

ORIGINAL RESEARCH

The July Effect: An Analysis of Never Events in the Nationwide Inpatient Sample

Timothy Wen, MPH^{1*}, Frank J. Attenello, MD², Brian Wu, BS³, Alvin Ng, BS⁴, Steven Y. Cen, PhD^{2,4,5,6}, William J. Mack, MD²

¹Keck School of Medicine, University of Southern California, Los Angeles, California; ²Department of Neurosurgery, Keck School of Medicine, University of Southern California, Los Angeles, California; ³Department of Integrative Biology of Disease, Keck School of Medicine, University of Southern California, Los Angeles; ⁴Department of Preventive Medicine, Keck School of Medicine, University of Southern California, Los Angeles, California; ⁵Department of Neurology, Keck School of Medicine, University of Southern California, Los Angeles, California; ⁶Department of Radiology, Keck School of Medicine, University of Southern California, Los Angeles, California.

BACKGROUND: Prior studies examining the impact of the “July effect” on in-hospital mortality rates have generated variable results. In 2008, the Centers for Medicare & Medicaid Services published a series of high-cost, high-volume, nonreimbursable hospital-acquired complications (HACs). These events were believed to be preventable and indicate deficiencies in healthcare delivery.

OBJECTIVE: The present study aims to investigate the impact of July admissions on patient safety in a national sample using the HACs as a metric.

DESIGN/SETTING/PATIENTS: Discharge data were collected from all admissions recorded in the Nationwide Inpatient Sample database from 2008 to 2011. HAC incidence was evaluated as a function of admission month, adjusting for demographic and hospital factors in multivariable analysis.

MEASURES: The outcome measures were HAC occurrence, prolonged length of stay (LOS), and higher inpatient costs.

RESULTS: A total of 143,019,381 inpatient admissions were recorded, with an overall HAC occurrence of 4.7%. July admissions accounted for 7.6% of the total number of inpatient admissions. July admissions experienced a 6% increase in likelihood of HAC occurrence (odds ratio = 1.06, 95% confidence interval: 1.06–1.07, $P < 0.001$) when compared to those admitted during all other months. Patients with HAC occurrence had almost 2 times increased likelihood of prolonged LOS ($P < 0.001$) and higher inpatient costs ($P < 0.001$).

CONCLUSIONS: July admissions are associated with increased likelihood of HAC occurrence. This trend may represent breakdowns in organization structure distinct from traditional quality measures, requiring novel transition protocols dedicated to improving HACs. *Journal of Hospital Medicine* 2015;10:432–438. © 2015 Society of Hospital Medicine

The simultaneous arrival of new residents, medical students, and faculty in July each year results in a complex transition period for hospitals. Medical centers strive to deliver high-quality and efficient care while undergoing these cyclical changes, with over 100,000 interns/residents in the United States taking part in this changeover.¹ This period is hypothesized to hold an increased risk of adverse outcomes referred to as the “July Effect.”^{1–5} Although studies have reported associated increases in mortality risk, decreases in efficiency, and an increase in “undesirable events” during this time, occurrences are still debated.^{1,3–5}

In 2008, the Centers for Medicare & Medicaid Services (CMS) published and instituted a nationwide

series of “never events.” These events, narrowed to a list of hospital-acquired complications (HACs), are characterized as iatrogenic adverse outcomes and deemed preventable and egregious. Medicare has subsequently withheld reimbursement for additional cost of treatment related to the events.^{6–8} HACs include complications such as air embolism, retained foreign body, blood incompatibility, pressure ulcer, catheter-associated urinary tract infection (UTI), vascular catheter-associated infection, manifestations of poor glycemic control, falls/trauma, deep venous thrombosis or pulmonary embolism after total knee and hip replacements, surgical site infections after coronary artery bypass graft, and surgical site infections after certain orthopedic or bariatric surgeries. Prior studies have utilized HACs as a metric for quality of healthcare delivery in subspecialties such as cerebrovascular surgery, bowel surgery, and urology.^{6,9,10}

Though the July effect has been assessed across multiple specialties and hospitals, no prior studies have evaluated this phenomenon on a national level and incorporated all hospital admission diagnoses. Through this study, we aim to provide insight into this relatively new quality metric when evaluating admissions made during the early months of the

*Address for correspondence and reprint requests: Timothy Wen, MPH, Keck School of Medicine of USC, University of Southern California, c/o: Dr. William Mack, 1520 San Pablo Street, Suite 3800, Los Angeles, CA 90033; E-mail: wentimot@usc.edu

Additional Supporting Information may be found in the online version of this article.

Received: October 23, 2014; Revised: March 2, 2015; Accepted: March 3, 2015

2015 Society of Hospital Medicine DOI 10.1002/jhm.2352

Published online in Wiley Online Library (Wileyonlinelibrary.com).

academic year. This study's primary aim is to evaluate the frequency of HAC occurrence across hospital discharges on a national level as a function of admission month after the initiation of the nonreimbursable nature of the CMS never events in 2008. Furthermore, the secondary aims of this study examine the impact of the July effect on inpatient length of stay (LOS) and charges. We hypothesized that July admission is associated with an increase in HAC occurrence, LOS, and inpatient charges.

