Original Article

Does "July effect" exist in colonoscopies performed at teaching hospitals?

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Background: To compare the outcomes of the colonoscopies between the early (July–September) and the later (April–June) academic year at the urban-teaching hospitals.

Methods: Our study cluster was derived from the National Inpatient Sample (NIS) database for the years 2010–2014. International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9 CM) procedure codes were used to identify the adult patients who underwent inpatient colonoscopy at urban-teaching hospitals. Post-colonoscopy outcomes and the complications were recognized using ICD-9 CM codes among any of the secondary diagnoses. Categorical and continuous variables were assessed using Pearson's Chi-square and Student's *t*-test respectively. Odds of complications during the early *vs.* later academic year was also evaluated by the two-way hierarchical logistic regression analysis.

Results: A total of 124,155 (weighted n=617,907) colonoscopy procedures were performed at the urban teaching hospitals in the US from 2010 to 2014. Out of these, 61,272 (weighted n=304,946) and 62,883 (weighted n=312,961) procedures were performed during early (July to September) and later (April to June) academic months, respectively. There was no significant difference in the all-cause mortality (1.4% *vs.* 1.4%, P=0.208), and the complications such as colonic perforations (3.1% *vs.* 3.2%, P=0.229) and postoperative infections (0.6% *vs.* 0.6%, P=0.733) between the two groups. Similarly, the splenic rupture (0.0% *vs.* 0.0%, P=0.180) was equally infrequent in both the groups. Bleeding/hematoma following colonoscopy (0.9% *vs.* 0.8%, P=0.004) was marginally higher during the later academic months. There were no statistically distinctions in terms of length of stay (LOS) (days) (7.3±9.1 *vs.* 7.3±9.1, P=0.918), total hospitalization charges ($60,549.41 *vs.* $59,918.56, P=0.311) and discharge of patients to other facilities between the early and the later academic months. Colonoscopy performed during the early academic months was not found to be a significant independent predictor for post-colonoscopy complications such as colon perforation (OR =0.99, 95% CI: 0.93–1.06, P=0.760), postoperative bleeding/hematoma (OR =0.92, 95% CI: 0.81–1.04, P=0.196) and postoperative infection (OR =0.99, 95% CI: 0.84–1.15, P=0.850).

Conclusions: There was no "July effect" on the outcomes of colonoscopies between the early *vs.* the later academic months.

Keywords: Colonoscopy; July effect; post-colonoscopy complications; perforation; infection; bleeding; splenic rupture; academic training; fellowship; fellow-in-training

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Introduction

Colonoscopy is one of the most consistently performed procedures to assess the wide variety of gastrointestinal conditions, as well as one of the primary screening and surveillance modalities to detect colorectal neoplasia (1). Although typically considered as a safe technique, colonoscopy can lead to a few serious and sometimes fatal adverse events such as colonic perforation, bleeding, infection and rarely splenic rupture (1,2). The incidence of these adverse events following colonoscopy is fairly low; colonic perforation (0.003% to 0.3%) (3-7), bleeding (0.1% to 0.6%) (3), infection (bacteremia) (0% to 25%) (8) and splenic rupture (0.001%) (9). The rate of hospitalization and median length of stay (LOS) due to the colonoscopy-related complications were found to be as low as 0.05% (95% CI: 0.00% to 0.26%) (10).

"July effect" is delineated as the influence of beginning of the academic year on the quality of the healthcare and patient care services due to the switchover of trained residents or fellows with inexperienced ones (11-13). Outcomes can vary between the studies while assessing the July effect, however, many large studies have shown a comparatively higher mortality due to various illnesses at the beginning of the academic year as compared to the later part of the academic year (13-17). Moreover, many studies have reported a negative impact on the quality of the patient care during the early academic months in the teaching hospitals by showing evidence of the prolonged hospital LOS and higher total hospital costs (18-23).

