



# Surgical Residents' Proficiency and Turnover May Affect the Overall Efficiency in an Emergency Department

Francesco Mongelli<sup>1</sup> · Henning Fischer<sup>2</sup> · Michael Stickel<sup>2</sup> · Miriam Patella<sup>3</sup> · Nickolaus Heeren<sup>1</sup> · Michael Christ<sup>2</sup> · Markus Gass<sup>1</sup>

Published online: 18 June 2019  
© Société Internationale de Chirurgie 2019

## Abstract

**Background** Within Emergency Department (ED), problem responsiveness and organizational capacity are extremely important for providing acute care. The “July effect” has been described as the period when junior doctors start new turnovers, possibly reflecting on hospital and ED efficiency. The objective of this study was to investigate the impact of residents' turnover on ED efficiency at a Swiss teaching hospital.

**Methods** We retrospectively evaluated patients presenting with surgical needs to ED from June 2014 to January 2019. Data regarding gender, age, length of stay (LOS), resident doctors and level of urgency were collected and analyzed.

**Results** We identified 27,767 surgical admissions treated by 92 residents. The LOS analysis within residents' period in the ED showed a progressive reduction over time, with 80% of proficiency achieved after 98 patients. The mean LOS was 257.3 and 237.6 min during and after the learning curve ( $p < 0.0001$ ), although no difference was noted in triage level 1 patients ( $p = 0.813$ ). By replacing 40–70% of residents (January and July), the LOS raised from 243.1 to 259.7 min (absolute difference 16.6 min,  $p < 0.001$ ), but if only 10–20% of residents newly started, no difference was detected ( $p = 0.071$ ).

**Conclusions** Our study demonstrates that surgical residents' turnover within the ED could affect the overall efficiency. The training period for new resident physicians was a caseload of 98 patients, respectively, 3 weeks of work. The impact of trainees' turnover was only relevant if more than 40% of the resident team is replaced at one time and only less urgent cases were affected.

## Introduction

Resident physicians represent an important workforce within the emergency care provided by hospitals. In addition to progressing within their training program, they provide a huge amount of services that are, in fact, the first line of contact with patients. A good balance between gradually learning the medical profession, progressively assuming roles of responsibility, and the efficiency and safety of the various departments is the basis for the proper functioning of the system in teaching hospitals. The “July effect” has been described as the period in which the junior doctors start new turnovers in different departments. It has

✉ Francesco Mongelli  
francesco.mongelli@mail.com

<sup>1</sup> Department of Surgery, Luzerner Kantonsspital, Spitalstrasse, 6000 Lucerne, Switzerland

<sup>2</sup> Emergency Department, Luzerner Kantonsspital, Lucerne, Switzerland

<sup>3</sup> Department of Surgery, Ospedale Regionale di Bellinzona e Valli, Bellinzona, Switzerland

been postulated to cause a decrement in the general expertise, possibly affecting the hospital's efficiency, increasing medical errors and waiting time [1–5]. Results of different studies investigating the clinical impact of this phenomenon have been heterogeneous, globally reducing the overall scale of the problem and its media resonance [6, 7].

It is intuitive that junior doctors are less experienced and need time to acquire the necessary tools to recognize and discriminate between different clinical questions and possible solutions. Moreover, beyond the personal clinical expertise, people take time to adapt to new working environments and to gather confidence with different workflows. Within Emergency Department (ED), problem responsiveness and organizational capacity are extremely important for providing acute care to patients. Bahl et al. [1] found that annual turnover of resident staffing has a significant impact on ED efficiency and called for action to mitigate this effect.

In our hospital and, more generally, within the Swiss Health Service, trainees turnover is organized according to departments' policies and needs. New trainees continuously enter the program without a fixed month over the year, and they are gradually incorporated in the different services. Particularly, in our ED, surgical trainees rotate every six months changing half of the entire medical contingent every three months. This schedule has been built to ensure adequate training to each resident without influencing ED efficiency.

