require biliary drainage.

To identify patients in the NIS database, we first chose patients admitted with cholangitis using diagnosis code 576.1 (primary diagnosis of cholangitis or sepsis with secondary diagnosis of cholangitis), narrowed it down to patients who underwent ERCP (procedure code: 51.10, 51.11, 52.13, 52.14, 51.84, 51.85, 51.88, 52.93), and according to our previous study (18), eliminated patients who underwent percutaneous biliary drainage (PTBD), and then separated them into patients admitted over the weekend and weekdays. We excluded the PTBD group as the usual standard of care for cholangitis is ERCP (19,20). A large percentage of patients who undergo PTBD have had an unsuccessful ERCP or anatomy not amenable to standard ERCP (e.g., surgically altered anatomy) (21). We did not want to bias the results by including this group as there are inherent delays to procedure in these patients due to their complexity. The sampling design used for the study is shown in **Figure 1**.

Outcome and predictor variables

The primary outcome measures were (a) time to ERCP from admission (<24,<48, <72 h), (b) length of stay, (c) total cost of hospitalization, and (d) in-hospital mortality. As the study spanned over 4 years (2009–2012), the total cost of hospitalization was adjusted for economy-wide inflation to 2012 dollars. Our primary exposure variable was admission on weekends vs. admission on weekdays. Each hospitalization in the NIS database is designated by a distinct variable as a weekday (Monday–Friday) or weekend (Saturday–Sunday) hospitalization based on the date of admission. Admission on weekend and weekday was defined using this variable. The NIS database does not allow identification of specific admission days. The covariates included in the study were age, gender, race, type of health insurance, admission status, hospital characteristics, admission to intensive care unit, and sepsis. The adverse events of ERCP (ERCP-associated hemorrhage, post ERCP pancreatitis, perforation, and cholecystitis) based on weekday or weekend admission were evaluated per previous methodology by our group (18).

The Elixhauser comorbidity index (22,23) was utilized to identify and adjust for comorbidities in the study. The Elixhauser comorbidity index is a list of 30 comorbidities, a well-validated algorithm for predicting in-hospital mortality caused by a variety of conditions (categorized as 0, 1, 2, and ≥3 comorbidities) (24). We used the Comorbidity Software created by HCUP for the creation and analysis of these comorbidities.

Statistical analyses

Patient characteristics and hospital characteristics among patients admitted over the weekend for cholangitis were compared using

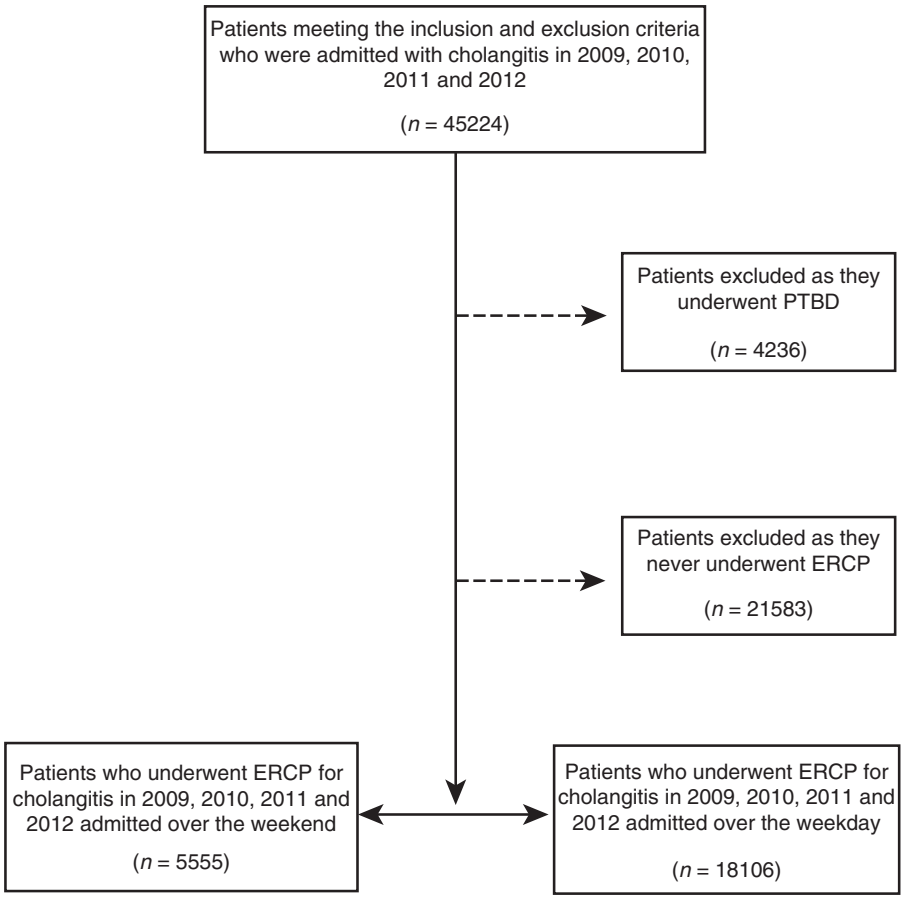

Figure 1. Diagram of the study population showing sampling scheme for the patients admitted with cholangitis who underwent endoscopic retrograde cholangiopancreatography (ERCP).

