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Original Research

The July Effect in Podiatric Medicine and Surgery Residency

Dominick J Casciato, DPM[1], John Thompson, DPM[1], Rona Law, DPM, AACFAS[2], Mallory Faherty, PhD[3], Ian Barron, DPM, AACFAS[4], Randall Thomas, DPM, FACFAS[4]

[1] Resident Physician, Medical Education Department, Grant Medical Center, Columbus, OH
[2] Fellow, Mon Valley Foot and Ankle Fellowship, Belle Vernon, PA
[3] OhioHealth Research Institute, Riverside Methodist Hospital, Columbus, OH
[4] Teaching Faculty, Medical Education Department, Grant Medical Center, Columbus, OH

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ABSTRACT

The period when medical students begin residency in teaching hospitals throughout the United States heralds a period known in the medical community as the “July Effect.” Though several sentinel studies associated this timeframe with an increase in medical errors, residencies since demystified this phenomenon within their respective specialty. This study aims to evaluate the presence of the July Effect in a podiatric medicine and surgery residency program. A retrospective chart review was conducted, comparing patient demographics and surgical outcomes including length of stay, operative time and readmission rate between the first (July, August, September) and fourth (April, May June) quarters of the academic year from 2014-2019. A total of 206 patients met the inclusion criteria, where 99 received care in the first, resident-naïve, quarter and 107 received care in the fourth, resident-experienced, quarter. No difference in patient demographics including sex, body mass index, or comorbidity index was appreciated between both quarters ($p<0.05$). Those patients who underwent soft tissue and bone debridements, digital, forefoot, midfoot and rearfoot amputations experienced no statistically significant difference in length of stay, operative time, or readmission rate between both quarters ($p<0.05$). The results of this study did not support the presence of the July Effect in our foot and ankle surgery residency. Future studies can further explore this phenomenon by examining patients admitted following traumatic injury or elective procedures. Moreover, this study shows the curriculum employed at our program provides sufficient support, guidance, and resources to limit errors attributed to the July Effect.

Resident participation in surgery and medical decision-making plays a central role in graduate medical education. By challenging the physician-in-training to apply their knowledge to clinical situations, medical residency remains an integral aspect of professional growth. From encountering complications to managing comorbidities from the first day of training, residency accelerates the transition from a passive student to an active resident. In the United States of America, this turnover begins in July; heralding in a period colloquially termed the July Effect. This effect describes the perceived increase in risk of surgical complications and medical errors following the initiation of medical school graduates into residency (1).

Though this phenomenon was originally based off anecdotal evidence, research has supported the July Effect. Specifically, the July spike in mortality, secondary to fatal medication errors or intraoperative complications, was attributed to new medical residents (1,2). Conversely, several studies failed to establish a link between the start of medical residency and fatal errors of operating room mismanagement (3,4). From joint arthroplasty to neurological surgery, the transition from student to resident showed no significant change in patient safety (5,6). Currently, no studies describe newly appointed or promoted resident effects as they relate to podiatric medicine and surgery residents.

Following the paucity of data examining the July Effect in podiatric medicine and surgery, we undertook a chart review to determine any effects this transition period has on patient care. Our primary aim was to compare the length of stay between cases in the first and last quarter of the residency year. Our secondary aims were (1) to compare the percentage of patients who exhibited early or late complications following several foot surgeries between the first and last quarter of the residency year (2) to compare time of each operation (3) to compare pain experienced between similar cases in the first and last quarter, and (4) to determine patient characteristics that contribute to complications and/or longer post-operative admissions.

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Address correspondence to: Dominick J Casciato, DPM, Medical Education Department, Grant Medical Center, 111 South Grant Avenue, Columbus, OH 43215.
E-mail address: dominick.casciato@ohiohealth.com (D.J. Casciato).

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Materials and Methods

Following institutional review board approval from the OhioHealth Research Institute (1486650-3), a retrospective chart review from the foot and ankle surgery inpatient log was conducted between the first (Q1) and last quarter (Q4) of July 2014 – June 2019 among patients admitted to GMC from multiple attendings offices and ultimately necessitated soft tissue debridement, digital amputations, forefoot amputations, midfoot amputations, or rearfoot amputations. Q1 (July-September) represented the period when residents were the least trained during their respective residency year and Q4 (April-June) represented the period when residents were the most trained during their respective residency year.