The objective of this study was to investigate the impact of the interim period on surgical trainees' ability to deal with a high-volume ED. We aimed to evaluate the length of stay of patients admitted to the ED during different periods of rotation of surgical residents and to identify the possible "critical" time frame in which ED workflow could be affected by doctors' inexperience.

## Materials and methods

### Data collection

The ED of the Luzerner Kantonsspital, Luzern, Switzerland, is a tertiary care provider. We retrospectively evaluated the access and length of stay (LOS) of patients presenting with surgical needs to ED from June 2014 to January 2019. Informed consent was not required since all data in this study were fully anonymized. Data regarding gender, age, admission time and date, destination (inpatients or outpatients), resident doctor responsible for the patient, specialty, level of urgency and admissions in resuscitation room were collected using the local emergency care information system (E.care bvba, Campus

Blairon 754, 2300 Turnhout, Belgium). Length of stay (LOS) was defined as the difference between the triage (visiting or waiting room) and the discharge of the patient to the ward, operatory room, intensive care or home. Emergency levels were defined as resuscitation (level 1), emergent (level 2), urgent (level 3), less urgent (level 4) and non-urgent (level 5) using the Emergency Severity Index triage system [8].

### ED organization

At our institution, residents of different surgical specialties and at different years of training are scheduled for a clinical rotation within the ED for a period of usually 6 months. Each ED surgical resident is responsible for the patients he/she takes care of after the initial triage, with the supervision of a senior surgeon physician. Patients triaged as level 1 cases are primarily managed by the senior physician, while a resident responsible for the patient in terms of clinical findings, laboratory tests, imaging and specialist consultations primarily evaluates patients in triage levels 2–5. "Walk-in" patients are primarily referred to a separate department ("acute care clinic") managed by a general practitioner and dedicated to less urgent cases. If further specialist evaluations are necessary, affected patients are redirected to our ED. Every 3 months, 25–75% of the ED residents' team is subjected to turnover.

### Statistical analysis

The statistical software used was MedCalc Statistical Software version 17.9.5 (MedCalc Software bvba, Ostend, Belgium; <http://www.medcalc.org>; 2017). The Pearson's test confirms a normal distribution, with a coefficient of skewness of 1.0218 ( $p < 0.0001$ ). An analysis on the seasonal variability on the workload in the ED was performed. An analysis of variance (ANOVA) test was used to evaluate admission times between resident's periods of activity. The threshold of statistical significance was set at  $p < 0.05$ . To determine the relation between admission time, level of emergency/urgency, level of experience and specialty, multiple R-squared line regression analysis was performed. For each resident, we evaluated the admission time trend over period in the ED with a logarithmic tendency line. The number of patients required to achieve 80% of the mean overall time improvement was used as a cutoff to define the learning curve. We compared the mean admission time during the learning curve and after the learning curve, as well as during turnover and non-turnover periods both in the overall and in subgroup analyses. Finally, the LOS and the percentage of new residents during the turnover periods were plotted.

## Results

During the study period, 92 surgical residents had a clinical rotation to our ED. We identified 85,082 admissions in our ED, of whom 27,767 displayed complete data and were referred to surgical care. The overall mean age of patients was  $52.2 \pm 21.9$  years, and 61.2% were male. Detailed data about the distribution of patients, age, gender and LOS divided for subspecialties are presented in Table 1. Statistical significant differences among subgroups were noted, indicating, as expected, a non-uniform distribution of patients among surgical specialties. The seasonal variability analysis showed no relevant differences among the different periods of the year either in the overall or in subgroup analysis.