the χ^2-test for categorical variables and student's *t*-test for continuous variables. Univariate and bivariate analyses were performed to assess adverse events and inpatient mortality among patients who underwent ERCP and were admitted with cholangitis over the weekend and weekday. A *P*-value of less than 0.05 was considered statistically significant. Data analysis was performed using SAS 9.2 (SAS Institute, Cary, NC).

In order to examine the association between in-hospital mortality and weekend vs. weekday admission, multiple logistic regression models were used to account for the potential confounding effects of patient demographics, health insurance, comorbidity, hospital characteristics teaching hospital status, intensive care unit admission, and the presence of sepsis. A generalized linear model (proc GLM) was used to estimate and compare the length of stay and total in-hospital cost between patients admitted over the weekend and weekdays. Multiple linear regression analyses were utilized to control for confounders as stated above. Because of the skewed nature of length of stay and total in-hospital cost, these were compared after natural log transformation. Least-squares estimates and *P*-values were obtained from the best fitted models.

Ethical considerations

The NIS database uses completely unidentified data with no risk of loss of confidentiality to the patients and hence was exempt from Institutional Review Board review. A data user agreement was completed with the AHRQ prior to using the NIS database. As per the data user agreement, individual table cell counts <10 cannot be presented.

RESULTS

Patient characteristics

In the 4 years (2009–2012) included in our study, there were 23,661 patients who were admitted with the primary diagnosis of cholangitis and who underwent inpatient ERCP. Of these, 5,555 were admitted over the weekend. **Table 1** shows the characteristics of the patients. The groups were similar. There was no difference in co-morbidities or requirement of the intensive care unit between the two groups.

All patients underwent ERCP for cholangitis. The vast majority of the procedures were for the indication of cholangitis secondary to choledocholithiasis (weekend: 78%; weekday: 73%). The

Table 1. Characteristics of patients with cholangitis who underwent ERCP admitted over the weekend and weekday

	Weekday (*n*=18,106)	Weekend (*n*=5,555)	*P* value[a]
Age, mean (years; 95% CI)	67.00 (66.76–67.26)	67.61 (67.15–68.07)	0.0228
< 50 years, %	16.72	16.63	0.0003
51–74 years, %	43.84	41.08	
≥75 years, %	39.44	42.29	
Race/ethnicity (%)			
White	69.74	69.80	0.4721
Black	8.02	7.39	
Hispanic	12.69	12.96	
Other	9.55	9.84	
Primary payer (%)			
Medicare	59.20	60.29	0.1219
Medicaid	8.35	8.44	
Private	25.34	23.79	
Other	7.11	7.48	
Median zip code income (%)			
First quartile	23.49	23.36	0.9510
Second quartile	24.30	24.64	
Third quartile	26.08	26.15	
Fourth quartile	26.13	25.85	
Elixhauser index, mean (95% CI)	2.61 (2.59–2.63)	2.63 (2.59–2.67)	0.3586
0, %	8.80	9.13	0.3460
1, %	17.93	17.08	
2, %	22.75	22.32	
3+, %	50.52	51.47	
Hospital size (%)			
Small	8.76	8.92	0.8975
Medium	21.84	21.63	
Large	69.40	69.45	
Ownership/control (%)			
Government, non-federal	3.50	3.45	0.4105
Private, nonprofit	18.50	18.21	
Private, investor-owned	7.70	6.97	
Other	70.30	71.38	
Hospital region (%)			
Northeast	21.98	23.04	0.1179
Midwest	23.15	21.91	
South	30.35	29.94	
West	24.52	25.11	
Teaching hospital (%)	57.51	58.26	0.3992
Rural (vs. urban) location (%)	5.18	5.29	0.7766
History of cholecystectomy	4.30	4.70	0.2013
Intensive care	5.52	5.65	0.7005

CI, confidence interval; ERCP, endoscopic retrograde cholangiopancreatography.
[a]Student's *t*-test used to compare means; Pearson's χ^2-test used to compare proportions.