METHODS

Data Source

An observational study was conducted using data extracted from the Nationwide Inpatient Sample (NIS) years 2008 to 2011. NIS is an annually compiled database maintained by the Agency for Healthcare Research and Quality and contains information on more than 8 million hospital admissions each year from more than 40 states and 1000 hospitals.¹¹ The database represents 20% of all US hospital discharges and contains a weighting system that allows for calculation of population estimates.¹¹

Patient Sample

All patients who were admitted to a hospital from 2008 to 2011 were included in this study. NIS does not contain unique patient identifiers; thus, each discharge was treated as an independent event, even if it may have represented a repeat hospitalization by the same patient. Each hospitalization contained patient and hospital factors that were included as covariates for analysis. Patient factors such as race (white, black, Hispanic, Asian/Pacific Islander, Native American, other), payer information (Medicare, Medicaid, private insurance, no charge, self-pay, other), and gender (male, female) were included as categorical variables. Other patient covariates of interest included age (recoded from a continuous to a categorical variable with the following groupings: <18, 19 to 30, 31 to 40, 41 to 50, 50 to 65, 66 to 80, and >80 years) and number of comorbidities (none, 1, 2 or more). The comorbidities variable was drawn from the NIS database and was derived directly from the Elixhauser comorbidity index that is often cited in other studies as a risk-adjustment measure.¹² Hospital factors, such as bed size (small [<200], medium [201–400], large [>400 beds]), teaching status (teaching, nonteaching), hospital region (Northeast, Midwest, South, West), and location (rural, urban) were included in the analysis as categorical variables. Variables with missing values were encoded as a missing category for all exposure variables.

Outcomes

The primary outcome of interest was the probability of HAC occurrence. The frequency of HAC occurrence in July was compared to that of other months.

HACs were defined using the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) codes and verified through CMS literature and data.¹³ Demographics of the patient and hospital variables, as well as the frequency of HACs were tabulated. Secondary outcomes included the likelihood of incurring higher inpatient charges and experiencing a prolonged LOS, defined as at or above the 90th percentile for both variables.

Statistical Analyses

Demographics were calculated using survey-adjusted univariate frequency and means analysis. Multivariable logistic regressions were modeled using survey-adjusted generalized estimating equations to assess the outcomes described above. Each model was adjusted for hospital (bed size, teaching status, hospital region, hospital location) and patient (race, payer information, gender, age, number of comorbidities) factors. The models assessing the prolonged LOS and higher inpatient charges outcomes were adjusted with the same patient and hospital factors, with the addition of HAC occurrence as a covariate. The main exposure of interest in this study was admission in the month of July. Admission month is included as a multilevel variable and recoded into a dichotomous variable.

Aside from hospital and patient covariates, multivariate analyses were also adjusted according to severity of admission. Admission severity was defined using three variables: All-Patient Refined Disease-Related Group (APR-DRG), admission type, and admission source. 3M's APR-DRG algorithm (3M Health Information Systems, Wallingford, CT) is a system of risk adjustment methods developed by 3M and based upon the existing DRG structure and used in a number of other NIS studies as a valid measure of admission severity.^{14–17} The algorithm divides patient admissions into 500 categories of similar clinical and resource utilization features. APR-DRGs in the NIS are categorized into five classifications: no class specified, minor loss of function, moderate loss of function, major loss of function, and extreme loss of function. Additionally, admission type (emergency, urgent, elective, newborn, trauma center, other), and admission source (emergency department, another hospital, other health facility, court/law enforcement, routine) were coded in the NIS. Together, these three variables were utilized as covariates in all multivariable logistic regression models to adjust for the severity of injuries patients harbored prior to admission.

In addition to our primary analyses, we conducted a series of secondary analyses. We conducted survey-adjusted multivariable logistic regression analysis with the primary predictor of interest being individual months, with July as a reference group and the outcome of HAC occurrence. We further analyzed our primary exposure of July versus non-July admissions and stratified it by the presence of an operating room