Study data were collected and managed using REDCap electronic data capture tools hosted at OhioHealth Grant Medical Center (7,8). REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

Patient Characteristics

As illustrated in Fig., patients admitted pre-operatively from multiple attendings' offices for a soft tissue or osseous debridement as well as foot amputations at varying levels were included in this study. Patients who received surgery from an ancillary service while admitted, or those that underwent foot and ankle surgery as a result of a consultation while admitted were excluded. This was done to limit analysis to patients admitted to the foot and ankle surgery service. In this residency program, as the admitting service, the resident has more responsibility for patient care from coordinating admission to discharge with surgery in between. Furthermore, this limits instances where resident involvement was a fraction of the patient care, such as those in intensive care or receiving treatment for terminal conditions where the primary and secondary aims may be biased. Pediatric patients, defined as those receiving care under the age of 18, were excluded from this study. Patients who did undergo surgery during this period but did not have a resident participate in their surgical case and pre or postoperative care during admission, as noted in the patients' charts, were excluded from this study. Demographic data including the patient's age, gender, weight, height, and BMI were collected. The collected medical history included smoking status, diabetes, hypertension, and chronic kidney disease. Each patient's pre-anesthesia medical co-morbidities as well as 10-year survival rate were calculated using the American Society of Anesthesiologists (ASA) classification and Charlson Comorbidity Index respectively (9,10).

Postoperative Outcomes

Primary outcomes of interest were the length of stay of those patients who underwent soft tissue debridements, digital amputations, forefoot amputations, midfoot amputations, or rearfoot amputations compared between the first and last quarters of the residency year. Along with laterality, the reason for procedure (infection, revision) as well as total length of hospital stays and length of stay after surgery were recorded.

The percentage of patients with early complications (readmitted within first 30 days) and late complications (30 days after discharge) between the first and last quarters of the residency year was then compared. Only patients who are re-admitted for a post-operative problem were considered for the study. These patients were identified by chief compliant on the readmission note, podiatry consultation upon readmission, or admission to the podiatry service. Operative time (minutes) and pain using the Defense and Veterans Pain Rating Scale (DVPRS) as recorded in the medical record were then compared between first and last quarter (11).

Statistical Analysis

All study data was summarized with descriptive statistics. Continuous variables were summarized with means, standard deviations, medians and ranges. Categorical variables were summarized with counts and percentages. Data was summarized overall and separately by first and last quarter of residency year.

Patient group (Q1 and Q4) demographics and medical history was compared on to ensure the groups are statistically equivalent (Table 1). Student's *t*-test was used to compare continuous variables and Fisher's exact test was used to compare categorical variables. Analysis was performed by combining and examining soft-tissue debridements;