Table 2. Timing of ERCP according to weekday vs. weekend admission

Days from admission	Overall (*n*=23,661), %	Weekday (*n*=18,106), %	Weekend (*n*=5,555), %	*P* value
ERCP				
Day 1	51.88	54.62	42.95	<0.0001
Day 2	68.93	70.02	65.36	<0.0001
Day 3	79.53	79.73	78.88	0.1713

ERCP, endoscopic retrograde cholangiopancreatography.
Percentages reflect cumulative proportion of patients who had ERCP by the specified day.

remaining patients had a biliary stricture. It is unknown how many had previous ERCPs and if they had prior placed biliary stents.

Patients with cholangitis who underwent PTBD were excluded as explained in the methods section. The average co-morbidity index of the PTBD group was similar to the ERCP group, indicating similar degree of comorbidity of patients (2.6 vs. 2.8).

Outcomes

The mean (±s.e.) number of days to ERCP was significantly lower among patients admitted over the weekday (2.32±2.79) compared with patients admitted over the weekend (2.48±2.61; *P*=0.0002). **Table 2** summarizes each group and percentage of patients who underwent ERCP at each time point (24, 48, and 72 h). Significantly, fewer patients underwent ERCP within 24 h if admitted over the weekend (42.95%) compared with the weekday (54.62%) (*P*<0.001); this significant trend was noted even for patients who underwent ERCP within 48 h of admission. Nearly 80% of the patients who underwent ERCP had the procedure carried out within 72 h of admission. There was no statistical difference among patients admitted over the weekend or weekday at this time point.

Table 3 presents the other primary outcomes that were examined. There was no difference in all-cause in-hospital mortality, adverse events of ERCP, length of stay, or total charges (adjusted for economy-wide inflation to 2012 dollars) between the two groups.

DISCUSSION

The weekend effect is a medical phenomenon that is increasingly being described in the literature. Our primary aim was to determine whether the weekend effect occurred for patients admitted with cholangitis who required an ERCP. In summary, we found that there was a delay in regard to time to ERCP for patients with cholangitis who required an ERCP; however, this did not affect the important outcomes of inpatient mortality, length of stay, or total cost of the hospitalization between the two groups. Thus, no weekend effect was observed. Patients who underwent PTBD were excluded for the reasons discussed in the methods section. The comorbidity index for the ERCP and PTBD groups was similar, and thus sicker patients were not selectively excluded.

Table 3. Outcomes of patients with cholangitis who underwent ERCP

	Weekday (*n*=18,106)	Weekend (*n*=5,555)	*P* value
All-cause in-hospital mortality, %	2.86	2.56	0.2369
All adverse events, %	10.81	10.06	0.1122
Risk adjusted estimated[a]			
Length of stay (days) (95% CI)	6.97 (6.89–7.04)	6.88 (6.75–7.01)	0.2801
Total charges ($) (95% CI)	71,552.7 (70,499.9–72,605.4)	71,469.9 (69,627.6–73,312.3)	0.9402

CI, confidence interval; ERCP, endoscopic retrograde cholangiopancreatography.
[a]All the hospital charges have been normalized and adjusted for economy-wide inflation to 2012 dollars.

It is not surprising why there was a delay in regard to timing of ERCP for the weekend vs. the weekday groups. ERCP requires many resources including an interventional gastrointestinal endoscopist, adequately trained nurses and technicians, anesthesia support, and proper fluoroscopic facilities. It can be challenging on the weekend to organize these resources.

The main take home point of this study is that, despite being a delay to ERCP on the weekend, this does not affect the main outcomes, which are in-hospital mortality, length of stay, and total cost of hospitalization. The data suggest that other factors contribute to the main outcomes besides time to ERCP. As it is well known, antibiotics and intravenous fluids are pivotal in the management of cholangitis. Given the acuity of patients presenting with cholangitis, it is likely that misdiagnosing cholangitis is infrequent. Ascending cholangitis has varied presentation ranging from mild cholangitis to severe cholangitis. Mild cholangitis usually responds to conservative management, but patients requiring ERCP are often very sick with change in mental status, hypotension, and jaundice. These presenting symptoms and the need for immediate care are obvious. Thus, it is likely that these sick patients are provided appropriate resources on the weekend despite having less staff on the weekends vs. the weekdays. On the other hand, in disease processes where the weekend effect is observed (pulmonary embolus, stroke, etc.), the presenting symptoms may be subtle and thus a reason for delayed care and worsened outcomes (2,3,5).

We chose to only include patients with cholangitis who underwent ERCP rather than all patients who underwent ERCP on the weekends. We felt that most centers that perform ERCP will only perform ERCP on the weekend for therapy of cholangitis. However, there are some high volume centers for advanced endoscopy throughout the country that perform ERCP for non-cholangitis cases on the weekend. These centers are often equipped with similar staff and resources on the weekend that are present on the weekday. We therefore did not want to bias the results by including these patients.