TABLE 1. Population Demographics, 2008 to 2011*

| | July Admission, n = 12,003,545 | | Non-July Admission, n = 131,015,837 | |
|-------------------------------------|-----------------------------------|-------|--|-------|
| | N | % | N | % |
| Patient demographic factors | | | | |
| HAC occurrence | | | | |
| HAC during admission | 594,000 | 4.9% | 6,145,000 | 4.7% |
| No HAC during admission | 11,410,000 | 95.1% | 124,871,000 | 95.3% |
| Race | | | | |
| White | 6,783,000 | 56.5% | 74,222,000 | 56.7% |
| Black | 1,468,000 | 12.2% | 15,993,000 | 12.2% |
| Hispanic | 1,231,000 | 10.3% | 13,186,000 | 10.1% |
| API | 288,000 | 2.4% | 3,142,000 | 2.4% |
| Native American | 77,000 | 0.6% | 867,000 | 0.7% |
| Other | 360,000 | 3.0% | 3,931,000 | 3.0% |
| Missing | 1,798,000 | 15.0% | 19,675,000 | 15.0% |
| Payer information | | | | |
| Medicare | 4,401,000 | 36.7% | 49,209,000 | 37.6% |
| Medicaid | 2,418,000 | 20.1% | 25,977,000 | 19.8% |
| Private insurance | 4,084,000 | 34.0% | 44,106,000 | 33.7% |
| Self-pay | 636,000 | 5.3% | 6,693,000 | 5.1% |
| No charge | 43,000 | 0.4% | 445,000 | 0.3% |
| Other | 393,000 | 3.3% | 4,261,000 | 3.3% |
| Missing | 28,000 | 0.2% | 323,000 | 0.2% |
| Comorbidities | | | | |
| No comorbidities | 3,957,000 | 33.0% | 42,249,000 | 32.2% |
| 1 | 2,104,000 | 17.5% | 23,209,000 | 17.7% |
| 2 or more | 5,943,000 | 49.5% | 65,557,000 | 50.0% |
| Age category | | | | |
| ≤18 years | 1,965,000 | 16.4% | 21,702,000 | 16.6% |
| 19–30 years | 1,482,000 | 12.3% | 15,385,000 | 11.7% |
| 30–40 years | 1,156,000 | 9.6% | 12,091,000 | 9.2% |
| 40–50 years | 1,196,000 | 10.0% | 12,737,000 | 9.7% |
| 50–65 years | 2,323,000 | 19.4% | 25,458,000 | 19.4% |
| 65–80 years | 2,345,000 | 19.5% | 26,218,000 | 20.0% |
| >80 years | 1,536,000 | 12.8% | 17,424,000 | 13.3% |
| Gender | | | | |
| Female | 6,994,000 | 58.3% | 76,146,000 | 58.1% |
| Male | 4,984,000 | 41.5% | 54,571,000 | 41.7% |
| Missing | 26,000 | 0.2% | 300,000 | 0.2% |
| Hospital demographic factors | | | | |
| Hospital region | | | | |
| Northeast | 2,561,000 | 21.3% | 27,650,000 | 21.1% |
| Midwest | 3,007,000 | 25.1% | 32,799,000 | 25.0% |
| South | 3,878,000 | 32.3% | 42,696,000 | 32.6% |
| West | 2,557,000 | 21.3% | 27,872,000 | 21.3% |
| Hospital location | | | | |
| Rural | 1,507,000 | 12.6% | 16,760,000 | 12.8% |
| Urban | 10,348,000 | 86.2% | 112,639,000 | 86.0% |
| Missing | 149,000 | 1.2% | 1,617,000 | 1.2% |
| Hospital teaching status | | | | |
| Nonteaching | 6,129,000 | 51.1% | 67,447,000 | 51.5% |
| Teaching | 5,726,000 | 47.7% | 61,952,000 | 47.3% |
| Missing | 149,000 | 1.2% | 1,617,000 | 1.2% |
| Hospital bed size | | | | |
| Small | 1,496,000 | 12.5% | 16,479,000 | 12.6% |
| Medium | 2,905,000 | 24.2% | 31,800,000 | 24.3% |
| Large | 7,453,000 | 62.1% | 81,120,000 | 61.9% |
| Missing | 149,000 | 1.2% | 1,617,000 | 1.2% |
| Admission severity factors | | | | |
| Admission source | | | | |
| Emergency department | 1,078,000 | 9.0% | 12,425,000 | 9.5% |
| Another hospital | 110,000 | 0.9% | 1,219,000 | 0.9% |
| Other health facility | 61,000 | 0.5% | 664,000 | 0.5% |
| Court/law enforcement | 3,000 | 0.0% | 35,000 | 0.0% |
| Routine | 1,545,000 | 12.9% | 16,529,000 | 12.6% |

TABLE 1. Continued

| | July Admission, n = 12,003,545 | | Non-July Admission, n = 131,015,837 | |
|--|-----------------------------------|-------|--|-------|
| | N | % | N | % |
| Missing | 9,205,000 | 76.7% | 100,144,000 | 76.4% |
| Admission type | | | | |
| Emergency | 4,842,000 | 40.3% | 53,386,000 | 40.7% |
| Urgent | 1,985,000 | 16.5% | 21,747,000 | 16.6% |
| Elective | 2,570,000 | 21.4% | 28,276,000 | 21.6% |
| Newborn | 1,130,000 | 9.4% | 11,625,000 | 8.9% |
| Trauma | 57,000 | 0.5% | 508,000 | 0.4% |
| Other | 4,000 | 0.0% | 45,000 | 0.0% |
| Missing | 1,417,000 | 11.8% | 15,430,000 | 11.8% |
| All-Patient Refined DRG, severity | | | | |
| No class specified | 10,000 | 0.1% | 132,000 | 0.1% |
| Minor loss of function | 4,289,000 | 35.7% | 46,092,000 | 35.2% |
| Moderate loss of function | 4,313,000 | 35.9% | 47,150,000 | 36.0% |
| Major loss of function | 2,630,000 | 21.9% | 28,939,000 | 22.1% |
| Extreme loss of function | 762,000 | 6.3% | 8,704,000 | 6.6% |

NOTE: Abbreviations: API, Asian/Pacific Islander; DRG, Diagnosis-Related Group; HAC, hospital-acquired complication.