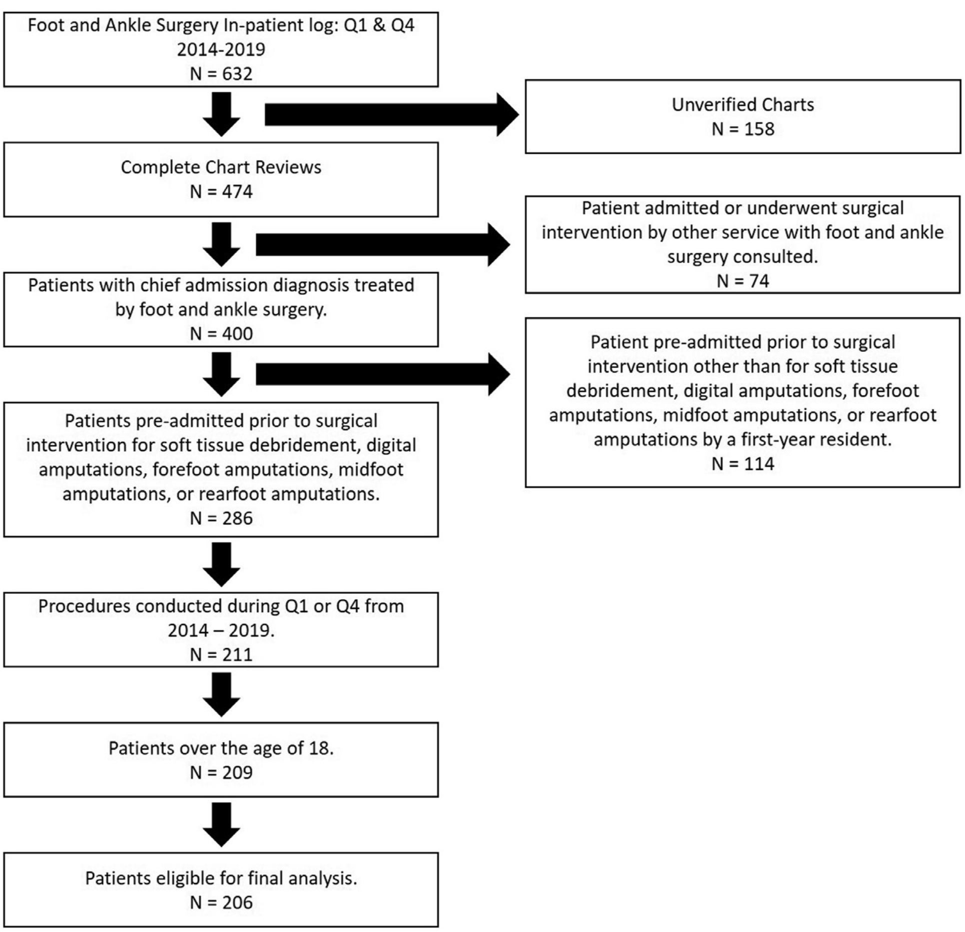

Fig. Flowchart detailing selection of patient charts prior to separation into respective quarters.

Table 1
Patient demographics during study period separated into period of treatment, Q1 and Q4

Demographics	Overall N = 206	First Quarter N = 99 (48.06%)	Last Quarter N = 107 (51.94%)	Significance $p < .05$
Age	56.18 ± 11.85	56.19 ± 11.83	56.17 ± 11.92	.99
Gender, n (%)				.06
Male	131 (63.59%)	56 (56.57%)	75 (70.09%)	
Female	75 (36.41%)	43 (43.43%)	32 (29.91%)	
Weight (lbs)	239.7 ± 67.60	243 ± 62.71	231.9 ± 71.99	.49
Height (inches)	69.24 ± 4.4	69.41 ± 4.15	69.08 ± 4.64	.59
BMI (kg/m^2)	35.08 ± 9.3	35.39 ± 8.48	34.79 ± 10.04	.64
		Medical history		
Smoking, n (%)				.21
No	100 (48.54%)	53 (53.54%)	47 (43.93%)	
Yes	106 (51.46%)	46 (46.46%)	60 (56.07%)	
Diabetes, n (%)				.43
No	29 (14.08%)	16 (16.16%)	13 (12.15%)	
Yes	177 (85.92%)	83 (83.84%)	94 (87.85%)	
Hypertension, n (%)				.73
No	41 (19.9%)	21 (21.21%)	20 (18.69%)	
Yes	165 (80.1%)	78 (78.79%)	87 (81.31%)	
Chronic Kidney Disease, n (%)				.87
No	162 (78.64%)	77 (77.78%)	85 (79.44%)	
Yes	44 (21.36%)	22 (22.22%)	22 (20.56%)	
ASA Classification, n (%)				.56
1	1 (0.49%)	0	1 (0.93%)	
2	14 (6.8%)	8 (8.08%)	6 (5.61%)	
3	136 (66.02%)	68 (68.69%)	68 (63.55%)	
4	54 (26.21%)	23 (23.23%)	31 (28.97%)	
5	1 (0.49%)	0	1 (0.93%)	
6	0 (0%)	0	0	
Charlson Comorbidity Index (CCI) Score, n (%)				.43
0	6 (2.91%)	2 (2.02%)	4 (3.74%)	
1	7 (3.4%)	2 (2.02%)	5 (4.67%)	
2	35 (16.99%)	22 (22.22%)	13 (12.15%)	
3	34 (16.5%)	16 (16.16%)	18 (16.82%)	
4	29 (14.08%)	14 (14.14%)	15 (14.02%)	
5+	95 (46.12%)	43 (43.43%)	52 (48.60%)	
Procedure, n (%)				.87
Soft Tissue and Bone Debridement	74 (35.92%)	36 (36.36%)	38 (35.51%)	
Digital Amputation	68 (33.01%)	33 (33.33%)	35 (32.71%)	
Forefoot Amputation	55 (26.7%)	27 (27.27%)	28 (26.17%)	
Midfoot and Rearfoot Amputation	9 (4.37%)	3 (3.03%)	6 (5.61%)	