Typically, a gastroenterology fellow at the start of training performs the colonoscopy procedure under the direct supervision of an attending physician. Despite the fact that it is a safe procedure to perform, the likelihood of colonoscopy-related complications may be higher during this learning curve. We presume that the incidence of post-colonoscopy complications might be lower at the end of the academic year since by this time fellows have enough experience and skills to perform the colonoscopy. Our primary aim was to assess the existence of the "July effect" in the colonoscopies performed at urban-teaching hospitals by using the largest National Inpatient Sample (NIS) database. Therefore, we proposed to measure and compare the all-cause mortality and the incidence of post-colonoscopy complications along with the LOS and total hospitalization charges and disposition between the first 3 months (July to September) and the last 3 months (April to June) of the academic year.

Methods

Data source

Our study population was derived from the 2010–2014 Healthcare Cost and Utilization Project's National Inpatient Sample (HCUP-NIS) database, which is funded by the Agency for Healthcare Research and Quality. The NIS is the largest publicly available all-payer inpatient healthcare database in the United States (US). This dataset is deliberated as a stratified sample from 20% nonfederal US community acute care hospitals, which represents 95% of the US population. It comprises of the more than 7 million unweighted discharges per year. Each hospitalization can be transformed into weighted (weight is calculated by the sum of discharges from all acute care hospitals in the US divided by the sum of discharges incorporated in the 20% sample) by discharge weight provided in the dataset to yield national estimates. The weighted dataset is intended to comprehend more than 35 million hospitalizations per year. Patients' demographics, diagnoses, resource utilization including the LOS, procedures, and total hospitalization charges are integrated into the NIS. The hospitalization characteristics are classified in the manner of ownership/control, bed size, teaching status, urban/rural location, and geographic region. Both patient and hospital level data is incorporated in this dataset. The International Classification of Diseases, 9th revision, Clinical Modification (ICD-9 CM) coding system is used to collect up to 25 discharge diagnoses and 15 procedures on each hospitalization. Institutional Review Board (IRB) authorization was not mandatory for this de-identified dataset (24).

Study population

ICD-9 CM procedure codes 45.22, 45.23, 45.25, 45.42, and 45.43 were used to identify the adult patients (>18 years of age) who underwent inpatient colonoscopy. Patients were excluded if the information about the colonoscopy was missing or it was carried out before or on the day of admission, and/or if they were hospitalized to the non-teaching urban or rural hospitals. Post-colonoscopy complications were identified by using the ICD-9 CM codes which were applied for a secondary diagnosis to recognize the post-colonoscopy complications in patients who received a colonoscopy as outlined above. All the

ICD-9 CM codes utilized were documented and validated in the previously published studies (25,26). Colonoscopies completed during the months of July, August and September were compared to those carried out during the months of April, May, and June in the urban-teaching hospitals.

Study variables

The analysis included baseline demographics of study cohort such as the age, sex, admission day, type of admission, race, median household income national quartile for patient zip code (first quartile: 0–25th; second quartile: 26–50th; third quartile: 51–75th; fourth quartile: 76–100th) and primary expected payer. The hospitalization characteristics such as the region of the hospital, bed size of hospital and control/ownership of the hospital, were also taken into consideration while performing the analyses.

Outcomes

The primary outcomes of this study were the all-cause mortality and the rate of post-colonoscopy complications including colonic perforation, post-colonoscopy hemorrhage/bleeding, postoperative infections, and splenic rupture. Secondary outcomes were the LOS, and total hospitalization charges and disposition. We also assessed the odds of complications during July–September *vs.* April–June after adjusting for potential confounding variables including age, sex, race, median household income national quartile for patient zip code and payer status.

Statistical analysis

Pearson's Chi-square test and Student *t*-test were used for evaluating the categorical and continuous variables, respectively. The categorical and continuous variables were stated in percentages and mean ± SD, correspondingly. A two-tailed P value <0.05 was considered as the threshold of the statistical significance. Multivariate regression analysis was executed to evaluate the odds of complications during July–September *vs.* April–June after adjusting for potential confounding variables including age, sex, race, median household income national quartile for patient zip code and payer status. Multivariate logistic regression results were described by adjusted OR, 95% CI, and P value. SPSS version 22 (IBM Corp, Armonk, NY, USA) was utilized to perform all statistical analyses. The patients with Missing data of cohort were excluded in the statistical analysis. We built in statistical analysis with weighted data to produce nationwide estimates.