*Numbers are rounded to the 1,000th place.

procedure as a surrogate measure of surgical versus nonsurgical admissions. We also analyzed LOS and total charges as continuous outcomes to elucidate the precise impact of HACs and July admission. Finally, to address the issue of missing values, we conducted a four-step multiple imputation for complex data with categorical variables using the methods outlined by Berglund et al.¹⁸ In doing so, we created five imputed datasets using a Markov Chain Monte Carlo method, producing monotone missing data patterns for a four-step procedure. We imputed the missing data using the monotone logistic facet of the multiple imputation model. We then used survey-adjusted logistic regression to estimate odds ratios (ORs) for each of the imputed datasets. Finally, we combined the results from the five logistic regression models by fully incorporating the variance adjustment from both logistic regressions and multiple imputations (PROC MIANALYZE).¹⁸ These analyses were similarly adjusted for with the same patient, hospital, and severity demographics adjusted for in the original model.

Statistical significance was achieved with a *P* value <0.05. All descriptive and logistic regression analyses were performed using SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Overview Demographics

There were 143,019,381 inpatient admissions between 2008 and 2011 in the NIS. Overall, 4.7% (6,738,949) of all US hospital inpatient admissions had incurred at least 1 HAC (Table 1). Approximately 7.6% of inpatient admissions occurred in July, whereas 83.5% occurred in the months of August to June (8.9% of

data is missing). July admits had a higher overall frequency of HAC occurrence compared to non-July admissions (4.9% vs 4.7%). There were marginal differences between hospital and patient factors associated with admissions in July compared to those in other months. The majority of patients in both July and non-July admissions were between 66 and 80 years old (Table 1).

The most commonly occurring HACs were falls (5,863,778), pressure ulcers (731,103), vascular catheter-associated infections (364,204), and catheter UTIs (290,207). HAC frequency showed a marked increase from 2008 to 2011.

HAC Occurrence

Multivariate logistic regression demonstrated that the likelihood of having one or more HACs was 6% higher in July admits compared to non-July admits, adjusting for patient and hospital covariates (OR = 1.06, 95% confidence interval [CI]: 1.06–1.07, $P < 0.0001$). However, admission during July was not the most significant predictor of an HAC occurrence (Table 2). Institutional factors, such as teaching hospitals (OR = 1.22, 95% CI: 1.16–1.28, $P < 0.001$ vs nonteaching hospitals) and large (OR = 1.11, 95% CI: 1.06–1.17, $P = 0.0002$ vs small bed-size facilities) and medium-sized facilities (OR = 1.06, 95% CI: 1.00–1.13, $P = 0.0461$ vs small bed-size facilities) were the most powerful predictors of HAC occurrence during an inpatient hospitalization (Table 2). Additionally, in a separate subanalysis with the month of admission as the primary exposure of interest, we noted that each month except for August demonstrated statistically significant decreased odds of HAC occurrence when compared to July (see Supporting Table 1 in the online version of this article). As the adjusted HAC likelihood was not statistically different between August and July, an additional analysis was run with the primary exposure being July and August admission versus all other months of admission. These resulted in a finding of 7% increased likelihood of HAC occurrence among July and August admissions compared to all others (OR = 1.07, 95% CI: 1.06–1.07, $P < 0.0001$; see Supporting Table 2 in the online version of this article). Similarly, a multiple imputation model adjusting for missing values produced a very similar July effect estimate to the nonimputed model (OR = 1.06, 95% CI: 1.03–1.09, $P < 0.01$).

We utilized similar models adjusting for the same patient, hospital, and severity factors in teaching hospital population. Patients discharged from teaching hospitals were 7% more likely to incur an HAC during admission in July compared to those admitted in the other months (OR = 1.07, 95% CI: 1.06–1.08, $P < 0.01$).

Higher Inpatient Charges and Prolonged LOS

The presence of one or more HACs was a significant predictor for higher inpatient charges (Table 3;

TABLE 2. July Admission on Hospital-Acquired Complication Occurrence Multivariable Analysis