The overall analysis of the LOS within residents' period in the ED showed a progressive reduction over time. In particular, the logarithmic tendency line indicated that the 80% of proficiency was achieved after the 98th patient visited and managed (Fig. 1). Therefore, we considered the first 98 patients as the number needed for the learning curve by residents working in the "new environment." On this basis, the mean LOS of surgical ED patients was  $257.3 \pm 15.7$  min and  $237.6 \pm 25.5$  min during and after the learning curve, respectively (absolute difference of 19.8 min,  $p < 0.0001$ ). The subgroup analysis for subspecialties showed no noteworthy differences as compared to the overall analysis for patients with an emergency/urgency levels 2, 3, 4 and 5. Of interest, in triage level 1 emergency patients and those admitted to the resuscitation room, the admission time trend has not changed. In the first ED period and specifically during the learning phase, the mean LOS was  $183.0 \pm 22.1$  min while in the late period it was  $180.1 \pm 26.6$  min (absolute difference of 2.9 min,  $p = 0.813$ ).

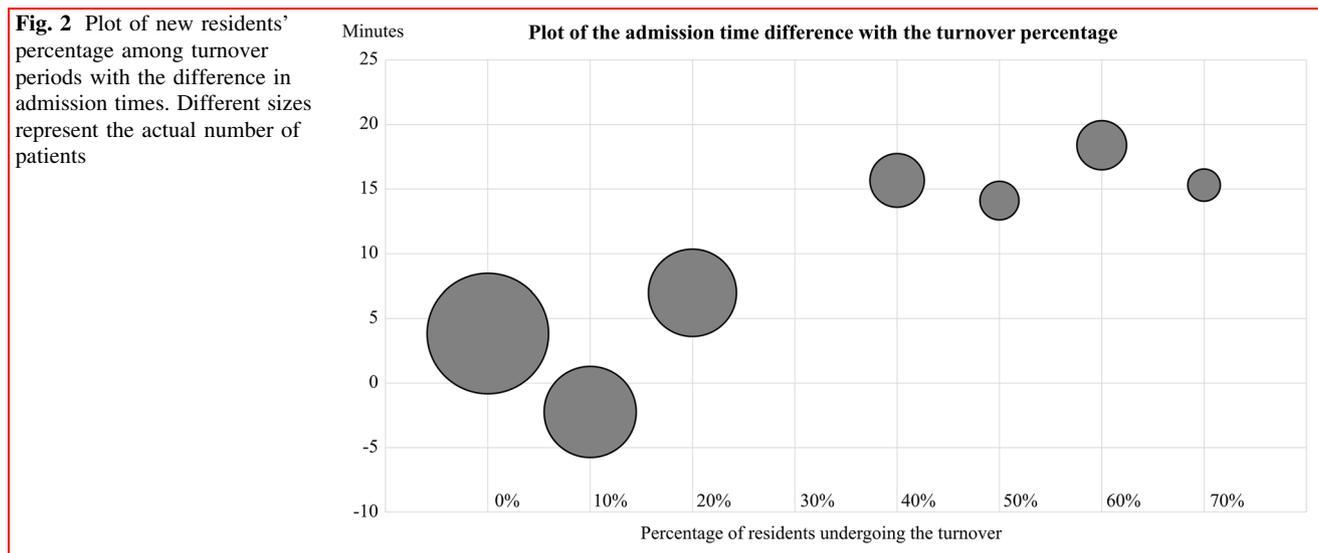
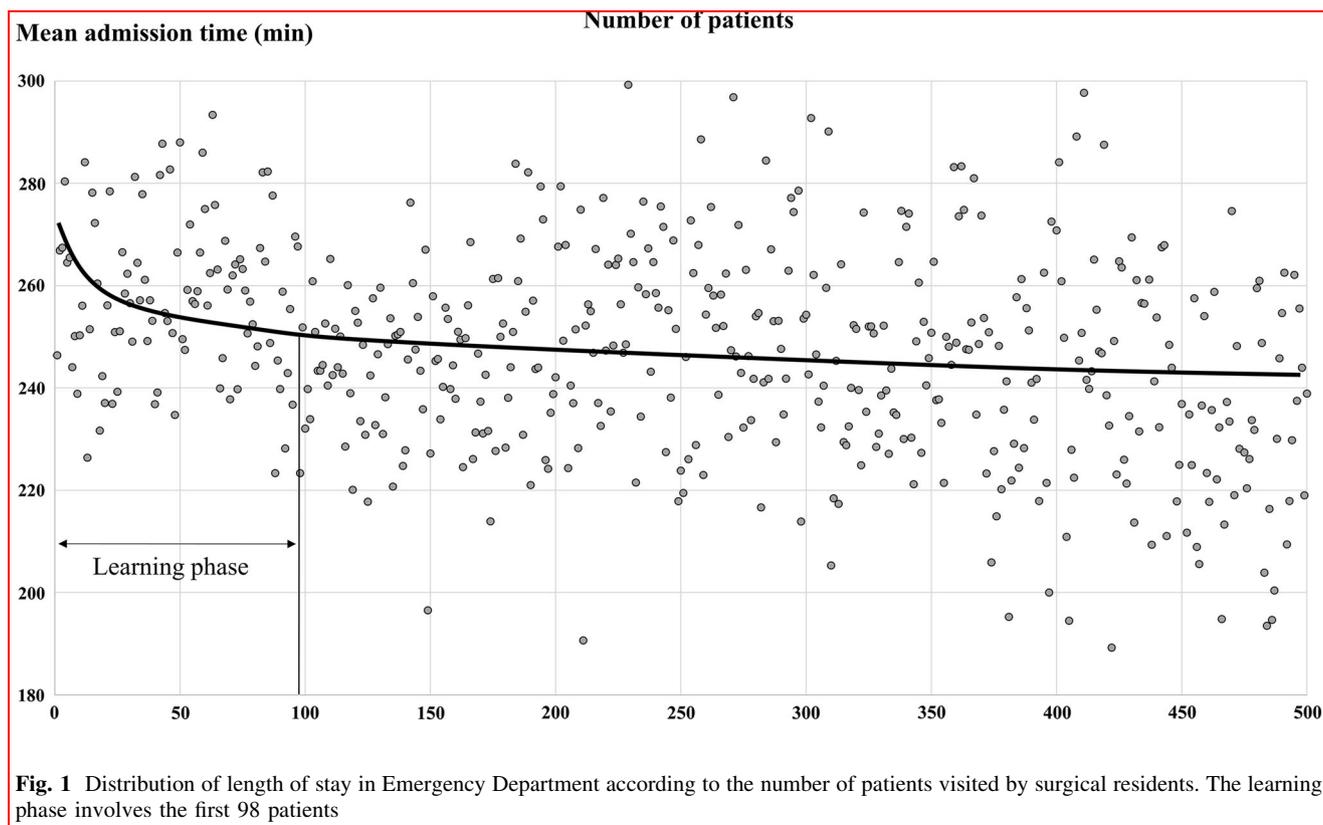
In order to compare how the residents' turnover affected the overall ED efficiency, we identified the turnover periods. Several times the new entries were distributed homogeneously, being only one or two residents new, out of a staff of ten physicians. However, in January and July a turnover of 40–70% of the residents occurred. Within the first week of rotation, the staff of the ED was increased by one experienced resident to support the initial training of new residents. When one or two residents were newly introduced, the overall admission time in the ED was not statistically significant different, being  $247.9 \pm 132.1$  min vs.  $256.1 \pm 133.4$  min during 3 weeks before and after the turnover, respectively ( $p = 0.071$ ). On the contrary, when 40–70% of the staffed residents are exchanged, the overall admission time was  $243.1 \pm 141.4$  min vs.  $259.7 \pm 142.2$  min (absolute difference 16.6 min,  $p < 0.001$ ). Figure 2 shows the plotted difference in LOS by percentage of trainee. A subgroup analysis was performed for the specialties providing more than 10% of patients (hand and plastic surgery, traumatology, urology and visceral surgery). No statistical significant difference was noted among the turnover periods when one or two residents were newly introduced in any of the specialties. On the other hand, when the high turnover periods of January and July have been analyzed, a significant difference was noted in the LOS before and after the new entries for hand and plastic surgery ( $222.5 \pm 139.9$  min vs.  $241.2 \pm 149.8$  min, absolute difference 18.7 min,  $p = 0.005$ ) and for traumatology ( $240.2 \pm 142.0$  min vs.  $252.6 \pm 137.8$  min, absolute difference 12.4 min,  $p = 0.015$ ). No statistical significant difference was noted for urology ( $274.2 \pm 146.8$  min vs.  $280.5 \pm 136.9$  min, absolute difference 6.3 min,  $p = 0.092$ ) and visceral surgery ( $307.8 \pm 153.3$  min vs.  $321.0 \pm 150.3$  min, absolute difference 13.2 min,  $p = 0.126$ ).