Our results are discordant with Parikh *et al.* (11), the only other study looking at weekend ERCP. Their study looked at all patients who underwent ERCP on the weekend, regardless of cholangitis. They found that weekend ERCP reduces length of hospital stay and cost of hospitalization. Thus, patients admitted with symptomatic bile duct stones without cholangitis could be discharged after therapeutic ERCP relieved their symptoms. The quicker the ERCP is performed, the faster the patient can be discharged. However, patients with cholangitis need to be treated with several days of intravenous antibiotics, even after endoscopic biliary drainage. This is the most likely reason for no difference in length of stay or total hospital cost between the weekend and weekday groups in this study.

A somewhat surprising statistic was the mean number of days to ERCP in the cholangitis cohort admitted on the weekday (2.32 days). This timing, over 1 day, was not expected for the weekday. Although over 54% of patients with cholangitis admitted on the weekday had an ERCP by day one of admission, there remained a significant number that had an ERCP after the first day. It is clear from the NIS database that in clinical practice the spectrum of timing for an urgent ERCP for cholangitis varies. Further research into the variables for predicating the timing of ERCP is needed (i.e.,: community hospitals vs. tertiary care hospitals, full time hospital employed endoscopist vs. private practice endoscopist, laboratory markers and clinical status of patients dictating timing, etc). These variables cannot be captured in the NIS database.

Our study is not advocating for delaying the timing of emergent or urgent ERCP in patients with cholangitis. There are clearly patients who need emergent lifesaving biliary drainage when resuscitative measures with fluids and antibiotics have failed. Biliary drainage should be performed in these patients. In this study, 43% of patients had an urgent ERCP within 24 h of admission on the weekend; these were likely lifesaving procedures.

There are limitations to this study. This is a retrospective study and thus subject to the inherent limitations of retrospective studies. In regard to the outcome for adverse events of ERCP, the database only includes information regarding the procedural adverse events for the hospitalization. Therefore, it is possible that a procedural adverse event was detected after discharge and not captured in this database. The likelihood of this occurring is low as patients with cholangitis are often kept in the hospital on intravenous antibiotics for many days after the ERCP. Finally, the database does not allow us to capture pure technical success of the procedure; however, this is not a main component to determining whether a weekend effect exists.

In conclusion, this large database study adds to the growing body of literature on the weekend effect in medicine. We found no weekend effect for patients admitted with cholangitis requiring ERCP. We are able to show that, despite there being a delay for timing to ERCP for patients admitted on the weekend, this does not affect the clinically relevant outcomes (length of stay, inpatient hospital mortality, or total cost of hospitalization). Further prospective studies are needed to confirm our findings.

CONFLICT OF INTEREST

Guarantor of the article: Arvind J. Trindade, MD.

Specific author contributions: Conception and design (Sumant Inamdar and Arvind J. Trindade). Analysis and interpretation of the data (Arvind J. Trindade, Sumant Inamdar, Mohammed Ullah and Divyesh V. Sejpal). Drafting of the article (Arvind J. Trindade, Sumant Inamdar, Divyesh V. Sejpal, and Mohammed Ullah). Critical revision of the article for important intellectual content (Arvind J. Trindade, Sumant Inamdar, Mohammed Ullah, and Divyesh V. Sejpal). Final approval of the article (Arvind J. Trindade, Sumant Inamdar, Divyesh V. Sejpal, and Mohammed Ullah). Sumant Inamdar and Arvind J. Trindade had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Weekend vs. weekday admissions for cholangitis requiring an ERCP: Comparison of outcomes in a national cohort.

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Potential competing interests: None.

Study Highlights

WHAT IS CURRENT KNOWLEDGE

- ✓ There have been several reports on a weekend effect in the hospital for patients admitted with cardiovascular, renal, and gastrointestinal illness.
- ✓ There is one previous study showing that weekend endoscopic retrograde cholangiopancreatography (ERCP) on patients admitted on the weekend, with biliary disorders requiring ERCP, decreased length of stay and cost for patients.
- ✓ It is unknown whether there is a weekend effect for patients admitted with cholangitis requiring ERCP.

WHAT IS NEW HERE

- ✓ There was a delay in regard to time to ERCP for patients with cholangitis who required an ERCP on the weekend vs. the weekday.
- ✓ There was no difference between the two groups in regard to hospital mortality, length of stay, or total cost of hospitalization; thus, there was no weekend effect observed for patients admitted with cholangitis requiring ERCP in this cohort.
- ✓ Although biliary drainage with ERCP is important, these results suggest that other factors in the management of cholangitis (e.g., antibiotics and intravenous fluids) contribute to outcomes.

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