| | OR | 95% CI | P Value |
|-------------------------------------|-------|--------------|---------|
| Patient demographic factors | | | |
| Admission time | | | |
| July admit | 1.06 | 1.06–1.07 | <0.0001 |
| Non-July admit | | Reference | |
| Race | | | |
| White | | Reference | |
| Black | 0.78 | 0.75–0.80 | <0.0001 |
| Hispanic | 0.81 | 0.76–0.85 | <0.0001 |
| API | 0.75 | 0.71–0.80 | <0.0001 |
| Native American | 0.92 | 0.83–1.02 | 0.1256 |
| Other | 0.91 | 0.84–0.98 | <0.0001 |
| Payer information | | | |
| Medicare | 1.00 | 0.97–1.02 | 0.7151 |
| Medicaid | 0.87 | 0.83–0.90 | <0.0001 |
| Private insurance | | Reference | |
| Self-pay | 1.27 | 1.20–1.33 | <0.0001 |
| No charge | 1.07 | 0.92–1.23 | 0.3871 |
| Other | 1.93 | 1.82–2.05 | <0.0001 |
| Comorbidities | | | |
| No comorbidities | | Reference | |
| 1 | 0.84 | 0.82–0.86 | <0.0001 |
| 2 or more | 0.70 | 0.68–0.72 | <0.0001 |
| Age category | | | |
| ≤18 years | 0.35 | 0.33–0.37 | <0.0001 |
| 19–30 years | 0.33 | 0.32–0.35 | <0.0001 |
| 30–40 years | 0.32 | 0.31–0.33 | <0.0001 |
| 40–50 years | 0.36 | 0.35–0.37 | <0.0001 |
| 50–65 years | 0.37 | 0.36–0.38 | <0.0001 |
| 65–80 years | 0.45 | 0.45–0.46 | <0.0001 |
| >80 years | | Reference | |
| Gender | | | |
| Female | 0.92 | 0.90–0.93 | <0.0001 |
| Male | | Reference | |
| Hospital demographic factors | | | |
| Hospital region | | | |
| Northeast | | Reference | |
| Midwest | 1.06 | 1.00–1.13 | 0.2563 |
| South | 1.11 | 1.06–1.22 | 0.0005 |
| West | 1.08 | 0.97–1.20 | 0.1431 |
| Hospital location | | | |
| Rural | | Reference | |
| Urban | 1.01 | 0.96–1.06 | 0.7144 |
| Hospital teaching status | | | |
| Nonteaching | | Reference | |
| Teaching | 1.22 | 1.16–1.28 | <0.0001 |
| Hospital bed size | | | |
| Small | | Reference | |
| Medium | 1.06 | 1.00–1.13 | 0.0461 |
| Large | 1.11 | 1.06–1.17 | 0.0002 |
| Admission severity factors | | | |
| Admission source | | | |
| Emergency department | 1.63 | 1.48–1.80 | <0.0001 |
| Another hospital | 1.96 | 1.76–2.17 | <0.0001 |
| Other health facility | 1.62 | 1.30–2.03 | <0.0001 |
| Court/law enforcement | 1.37 | 1.01–1.85 | 0.0438 |
| Routine | | Reference | |
| Admission type | | | |
| Emergency | 2.15 | 2.03–2.28 | <0.0001 |
| Urgent | 1.28 | 1.20–1.35 | <0.0001 |
| Elective | | Reference | |
| Newborn | 0.69 | 0.63–0.76 | <0.0001 |
| Trauma | >1000 | <0.001–>1000 | 0.9962 |
| Other | 0.91 | 0.53–1.55 | 0.7183 |

TABLE 2. Continued

| | OR | 95% CI | P Value |
|-----------------------------------|------|-----------|---------|
| All-Patient Refined DRG, severity | | | |
| No class specified | 0.73 | 0.62–0.85 | <0.0001 |
| Minor loss of function | | Reference | |
| Moderate loss of function | 1.14 | 1.12–1.16 | <0.0001 |
| Major loss of function | 1.61 | 1.57–1.66 | <0.0001 |
| Extreme loss of function | 4.65 | 4.50–4.80 | <0.0001 |

NOTE: Abbreviations: API, Asian/Pacific Islander; CI, confidence interval; DRG, Diagnosis-Related Group; OR, odds ratio.

TABLE 3. Higher Inpatient Costs and Prolonged LOS Multivariable Analysis

| | OR | 95% CI | P Value |
|------------------------|------|-----------|---------|
| Higher inpatient costs | | | |
| Admission time | | | |
| July admit | 1.00 | 0.99–1.01 | 0.9693 |
| Non-July admit | | Reference | |
| HAC occurrence | | | |
| HAC occurrence | 1.81 | 1.74–1.87 | <0.0001 |
| No HAC occurrence | | Reference | |
| Prolonged LOS | | | |
| Admission time | | | |
| July admit | 0.98 | 0.98–0.99 | <0.0001 |
| Non-July admit | | Reference | |
| HAC occurrence | | | |
| HAC occurrence | 1.45 | 1.42–1.48 | <0.0001 |
| No HAC occurrence | | Reference | |

NOTE: Abbreviations: CI, confidence interval; HAC, hospital-acquired complication; LOS, length of stay; OR, odds ratio.

OR = 1.81, 95% CI: 1.74-1.87, $P < 0.0001$), when adjusting for July admission, patient and hospital factors, and admission severity. HAC occurrence was also a significant predictor of prolonged LOS (Table 3; OR = 1.45, 95% CI: 1.42-1.48, $P < 0.0001$). Mean inpatient charges and LOS in this sample were \$33,662.00 and 4.6 days. Patients with at least 1 HAC had a mean inpatient charge of \$61,457.00, whereas those with no HAC had a mean charge of \$32,377.00. Furthermore, LOS was prolonged in patients with HACs versus those who did not have HACs during hospitalization (7.14 days vs 4.49 days). Our regression analyses indicated that HAC patients had 1.48 ($P < 0.0001$) more days of LOS and \$18,258.00 ($P < 0.0001$) more in total charges.

DISCUSSION

This study analyzes the relationship between admission month and the incidence of HACs in a national sample. This study is also among the first to examine preventable complications as a measure of inefficiencies and inexperience of new staff during staff turnover in the month of July. In our retrospective cohort study of more than 100 million admissions across 4

years, we found a 4.9% prevalence of HACs among July admits compared to 4.7% in the non-July admission population. In multivariate analysis, July admissions were associated with a 6% increased likelihood of HACs. Such data are concordant with other studies that demonstrate a positive July effect on mortality and efficiency.^{3,19} Evaluation of a surgical cohort revealed an 18% increase in risk-adjusted surgical morbidity and a 41% increase in risk-adjusted surgical mortality during July and August, using the American College of Surgeons' National Surgical Quality Improvement Program.²⁰ Though several studies have noted worsened outcomes during the month of July, results have been mixed. Several studies in subspecialty populations or local databases suggest no clear increase in mortality or complication rate.^{3–5,21–25} This current study is the first to examine these relationships using HACs as a surrogate measure indicative of quality of care and safety of new staff in the month of July.