Results

Baseline demographics and hospital characteristics

In this cohort, we incorporated a total of 124,155 (weighted n=617,907) colonoscopy procedures which were performed in the urban-teaching hospitals of the US from January 2010 through December 2014. Out of these, 61,272 (weighted n=304,946) and 62,883 (weighted n=312,961) procedures were performed during early (July to September) and later (April to June) academic months, respectively. Demographics and hospitals variables were comparable in the patients undergoing the colonoscopy procedures during the early academic months (July to September) and later academic months (April to June). Baseline demographic and hospitals characteristics are shown in *Table 1*.

The all-cause mortality and post-colonoscopy complications

There was no significant difference in the all-cause mortality (1.4% *vs.* 1.4%, P=0.208), and the Post-colonoscopy complications such as colonic perforations (3.1% *vs.* 3.2%, P=0.229) and postoperative infections (0.6% *vs.* 0.6%, P=0.733) were also comparable between the two groups. Similarly, the incidence of splenic rupture (0.0% *vs.* 0.0%, P=0.180) was equally rare in both the groups. The incidence of bleeding/hematoma following colonoscopy (0.9% *vs.* 0.8%, P=0.004) was marginally higher during the later academic months (April to June) than the early academic months (July to September) (*Table 2*).

LOS and total hospitalization charges and disposition of patients post-colonoscopy

There were no distinctions in terms of LOS (days) (7.3±9.1 *vs.* 7.3±9.1, P=0.918) and total hospitalization charges ($60,549.41 *vs.* $59,918.56, P=0.311) following the colonoscopies between the early (July to September) and later (April to June) academic months. There was no statistical difference in the disposition of the patients to routine (69.7% *vs.* 69.4%), transfer to short-term hospital (1.0% *vs.* 0.9%), other transfers (skilled nursing facility, intermediate care facility, and other facility) (14.6% *vs.* 14.7%), home health care (12.7% *vs.* 12.9%) and against

Table 1 Baseline characteristics of study population during early (July to September) *vs.* later (April to June) academic months

Variable	Early (July to September) (n=61,272, weighted n=304,946)		Later (April to June) (n=62,883, weighted n=312,961)		P value
	Count	%	Count	%	
Age in years					<0.001
Mean ± SD	63.2±17.2		64.2±17.1		
18–44	43,503	14.3	43,042	13.8	
45–64	99,742	32.7	100,909	32.2	
65–84	130,169	42.7	135,693	43.4	
≥85	31,531	10.3	33,317	10.6	
Indicator of sex					0.398
Male	140,003	45.9	143,374	45.8	
Female	164,840	54.1	169,540	54.2	
Admission day					<0.001
Weekday	235,642	77.3	244,263	78.0	
Weekend	69,304	22.7	68,698	22.0	
Type of admission					<0.001
Non-elective	279,431	91.7	285,107	91.2	
Elective	25,157	8.3	27,477	8.8	
Race					<0.001
White	183,579	64.6	187,169	64.2	
African American	58,133	20.5	61,475	21.1	
Hispanic	26,428	9.3	26,188	9.0	
Asians/Pacific Islander	7,052	2.5	7,265	2.5	
Native American	1,319	0.5	1,260	0.4	
Others	7,508	2.6	8,385	2.9	
Median household income national quartile for patient zip code					0.148
0–25th	89,428	29.9	92,363	30.1	
26–50th	72,296	24.2	74,302	24.2	
51–75th	73,601	24.6	74,812	24.4	
76–100th	63,869	21.3	65,568	21.4	
Primary expected payer					<0.001
Medicare	173,164	56.9	179,491	57.4	
Medicaid	31,871	10.5	32,836	10.5	
Private including HMO	74,387	24.4	75,361	24.1	
Self-pay/no charge/others	25,078	8.2	24,848	8.0	

Table 1 (*continued*)