digital amputations; forefoot amputations, midfoot amputations and rearfoot amputations. Patient group (first and last quarter) operative and post-operative variables were compared. Wilcoxon rank sum test was used to compare time and pain variables (denoted in tables as "^"). Fisher's exact test was used to compare categorical variables.

Patient group (Q1 and Q4) were compared on the percentage of patients with early complications using a Fisher's exact test. In addition, the same will be done for late complications and death, separated for early medical complications and early surgical complications. The primary outcome, length of stay, was examined in total between both periods, as well as following grouping into short (≤5 days) and long (>5 days) stay. Five days was chosen as it represented the median length of stay in this study. Similarly, 5 days is just above the average length of stay, 4.75 days, reported in a similar patient population in a facility without a disease management program specific to the diabetic foot (12). Results with a p-value less than or equal to 0.05 will be considered statistically significant. A power analysis was performed using G*Power, with an effect size of 0.5, and a p-value of 0.05 with power set at 0.90 which recommended a sample size of 172 split between two groups, which this study met (13).

Results

A total of 206 patients were included in the final analysis, greater than the sample size calculated by the power analysis. Table 1 shows that Q1 (n = 99, 48.06%) and Q4 (n = 107, 51.94%) groups were nearly equivalent in size. Patient demographics between Q1 and Q4 were comparable as shown in Table 1. The groups did not differ by age, gender, height, weight, or body mass index (BMI). Overall, more patients were male than female, the average age was 56.18 years (±11.85), and the average BMI was 35.08 ± 9.30 kg/m^2. Likewise, the groups did not differ by smoking status, history of diabetes, history of hypertension, history of chronic kidney disease, American Society of Anesthesiologists (ASA) classification, Charlson Comorbidity Index (CCI), or procedure type. Proportion of patients who underwent soft tissue debridements or varying levels of amputations did not significantly differ between periods.

First and last quarter groups did not significantly differ on most perioperative variables including total length of stay (p = .269), initial (p = .112) or final (0.071) pain assessments, and operative time (p = .746) except for the early surgical complications following surgical interventions as shown in Table 2. For this group, a greater proportion of patients experienced complications in Q4 (20 patients; 18.69%) stemming from the previous foot and ankle surgical intervention compared to Q1 (6 patients; 0.61%), and this difference was statistically significant (p = .007).

The proportion of patients exhibiting a long admission, greater than 5 days, did not significantly differ between Q1 and Q4. Among patients with an admission greater than 5 days (n = 34), the most common reason for this was delayed primary closure (DPC; 26.47%). Of those with early medical complications (n = 7), pain was the most common reason for early medical readmission (n = 3, 42.86%) as shown in Table 3. Of those with early surgical complication (n = 26), half needed revision