Although multiple investigations studying July admission use mortality as an outcome measure, evaluation of preventable hospital complications may actually be more reflective of the impact of new staff on care quality and safety.^{20,26–29} Mortality rates can be significantly confounded by patient-specific factors, such as disease severity and comorbidities, whereas iatrogenic adverse events, such as HACs, are postulated to be more reflective of errors in systems and processes within the healthcare delivery institution. For example, studies demonstrate that anesthetic procedures that do not result in mortality are often associated with significant increases in complications such as central and peripheral nerve injuries, inadequate oxygenation, perioperative vomiting/aspiration, and technical failures of tracheal tube placement.¹ It is therefore not surprising that studies show July admissions are associated with longer LOS and duration of procedure, in addition to increased hospital charges.³

We did attempt to adjust for the effect of disease severity on HACs by incorporating 3M's APR-DRG system, admission source, and admission type into our multivariate analyses. After adjusting for disease severity in our multivariate analysis, July admission maintained a statistically significant association with increased HAC incidence.

In our secondary analyses, we noted that all months except for August experienced significantly decreased odds of HAC occurrence compared to July admissions with similar magnitudes of likelihood found when combining July and August admissions versus all others (see Supporting Tables 1 and 2 in the online version of this article). This "spillover" finding may indicate the learning curve of inexperienced and new hospital staff and also suggest that the July effect is not limited only to the month of July. However, because the magnitudes of the 2 models (Table 2; Supporting Table 2 in the online version of this article)

are so similar, we continue to refer to this phenomena as the July effect, with the known implication that there is a continuance beyond July and into August.

It is of interest to note that when the analysis was subsetted to only teaching institutions, July admissions in the teaching hospital cohort showed significant increases in HAC likelihood compared to non-July admissions. Although studies suggest that inexperienced residents contribute to patient complications, the increased rate of HACs in July admits may also be multifactorial.³⁰ It is likely that the need for new healthcare staff to gain experience, familiarity, and effective communication also influences the HAC rate. The impact of nursing and ancillary staff involvement in the prevention of HACs is crucial. Although the July effect was primarily focused on physician elements, the nursing and ancillary staff elements are more clearly noted when evaluating HACs as an outcome. Pilot studies including multidisciplinary hospital, nursing, and physician teams, involving a significant effort to streamline communication and established protocols, have resulted in drastic decreases in patient falls, the most common of the HAC occurrences.³¹ The increased hires during this time period (as new physicians and nurses complete training in June) accompanied with the need to acclimate these groups to one another and to train them on established protocols may result in risks for HACs not previously noted when evaluating more standard outcome measures.

Separate studies have shown worsened outcomes for July surgical admissions in large databases, with results indicating longer operative times for July admissions, inpatient mortality, intraoperative complications, and postoperative morbidity in areas like cardiac or spinal surgeries.^{20,22,26,32-34} Similarly, other studies noted that medical admissions also demonstrated worse outcomes for July admissions, resulting in increased fatal medication errors, preventable complications, and worse documentation errors.^{21,28,30,35,36} In the present study, July admissions demonstrated an increased likelihood of HACs when stratified by surgical and medical admissions, as seen in the current literature.

Our study also indicates that surgical patients are noted to have a 2% increase in HACs during July versus a 9% July increase in medical patients. To the authors' knowledge, this is one of the first studies to stratify a patient population by surgical and medical services to evaluate the effect of July admission on outcomes. Possible explanations are that surgical candidates are often medically optimized prior to elective procedures, requiring a stringent protocol to be executed prior to performing an operation on a patient. Thus, the surgical patients are inherently prescreened to be of better overall health to be deemed operable compared to the traditional medicine patient. Rich et al. (1993) performed a comparison analysis of multiple services, noting that patients with internal medicine

diagnoses demonstrated the expected July effect with declines in diagnostic and pharmaceutical changes throughout the year as an indicator of improved experience leading to decreased utilization.³⁶ However, in that same study, the authors noted no discernible July effect among surgical patients, possibly related to the difference in resource utilization emphasized in the medical versus surgical programs.³⁶

The presence of one or more HACs was a significant predictor for higher inpatient charges, when adjusting for July admission and patient/hospital factors. HAC occurrence was also a significant predictor of prolonged LOS. This is in concordance with multiple prior studies noting the association of higher LOS with HAC occurrence.³⁷⁻⁴² This further supports the elevated HAC-associated burden predicted by the CMS when compiling specific HACs.³⁸⁻⁴² Further studies in the coming years may determine whether CMS HAC regulation translates to decreased inpatient admissions durations and cost reductions over time.