Table 1 (*continued*)

Variable	Early (July to September) (n=61,272, weighted n=304,946)		Later (April to June) (n=62,883, weighted n=312,961)		P value
	Count	%	Count	%	
Control/ownership of the hospital					<0.001
Government, nonfederal	32,266	10.6	32,148	10.3	
Private, non-profit	250,275	82.1	257,704	82.3	
Private, invest-own	22,405	7.3	23,109	7.4	
Bed size of the hospital					<0.001
Small	52,613	17.3	54,061	17.3	
Medium	84,845	27.8	88,960	28.4	
Large	167,488	54.9	169,940	54.3	
Region of hospital					0.018
Northeast	76,013	24.9	78,634	25.1	
Midwest	83,734	27.5	85,541	27.3	
South	106,164	34.8	109,410	35.0	
West	39,034	12.8	39,376	12.6	

P<0.05 indicate clinical significance. HMO, health maintenance organization.

Table 2 Outcomes in colonoscopy during early (July to September) *vs.* later (April to June) academic months

Outcomes	Early academic months (July to September)		Later academic months (April to June)		P value
	Count	%	Count	%	
Colonic perforation	9,503	3.1	9,920	3.2	0.229
Postoperative bleeding/hematoma	2,475	0.8	2,749	0.9	0.004
Postoperative infection	1,772	0.6	1,798	0.6	0.733
Splenic rupture	10	0.0	5	0.0	0.180
Disposition of patient					0.088
Routine	212,498	69.7	217,177	69.4	
Transfer to short-term hospital	2,921	1.0	2,920	0.9	
Other transfers (SNF, ICF, other facility)	44,394	14.6	45,898	14.7	
Home health care	38,820	12.7	40,407	12.9	
Against medical advice	1,875	0.6	1,878	0.6	
All-cause mortality	4,280	1.4	4,272	1.4	0.208
Length of stay (days) (mean ± SD)	7.3±9.1		7.3±9.1		0.918
Total hospital charges (mean)	$60,549.41		$59,918.56		0.311

P<0.05 indicate clinical significance. SNF, skilled nursing facility; ICF, intermediate care facility.

Table 3 Odds of post-colonoscopy complications during early (July to September) *vs.* later (April to June) academic months

Complications	Adjusted OR	95% CI (UL–LL)	P value
Colon perforation	0.99	0.93–1.06	0.760
Postoperative bleeding/hematoma	0.92	0.81–1.04	0.196
Postoperative infection	0.99	0.84–1.15	0.850

P<0.05 indicate clinical significance. A multivariate regression model was controlled for age, sex, race, median household income and payer status. OR, odds ratio; CI, confidence interval; LL, lower level; UL, upper level.

medical advice (0.6% *vs.* 0.6%) (P=0.088) following the colonoscopy procedures between the two groups (*Table 2*).

Odds of post-colonoscopy complications according to academic months

After regulating the plausible confounders, colonoscopy during the July–September months was not found to be a significant independent predictor for post-colonoscopy complications such as colon perforation (OR =0.99, 95% CI: 0.93–1.06, P=0.760), postoperative bleeding/hematoma (OR =0.92, 95% CI: 0.81–1.04, P=0.196) and postoperative infection (OR =0.99, 95% CI: 0.84–1.15, P=0.850) (*Table 3*).

Discussion

As far as we know, this is the first large nationwide study looking for the existence of a July effect in the all-cause of mortality, the incidence of complications, LOS, total hospital charges and the disposition of patients following colonoscopy procedures at urban-teaching settings. We have also compared the odds of post-colonoscopy complications between early (July to September) *vs.* later (April to June) academic months. The noteworthy result of this study is that July effect was not identified in the utilization and the outcomes of colonoscopy procedure in the urban teaching hospitals. Our results indicate that experienced gastroenterologists monitor fellows closely and share their skills, experiences and knowledge with them while performing the procedure to improve the potential complications and procedure-related outcomes.