**Table 1** Data about the distribution of patients, age, gender and admission time divided into subspecialties

Specialty	Cases (%)	Age (years)	Male gender (%)	Admission time (min)	<i>p</i>
Internal medicine	2.8	$56.6 \pm 23.3$	62.7	$276 \pm 188$	<0.05*
Cardio-thorax surgery	1.6	$57.1 \pm 20.7$	75.1	$258 \pm 142$	
Hand and plastic surgery	14.7	$43.3 \pm 18.5$	71.2	$215 \pm 138$	
Maxillofacial surgery	2.9	$45.4 \pm 21.4$	58.9	$214 \pm 132$	
Neuro-surgery	2.3	$57.8 \pm 20.0$	56.5	$245 \pm 131$	
Spine surgery	3.0	$57.7 \pm 18.7$	54.4	$278 \pm 134$	
Traumatology	35.6	$53.9 \pm 23.5$	55.2	$246 \pm 136$	
Urology	17.1	$56.6 \pm 20.7$	76.3	$260 \pm 134$	
Vascular surgery	3.9	$70.3 \pm 15.2$	67.2	$256 \pm 135$	
Visceral surgery	16.1	$47.3 \pm 20.2$	50.1	$296 \pm 157$	

Continuous variables are expressed as the mean value  $\pm$  standard deviation

\*Indicates a statistically significant difference



## Discussion

Several studies examine the clinical impact of trainee turnover within the ED on patient safety and clinical efficiency. We present first data on the effect of trainee turnover in the ED of a Swiss ED. The major findings of our analysis are the following: (1) The learning phase for trainees was estimated to be 98 cases, corresponding to

3 weeks of work within the ED. (2) Length of stay of triage level 1 patients did not change during residents' turnover, because those patient category is exclusively managed by experienced emergency physicians. (3) Of note, when more than 40% of the ED team is renewed due to trainee turnover, length of stay of ED patients significantly increases by about 20 min. A staff turnover of 10–20% did not significantly influence the overall ED LOS and efficiency.

The term “July effect” has been associated with the yearly turnover of medical trainees in teaching hospitals. In the US Health Care System, the junior doctors’ annual change of the working place during July has been noticed with a reduction in departments’ productivity and a parallel increase in medical errors [3, 9, 10]. However, not all the studies carried out to investigate this phenomenon have shown homogenous results. Depending on the specialty, the “July effect”\* has been demonstrated to be absent [6, 7, 11–14] or largely downsized [15, 16]. In fact, despite many evidence-based clarifications, the “fear” to be mistreated in teaching hospitals at the beginning of the academic year has reached a remarkable media resonance. Of note, even the New York Times published an essay “It’s July, the Greenest Month in Hospitals, No Need to Panic” to try to reassure the US community [2]. Whether the “July effect” is an “urban legend” based on sporadic findings or a real phenomenon has not been adequately evaluated. In addition, no comparable data exist for Middle European countries. Therefore, we assessed efficiency and safety during different times of the year, the week or the day.