This study has several limitations largely associated with the use of a standardized national database. Coding of HACs depends on consistent and accurate reporting, with errors resulting in information bias. Estimates regarding ICD-9-CM coding in the NIS have been cited as approximately 80% accurate.⁴³ Furthermore, missing variables, though noted in results, and the heterogeneity of the study population, may influence the data. Unfortunately, the nature of the data collection throughout NIS practices is not uniform within states, which may explain why a percentage of data is missing. Because of this data structure, NIS does not have documentation of the month during which an HAC was noted for admissions spanning multiple months. In regard to the missing data, we attempted to account for this using a multiple imputation model that generated similar results to our original model with "missing categories" coded into it; with the only major difference being expectedly larger standard errors.⁴⁴ With yearly changes in CMS coding, the addition and familiarity with new codes may influence analysis over time. Of note, the HAC denoting "pressure ulcer" did not exist before 2009. We were also unable to use splines to incorporate a time-series method, as the focus of our study was targeted to looking at the higher incidences of HACs associated with July admission and not a temporal trend prior to and after July, and also the limitations we had in number of time points required for a proper time series analysis.⁴⁵ Finally, HACs are only capable of evaluating inpatient events and omit events occurring after discharge.

CONCLUSIONS

These data reveal an increase in HAC frequency during the month of July in a large national sample of patients. Recognition of a noted statistical trend in July may direct necessary attention to a time

associated with increased occurrence of preventable iatrogenic adverse events. The HACs represent potential breakdowns in organizational structure distinct from traditional measures of safety, such as mortality and specialty-specific morbidity. New guidelines dedicated to improving HACs during this time may help to decrease prevalence in both teaching and nonteaching hospitals.

Disclosures: Nothing to report.

