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Achieving Accreditation Council for Graduate Medical Education duty hours compliance within advanced surgical training: a simulation-based feasibility assessment

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Abstract

BACKGROUND: Certain operative cases occur unpredictably and/or have long operative times, creating a conflict between Accreditation Council for Graduate Medical Education (ACGME) rules and adequate training experience.

METHODS: A ProModel-based simulation was developed based on historical data. Probabilistic distributions of operative time calculated and combined with an ACGME compliant call schedule.

RESULTS: For the advanced surgical cases modeled (cardiothoracic transplants), 80-hour violations were 6.07% and the minimum number of days off was violated 22.50%. There was a 36% chance of failure to fulfill any (either heart or lung) minimum case requirement despite adequate volume.

CONCLUSIONS: The variable nature of emergency cases inevitably leads to work hour violations under ACGME regulations. Unpredictable cases mandate higher operative volume to ensure achievement of adequate caseloads. Publically available simulation technology provides a valuable avenue to identify adequacy of case volumes for trainees in both the elective and emergency setting.

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Since the implementation of the 80-hour work week by the Accreditation Council for Graduate Medical Education (ACGME) in 2003, numerous studies have documented a decrease in operative volume of general surgery residents, as well as fellowships such as cardiothoracic (CT) surgery.[1–3] Beyond the decreased case volume and time spent in the hospital, another question arises: are we setting up our trainees for inevitable failure? Namely, is it feasible to expect that while engaged in operations which are long and unplanned that residents will be able to meet 2 opposing restrictions set forth by the ACGME: reduced work hours with increasingly rigid schedules and fulfillment of recommended case volume? We hypothesized that it would be impossible for residents who participate in long, emergent cases to consistently comply with ACGME duty hour regulations and to achieve recommended case numbers (graphical abstract). To test these hypotheses, we developed a computer simulation model, based on historical operative data, which enabled us to analyze case volumes and ACGME work hour violations, including 80-hour violations and "day off" violations.

Although the simulator (available at https://goo.gl/Rc47JK) can analyze any type of emergent or elective case distribution, for the purposes of succinct illustration we present here the results of analysis for CT residents training to perform heart and lung transplantations. This analysis is relevant and timely for several reasons: the area of CT transplant encompasses cases that are consistently long and emergent and thus among the most threatened by duty hour regulations. Second, over the last 2 decades, the number of CT transplants increased from 1,500 to over 4,000 cases per year.[4] Consequently, the need to have trained surgeons to meet volume requirements is paramount, but with over 50% of current CT surgeons estimated to be over 55 years old, there is a severe work force shortage predicted by 2020.[5] Furthermore, the number of cases required for certification by the United Network of Organ Sharing (UNOS) has remained unchanged over the past decade.[4] The decrease in time and flexibility available for performing transplants, without a corresponding decrease in the required number, affects the ability of residents to acquire case volume while complying with stricter work hour regulations, and may directly affect the future of CT transplantation, among other advanced surgical training subspecialties.

CT transplantation operative data were obtained retrospectively from institutional billing records and transport logs to build a model for predicting the arrival patterns of emergency operations. This study was approved by the institutional review board (HUM00054073) through a waiver of informed consent, as no identifiable patient information was reported.

An academic tertiary care center which serves as the only CT transplant center in the state was the data source. Data were collected regarding all adults greater than or equal to 18 years of age undergoing lung (January 1, 2009 to June 30, 2011) or heart transplant procedures (July 1, 2008 to June 30, 2011) and heart–lung procurements (April 1, 2009 to June 30, 2011). Time points collected included the following: organ acceptance notification, transportation departure and arrival, and operating room entry/exits. Four (2 junior and 2 senior) residents form the call pool. A standard ACGME compliant call schedule presumes each resident is on a primary service (6 am to 6 pm), 5 days a week with home call occurring every fourth night (6 pm to 6 am) (Table S1). A "primary" resident is on call for transplants, with a "backup" resident on call for procurements. Each resident has 1 day off per week. In this model, work hours range from 60 to 90 hours/week (with a 4-week average of 63 to 79 hours/week), if the resident spent his/her entire call time "in house."

Initial data analysis included calculation of time intervals between critical events and analysis of the distribution of interarrival times between critical events. Using these data, we developed a simulation model using the ProModel simulation language. The model was then run 50 times to simulate 50 years of operations with the same rate of variability as seen in our historic data (Fig. S1), as previously described.[6]

When the simulation is run, it generates the timing of random transplant procedures and matches these procedures to the appropriate resident. The random duration of the procedures is also generated, and this time is mapped to the residents' schedules, determining the amount of call time which is used in participating in the transplant and the amount of time that the procedure carries over into the resident's scheduled rest period. Aggregate calculations are then made over the week and month to determine ACGME compliance and progress toward certification.

Timing data for each step in the process of a transplant from the time of initial organ offer to the time of completion of the transplant and exiting of the operating room were collected and averaged (Table 1) for 118 cardiac transplants, 77 lung transplants, and 132 procurements. Using the operative data, specifically the rate and variability of transplants, 50 years of heart and lung transplants were simulated, resulting in a normal distribution for the number of transplants of each organ per year (Fig. S1). The mean annual volume of heart transplants was 32.82 $\pm$ 6.04 (range 24 to 52) and lung transplants was 31.3 $\pm$ 6.25 (range 16 to 44).

In total, 53% of cardiac transplants, 56% of lung transplants, and 57% of procurements from the historic operative data began during "off-hours" (6 pm to 6 am). When the simulator was run to replicate 50 years for 4 residents (resulting in 10,400 resident-weeks), assuming transplants/procurements as the only emergent cases, there were an estimated 631 violations of the 80-hour average, resulting in an approximate 6% violation rate (95% confidence interval 5.62 to 6.52). The range of work hours per resident over one sample simulated year is shown in Fig. 1. On average, 6.04% of weeks will have a scheduled day off occupied by work. This translates to a day off violation in up to 22.50% of working months.