In Swiss institutions, residents of different surgical specialties begin their working activities according to hospitals’ needs and the beginning of an academic year is different for every resident. This kind of organization appears therefore less prone to suffer from the July effect [1]. Nevertheless, it is possible that the internal turnover through different wards and specialties makes a large percentage (up to 75%) of residents to start contemporarily in a new environment.

The Luzerner Kantonsspital is a large volume teaching hospital, rated as Class A within the Swiss medical teaching system. The ED of the Luzerner Kantonsspital cares for about 22,000 patients per year of which 12,000 present with surgical symptoms. The “first-line” doctors evaluating these patients are surgical and medical trainees from different specialties and at different levels of their medical education. Of course, each resident acts under the supervision of a senior doctor, but he/she takes his/her own responsibilities and gradually gains autonomy. Along with the acquisition of personal medical experience, the trainees learn to deal with administrative work, organization and workflow of the ED. This skills achievement pathway, altogether, represents a learning curve with the result of ultimately optimizing timing and productivity.

In some studies in ED environment, the definition of this period of least experience and its comparison with most experience periods is arbitrary [1, 17]. The first analysis of our study was intended to clearly define the period (expressed as number of visits done) in which the trainees continue to reduce the average time needed to visit a patient and take decisions. This threshold has been identified at 98 patients visited, which can be translated into a

period of three weeks of work in our ED. After this number, the learning curve reaches a plateau, possibly limited by many variables outside the control of the trainee [18]. Interestingly, in more urgent cases, as level 1 and patients in the resuscitation room, the LOS was comparable during and after the learning phase. This finding possibly reflects the presence of senior physicians during the evaluation and the first treatments of these patients, or the observance of more strict guidelines and pathways for severe and life-threatening conditions.

Analyzing the turnover periods, we found that a change in 10–20% of surgical trainees’ staff does not affect the overall LOS, but when this proportion rises over 40%, the efficiency of the ED decreases. This condition was found to be significant when analyzing both the overall population and the different specialties (hand and plastic surgery and traumatology). On average, 16.6 additional minutes per patient, in a regular day in which the affluence is about 33 patients, produces an increase of 9.1 h of ED occupation time per day. This observation usually happens twice during the year. Consequently, it appears reasonable to reduce the team turnover for new trainees to less than 40%. In our example, 20 residents are planned to do their rotation every year within the ED and it would be possible to change only one or two residents every months. In this case, the needed turnover would be fully covered without possibly compromising the ED efficiency. Moreover, ED should take into account the possibility to plan some residents’ rotation for 9 or 12 months in order to reduce the need of team change. Although this kind of organization would be more demanding, it should be further promoted for a better workflow within ED.

Some limitations of this study should be considered: This is a retrospective analysis possibly confounding our conclusions. In addition, clinical information of our ED patients, such as comorbidities, complications and procedures in the ED, was not available for statistical adjustment. This could be a relevant bias in small cohorts of patients, but in our study, we analyzed more than 27,000 admissions in the ED and 92 residents, suggesting robustness of our findings. The large sample size and the completeness of data collection including complete information about level of emergency/urgency of affected patients, length of stay, specialties, responsible residents and period strongly support the generalizability of our conclusions. However, our sensitivity analysis did not show any noteworthy differences as compared to the main analysis. Regarding the LOS, we evaluated the total time from the triage to the final destination (admission or discharge), but no information was provided in terms of subintervals. Since our dataset considered for every patient the responsible resident only and no information was provided in terms of the attending physician, this potential variable

should be considered. Moreover, the LOS is influenced by many variables that are not directly under the physician's control, such as transport delays, patient flow within the hospital, equipment and technology malfunction and consultants waiting. These factors should represent a bias, but the large sample size in our study is expected to mitigate these differences, making this bias less likely. Furthermore, our data represent a single-center experience. Therefore, it is possible that our findings are not directly applicable to other academic centers. Further prospective multicenter studies could help to confirm our results and support our conclusions.