Table 2
Analysis for patients who had undergone surgical interventions

All Procedures	Overall N = 206	First Quarter N = 99 (48.06%)	Last Quarter N = 107 (51.94%)	Significance $p < .05$
Laterality, n (%)				.949
Left	96 (46.60%)	45 (45.45%)	51 (47.66%)	
Right	102 (49.51%)	50 (50.50%)	52 (48.60%)	
Bilateral	8 (3.88%)	4 (4.04%)	4 (3.74%)	
Reason, n (%)				.934
Infection	199 (46.60%)	96 (46.60%)	103 (96.26%)	
Revision	2 (46.60%)	1 (46.60%)	1 (0.93%)	
Other	5 (46.60%)	2 (46.60%)	3 (2.80%)	
Operative time (minutes)	32.65 ± 15.69	33.02 ± 15.82	32.31 ± 15.64	.746*
Initial DVPRS pain	3.12 ± 3.39	2.73 ± 3.29	3.47 ± 3.46	.122*
Final DVPRS pain	2.89 ± 3.02	2.49 ± 2.97	3.25 ± 3.02	.071*
Length of hospital stay	6.00 ± 3.00	5.00 ± 3.00	6.00 ± 3.00	.269*
Length of stay following procedure	2.95 ± 2.86	2.66 ± 2.56	3.22 ± 3.11	.156*
Short length of stay (admission < or equal to 5 days)	172 (83.50%)	81 (81.82%)	91 (85.05%)	.577
Long length of stay (admission >5 days)	34 (16.50%)	18 (18.18%)	16 (14.95%)	
Early medical readmission, n (%)				.121
No	199 (99.60%)	98 (98.99%)	101 (94.39%)	
Yes	7 (3.40%)	1 (1.10%)	6 (5.61%)	
Early surgical complication, n (%)				.007
No	180 (87.37%)	93 (93.94%)	87 (81.31%)	
Yes	26 (12.56%)	6 (0.61%)	20 (18.69%)	
Late complication needing revision, n (%)				1.00
No	187 (90.78%)	90 (90.90%)	97 (90.65%)	
Yes	19 (9.22%)	9 (9.09%)	10 (9.35%)	
30-day death rate, n (%)				.498
No	204 (99.03%)	99 (100.00%)	105 (98.13%)	
Yes	2 (0.97%)	0 (0.00%)	2 (0.97%)	

* Wilcoxon rank sum test (nonparametric).

(n = 13, 50.00%). Of those with late complication (n = 19), 84.21% needed revision (n = 16).

Discussion

The association between the year-end transition of new residents into clinical practice and medical errors, termed the July Effect, has been the subject of much debate. Since its original description in 1990 and subsequent studies citing increased mortality in teaching-hospitals and medication errors during the month of July, some residency programs have made changes to the beginning of their respective academic year (14-16). These programs cited limited trainee experience, lack of understanding of hospital workflow, and difficulty using electronic medical record systems as the most common factors that attribute to errors in July (15). Contrary to these findings, several residencies ranging from neurological to orthopedic surgery found no merit in this phenomenon following their investigations (6,17-20). Though previous research has shown that resident involvement in open reduction and internal fixation of ankle fractures does not increase postoperative complications, no study analyzes the July Effect and the impact new foot and ankle surgery residents have on patient care (21).

To evaluate the effect of new residents on patient care, admission and operative characteristics were compared in patients who underwent surgery and medical management from first-year foot and ankle surgery residents between Q1 and Q4 of the residency year. Importantly, there was no difference in the recorded pre-anesthesia medical co-morbidity score as seen in ASA Classification and CCI which predicts the ten-year survival in patients with multiple comorbidities. This similarity between both periods illustrates a mostly commensurate population regarding patient health, which also appears in cohorts examined by other specialties (6,22). Though no previous study specifically examined this seasonal variation in patient demographics and the July Effect, our results shows that neither period was prone to treating "sicker" patients.

Table 3
Analysis for patients whose stay was greater than 5 nights following surgical intervention

All Procedures	Overall	First Quarter	Last Quarter	Significance $p < .05$
Reason for overnight stay > 5 days following surgery, n (%)				.628
Delayed Primary Closure (DPC)	19 (55.88%)	9 (50.00%)	10 (62.50%)	
Skilled Nursing Facility Placement (SNF)	9 (26.47%)	6 (33.33%)	3 (18.75%)	
Culture and Pathology Results (Cx/Path)	1 (2.94%)	0 (0.00%)	1 (6.25%)	
Medical Management (MM)	4 (11.76%)	2 (11.11%)	2 (12.50%)	
Home Health Care (HH)	1 (2.94%)	1 (5.56%)	0 (0.00%)	
Early medical readmission reason of those with early medical complications, n (%)				.400
Pain	3 (42.86%)	0 (0.00%)	3 (50.00%)	
Shortness of breath	2 (28.57%)	1 (100.00%)	1 (16.67%)	
Sepsis	1 (14.29%)	0 (0.00%)	1 (16.67%)	
Urinary tract infection	1 (14.29%)	0 (0.00%)	1 (16.67%)	