Not many studies have compared the outcomes of only gastroenterologist (GI) physicians involved in the colonoscopy procedures *vs.* GI physicians with fellows or trainees involved colonoscopy procedures. The higher risk of colonic perforation was documented with GI fellows and untrained physician during the procedure (27,28). Anderson *et al.* investigated the incidence of colonic perforation from the colonoscopy and sigmoidoscopy procedure. Out of 10,486 colonoscopies procedures, authors found 20 colonic perforations. Among them, 8 colonic perforations happened when the procedures were performed by GI fellows. However, the study concluded that the risk of colonic perforation was not statistically amplified with GI fellows or trainee involved in the procedure (28). Bielawska *et al.* also documented that the risk of colonic perforation was 2% higher with non-GI endoscopists (surgeons and unknown specialty endoscopists) as compared to experienced GI physicians involved procedures (27). Both studies documented the worse outcomes with unexperienced GI trainee or physicians as compared to the trained GI physicians. However, we have not revealed the statistically significant difference in the incidence of post-colonoscopy complications between the inexperienced GI fellows (early academic months) *vs.* experienced GI fellows (later academic months).

The incidence of the all-cause mortality (0.03%) following the colonoscopy procedure was measured in previously published studies (3). Colonoscopy-related deaths (0.007%) (5,29) have not frequently occurred as well as post-colonoscopy complications are also rare. Therefore, it could be less probability to have the statistically significant difference in the all-cause mortality following the colonoscopy procedure between early *vs.* later academic months. Our data have not revealed any significant difference in the all-cause of mortality between the early *vs.* late academic months too.

There are numerous studies, which have assessed the July effect on length of hospital stay and hospitalization charges for various medical conditions. However, results of these studies have not been consistent. Barry *et al.* did not find any differences in the intensive care unit (ICU) LOS after adjusting for the severity of illness over the period of an academic year (18). In the same way, July phenomenon was also not documented while assessing differences in the total charges and LOS between early *vs.* later academic months

for any medical illness (30) as well as for ERCP-induced pancreatitis (23). Conversely, both total hospital charges and LOS for a wide range of internal medicine patients were significantly lower with experienced house staff (later academic months) as compared to inexperienced trainees (early academic months) (19). In our study cohort, the existence of the July effect in total hospital charges, LOS, and disposition of patients was also not established following colonoscopy procedures at the teaching institutions.

The most significant strength of our study is the large sample size. NIS is one of the largest databases in the US, thus, results of this study represent national level healthcare practice. Our study cohort is large enough to minimize the selection and participation biases which are mostly limited to the small studies. However, some limitations of this study need to be addressed. Gastroenterology fellowships might not be offered at all urban teaching hospitals, it could be one of the factors for overestimation or underestimation as well as dilution of our study results. Our study cohort was derived from the administrative database. Therefore, ICD-9 CM coding errors could be a possibility in our study. It is always not possible to measure the severity of post-colonoscopy complications based on ICD-9 CM codes. The process of randomization is not possible in all the retrospective studies. Hence, remnant confounding cannot be eliminated even though we adjusted the confound factors in our analysis. We could not evaluate the effects of other factors such as bowel preparation, cecum intubation time, withdrawal time, the degree of supervision by GI physicians. All these factors could be the quality indicators which could affect the study results. We could not differentiate between the screening colonoscopy and surveillance colonoscopy too. However, these limitations can be overlooked by strengths of the study.

Conclusions

The safety of colonoscopy was steady over the period of the academic year at urban teaching hospitals, as evidenced by no difference in the all-cause mortality and the incidence of post-colonoscopy complications between early and later academic months. The utilization and outcomes of colonoscopy procedures were also consistent across the academic year, as shown by no difference in LOS, total hospital charges and disposition of patients. Our study concludes that house staff experience might not influence the clinical outcomes in hospitalized patients undergoing colonoscopy. However, these results do not propose that just started GI fellowship trainees can perform colonoscopy procedure safely without the supervision of attending GI physician. These results also suggest that the GI fellows are being closely supervised by their GI attendings to develop the skills, techniques, and knowledge of colonoscopy procedures as per the current GI fellowship training guidelines.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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