## Conclusions

Our study demonstrates that surgical trainees' turnover within the ED could affect the overall efficiency. The learning phase for trainees was estimated to be 98 cases, corresponding to 3 weeks of work. The impact of trainees' turnover for the workflow of the ED was relevant when more than 40% of the staffed team is renewed. The impact was significant within triage levels 2–5 only, while triage level 1 cases were not affected at all. On the other hand, 10–20% of the staff turnover did not influence the overall LOS and efficiency. ED should consider interventions to better plan in the residents' turnover within the academic year.

## Compliance with ethical standards

**Conflict of interest** All authors have no conflicts of interest or financial ties to disclose.

**Informed consent** Informed consent was not required since all data in this study were fully anonymized and it is no longer possible to track sensible data.

## References

- Bahl A, Hixson CC (2019) July phenomenon impacts efficiency of emergency care. *West J Emerg Med* 20(1):157–162
- Zugar A (2019) Essay: "It's July, the greenest month in hospitals. No need to panic." *New York Times*. Science Desk. 2018. Available at: <https://www.nytimes.com/1998/07/07/science/essay-it-s-july-the-greenestmonth-in-hospitals-no-need-to-panic.html>. Accessed Feb 16 2019
- Phillips DP, Barker GE (2010) A July spike in fatal medication errors: a possible effect of new medical residents. *J Gen Intern Med* 25(8):774–779
- Myers L, Mikhael B, Currier P et al (2017) The association between physician turnover (the "July Effect") and survival after in-hospital cardiac arrest. *Resuscitation* 114:133–140
- Kang H, Bastian ND, Riordan JP (2017) Evaluating the relationship between productivity and quality in emergency departments. *J Healthc Eng* 2–17:1–8
- Yaghoubian A, de Virgilio C, Chiu V et al (2010) "July effect" and appendicitis. *J Surg Educ* 67(3):157–160
- Ford AA, Bateman BT, Simpson LL et al (2007) Nationwide data confirms absence of 'July phenomenon' in obstetrics: It's safe to deliver in July. *J Perinatol* 27(2):73–76
- Tanabe P, Travers D, Gilboy N et al (2005) Refining emergency severity index triage criteria. *Acad Emerg Med* 12(6):497–501
- Inaba K, Recinos G, Teixeira PG et al (2010) Complications and death at the start of the new academic year: is there a July phenomenon? *J Trauma* 68(1):19–22
- Haller G, Myles PS, Taffé P et al (2009) Rate of undesirable events at beginning of academic year: retrospective cohort study. *BMJ* 339:b3974
- Dhaliwal AS, Chu D, Deswal A et al (2008) The July effect and cardiac surgery: the effect of the beginning of the academic cycle on outcomes. *Am J Surg* 196(5):720–725
- Tobert DG, Menendez ME, Ring DC et al (2018) The "July Effect" on shoulder arthroplasty: are complication rates higher at the beginning of the academic year? *Arch Bone Jt Surg* 6(4):277–281
- Buchwald D, Komaroff AL, Cook EF et al (1989) Indirect costs for medical education: Is there a July phenomenon? *Arch Intern Med* 149(4):765–768
- Barry WA, Rosenthal GE (2003) 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* 18(8):639–645
- Bakaen FG, Huh J, LeMaire SA et al (2009) 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* 88(1):70–75
- Chousterman BG, Pirracchio R, Guidet B (2016) Impact of resident rotations on critically ill patient outcomes: results of a French multicenter observational study. *PLoS ONE* 11(9):e0162552
- Riguzzi C, Hern HG, Vahidnia F et al (2014) The July effect: is emergency department length of stay greater at the beginning of the hospital academic year? *West J Emerg Med* 15(1):88–93
- Rathlev NK, Chessare J, Olshaker J et al (2007) Time series analysis of variables associated with daily mean emergency department length of stay. *Ann Emerg Med* 49(3):265–271

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.