Among patients who underwent soft tissue or osseous debridements as well as forefoot, midfoot, or rearfoot amputations, the operative time was no different in each group of procedures between Q1 and Q4. Sanford and colleagues similarly reported such findings when evaluating operational inefficiency secondary to the July Phenomenon in terms of operating minutes, overutilized minutes, or the number of ORs working late in July (23). Length of hospital stay, the primary outcome of this study, was no different between Q1 and Q4. As Riguzzi and colleagues similarly pointed out, the presence of residents is not attributable to an increase in length of stay due to errors or teaching (24). Shah also shared this outcome, citing no change in length of stay among a sample of 470,000 cardiac procedures (25). Along with length of stay, the overall early readmission, late complication, and 30-day death rate between Q1 and Q4 did not reach significance, further disparaging the phenomenon that July admissions result in greater complications. Such results could be attributable to workload or time spent on each patient as Averbukh and colleagues concluded when studying 12,118 admissions on their medical teaching service (26). The early surgical complication rate did differ between Q1 and Q4; however, as Q4 experienced a higher proportion of patient complications, this outcome contradicts the theory of the July Effect.

We recognize that our study has several limitations and due its retrospective nature, we can only make correlational claims. As only two quarters of the year are being assessed, the sample size is not as large as several publications utilizing health system-wide databases. Likewise, a single electronic medical records system was used to track and collect information from follow-up visits and some data may be inaccessible due to visits occurring in offices that do not log notes in the same electronic medical record. It is also possible that follow-up visits did not occur and no data was collected. Thus, the present study focused only on inpatient complications following surgery necessitating an emergency room visit, readmission, and possible surgical revision.

Though this study does not consist of all patients who underwent surgery during this period, the study population provides for a limitation of potential biases inherent in many types of podiatric medicine and surgery cases. For example, analyzing only patients admitted preoperatively to Grant Medical Center limits the potential biases by minimizing the number of comorbidities of the study population. For instance, patients consulted for podiatry services while receiving care for another health issue, typically have multiple comorbidities being treated during the admission, which can greatly impact the course of the hospital stay and is outside the purview of this study. As the patients presented in this study were admitted to the foot and ankle surgery service with the medicine team consulted, the inpatient stay was overseen and coordinated by the resident, limiting changes to care beyond the resident's control. Furthermore, elective procedures first-year residents typically do not contribute other than medical management were excluded to limit bias, such as complex reconstruction cases, accounted for many of the excluded patients (114) as shown in Fig.

Moreover, as this study examines one institution, policies set in place by different programs may share the same outcome. For example, at Grant Medical Center, second and first-year residents share inpatient responsibilities together in both Q1 and Q4 with no change in oversight responsibilities. Similarly, cases reported in this study, as most inpatient cases at this program, are performed and managed by first-year residents at the discretion of the attending physician and senior resident which we recognize as a limitation.

In conclusion, the results of this study show an absence of the July Effect in our hospital's foot and ankle surgery residency. The preservation of patient care during periods of promotion during the residency cycle as examined in this study places foot and ankle surgery resident performance alongside several medical and surgical specialties. With knowledge of the impact of each year's new residency class on patient care, directors may be rest assured senior residents provide sufficient overlook during this transition from school to residency. Future studies can further analyze the July Effect with respect to other pathologies residents, specifically first-year residents, encounter, including traumatic injuries or elective procedures. Overall, this study suggests that current foot and ankle surgery residency training at our institution provides sufficient support, guidance, and resource to limit errors attributed to the July Effect.

Author Contributions

Dominick Casciato, John Thompson, and Rona Law assisted with the data collection and drafting of the manuscript. Mallory Faherty assisted with data analysis and IRB approval. Ian Barron and Randall Thomas assisted with editing and drafting of the manuscript.

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