References

- Haller G, Myles PS, Taffe P, Perneger TV, Wu CL. Rate of undesirable events at beginning of academic year: retrospective cohort study. *BMJ*. 2009;339:b3974.
- Barzansky B, Etzel SI. Medical schools in the United States, 2007–2008. *JAMA*. 2008;300(10):1221–1227.
- Young JQ, Ranji SR, Wachter RM, Lee CM, Niehaus B, Auerbach AD. “July effect”: impact of the academic year-end changeover on patient outcomes: a systematic review. *Ann Intern Med*. 2011;155(5):309–315.
- van Walraven C, Jennings A, Wong J, Forster AJ. Influence of house-staff experience on teaching-hospital mortality: the “July phenomenon” revisited. *J Hosp Med*. 2011;6(7):389–394.
- McDonald RJ, Cloft HJ, Kallmes DF. Impact of admission month and hospital teaching status on outcomes in subarachnoid hemorrhage: evidence against the July effect. *J Neurosurg*. 2012;116(1):157–163.
- Morse BC, Boland BN, Blackhurst DW, Roettger RH. Analysis of Centers for Medicaid and Medicare Services “never events” in elderly patients undergoing bowel operations. *Am Surg*. 2010;76(8):841–845.
- Milstein A. Ending extra payment for “never events”—stronger incentives for patients’ safety. *N Engl J Med*. 2009;360(23):2388–2390.
- Rosenthal MB. Nonpayment for performance? Medicare’s new reimbursement rule. *N Engl J Med*. 2007;357(16):1573–1575.
- Wen T, He S, Attenello F, et al. The impact of patient age and comorbidities on the occurrence of “never events” in cerebrovascular surgery: an analysis of the Nationwide Inpatient Sample. *J Neurosurg*. 2014;121(3):580–586.
- Joice GA, Deibert CM, Kates M, Spencer BA, McKiernan JM. “Never events”: Centers for Medicare and Medicaid Services complications after radical cystectomy. *Urology*. 2013;81(3):527–532.
- Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project. Available at: <http://www.ahrq.gov/data/hcup/index.html>. Accessed June 2013.
- Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project. HCUP frequently asked questions. Available at: www.hcup-us.ahrq.gov/tech_assist/faq.jsp. Accessed January 2015.
- US Department of Health and Human Services. Centers for Medicare & Medicaid Services. Hospital-acquired conditions (HAC) in acute inpatient prospective payment system (IPPS) hospitals. Available at: <http://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/wPOAFactSheet.pdf>. Accessed June 2013.
- Zhan C, Miller MR. Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization. *JAMA*. 2003;290(14):1868–1874.
- Hamdy O, Ernst FR, Baumer D, Mustad V, Partridge J, Hegazi R. Differences in resource utilization between patients with diabetes receiving glycemia-targeted specialized nutrition vs standard nutrition formulas in U.S. hospitals. *JPEN J Parenter Enteral Nutr*. 2014;38(2 suppl):86S–91S.
- Stanford R, McLaughlin T, Okamoto LJ. The cost of asthma in the emergency department and hospital. *Am J Respir Crit Care Med*. 1999;160(1):211–215.
- Mullen MT, Kasner SE, Kallan MJ, Kleindorfer DO, Albright KC, Carr BG. Joint Commission primary stroke centers utilize more rt-PA in the Nationwide Inpatient Sample. *J Am Heart Assoc*. 2013;2(2):e000071.
- Berglund PA. An introduction to multiple imputation of complex sample data using SAS 9.2. Paper presented at: SAS Global Forum Proceedings, April 11–14, 2010; Seattle, WA.
- Blumberg MS. Measuring surgical quality in Maryland: a model. *Health Aff*. 1988;7(1):62–78.
- Englesbe MJ, Pelletier SJ, Magee JC, et al. Seasonal variation in surgical outcomes as measured by the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP). *Ann Surg*. 2007;246(3):456–462; discussion 463–465.
- Inaba K, Recinos G, Teixeira PG, et al. Complications and death at the start of the new academic year: is there a July phenomenon? *J Trauma*. 2010;68(1):19–22.
- Bakaeen FG, Huh J, LeMaire SA, et al. The July effect: impact of the beginning of the academic cycle on cardiac surgical outcomes in a cohort of 70,616 patients. *Ann Thorac Surg*. 2009;88(1):70–75.
- Ford AA, Bateman BT, Simpson LL, Ratan RB. Nationwide data confirms absence of “July phenomenon” in obstetrics: it’s safe to deliver in July. *J Perinatol*. 2007;27(2):73–76.
- Barry WA, Rosenthal GE. Is there a July phenomenon? The effect of July admission on intensive care mortality and length of stay in teaching hospitals. *J Gen Intern Med*. 2003;18(8):639–645.
- Weaver KJ, Neal D, Hoh DJ, Mocco J, Barker FG II, Hoh BL. The “July phenomenon” for neurosurgical mortality and complications in teaching hospitals: an analysis of more than 850,000 neurosurgical patients in the nationwide inpatient sample database, 1998 to 2008. *Neurosurgery*. 2012;71(3):562–571; discussion 571.
- Anderson KL, Koval KJ, Spratt KF. Hip fracture outcome: is there a “July effect.” *Am J Orthop*. 2009;38(12):606–611.
- Shuhaiber JH, Goldsmith K, Nashef SA. Impact of cardiothoracic resident turnover on mortality after cardiac surgery: a dynamic human factor. *Ann Thorac Surg*. 2008;86(1):123–131.
- Phillips DP, Barker GE. A July spike in fatal medication errors: a possible effect of new medical residents. *J Gen Intern Med*. 2010;25(8):774–779.
- Gosbee J. Human factors engineering and patient safety. *Qual Saf Health Care*. 2002;11(4):352–354.
- Walling HW, Veremakis C. Ordering errors by first-year residents: evidence of learning from mistakes. *Mo Med*. 2004;101(2):128–131.
- Goldsack J, Bergey M, Mascioli S, Cunningham J. Hourly rounding and patient falls: What factors boost success? *Nursing*. 2015;45(2):25–30.
- McDonald JS, Clarke MJ, Helm GA, Kallmes DF. The effect of July admission on inpatient outcomes following spinal surgery: clinical article. *J Neurosurg Spine*. 2013;18(3):280–288.
- Dhaliwal AS, Chu D, Deswal A, et al. The July effect and cardiac surgery: the effect of the beginning of the academic cycle on outcomes. *Am J Surg*. 2008;196(5):720–725.
- Bohl DD, Fu MC, Gruskay JA, Basques BA, Golinvaux NS, Grauer JN. “July Effect” in elective spine surgery: analysis of the American College of Surgeons National Surgical Quality Improvement Program Database. *Spine*. 2014;39(7):603–611.
- Shulkin DJ. The July phenomenon revisited: are hospital complications associated with new house staff? *Am J Med Qual*. 1995;10(1):14–17.
- Rich EC, Hillson SD, Dowd B, Morris N. Specialty differences in the ‘July Phenomenon’ for Twin Cities teaching hospitals. *Med Care*. 1993;31(1):73–83.
- Teufack SG, Campbell P, Jabbar P, Maltenfort M, Evans J, Ratliff JK. Potential financial impact of restriction in “never event” and peri-procedural hospital-acquired condition reimbursement at a tertiary neurosurgical center: a single-institution prospective study. *J Neurosurg*. 2010;112(2):249–256.
- Allman RM, Goode PS, Burst N, Bartolucci AA, Thomas DR. Pressure ulcers, hospital complications, and disease severity: impact on hospital costs and length of stay. *Adv Wound Care*. 1999;12(1):22–30.
- Fleischmann KE, Goldman L, Young B, Lee TH. Association between cardiac and noncardiac complications in patients undergoing noncardiac surgery: outcomes and effects on length of stay. *Am J Med*. 2003;115(7):515–520.
- Lee MK, Dodson TB, Karimbux NY, Nalliah RP, Allareddy V. Effect of occurrence of infection-related never events on length of stay and hospital charges in patients undergoing radical neck dissection for head and neck cancer. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2013;116(2):147–158.
- Stansbury JP, Jia H, Williams LS, Vogel WB, Duncan PW. Ethnic disparities in stroke: epidemiology, acute care, and postacute outcomes. *Stroke*. 2005;36(2):374–386.
- Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: adverse quality of life, excess length of stay, and extra cost. *Infect Control Hosp Epidemiol*. 2002;23(4):183–189.
- Burns EM, Rigby E, Mamidanna R, et al. Systematic review of discharge coding accuracy. *J Public Health (Oxf)*. 2012;34(1):138–148.
- Ghosh S, Pahwa P. Assessing bias associated with missing data from joint Canada/US survey of health: an application. *Biometrics Section JSM*. 2008;3394–3401.
- Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther*. 2002;27(4):299–309.