SPECIFIC AIMS

Acute Care Surgery services account for 20% of all inpatient hospital admissions, but despite this, workforce planning and optimal patient ratios remain undefined. Our prior work demonstrated that 72% of trauma centers exceed their own leadership-recommended maximum patient-to-surgeon (PTS) ratios, yet the impact on patient outcomes has never been quantified. Building upon our existing infrastructure across 32 trauma centers, this study will leverage natural variation in daily patient-to-surgeon ratios to determine their causal effect on patient outcomes.

Primary Aim: Determine the causal relationship between daily patient-to-surgeon ratios and hospital length of stay (LOS) across trauma, emergency general surgery (EGS), and surgical intensive care unit (SICU) services. **Hypothesis:** Patient-to-surgeon ratios above service-specific thresholds will causally increase hospital LOS, with threshold effects rather than linear dose-response. **Secondary Aims:** (1) Identify threshold ratios above which outcomes deteriorate for each service line; (2) Examine whether relationships differ by institutional characteristics; (3) Validate the ICU 1:14 threshold from critical care literature.

SIGNIFICANCE, INNOVATION, AND APPROACH

Significance

This research directly addresses the NTRAP priority question: "What is the optimal ratio of work to faculty surgeons?" Current workforce planning relies on volume metrics (time, wRVUs), ignoring cognitive demands and contributing to inadequate staffing and burnout. The Society of Critical Care Medicine established intensivist-to-patient ratios (maximum 1:14) based on evidence linking excessive workload to mortality, yet no such guidelines exist for ACS. Our prior work found surgeons perceive maximum safe ratios of 20 patients for independent coverage and 40 with full team support on trauma/EGS, with lower SICU thresholds (10-20 patients). Critically, 72% of centers exceed these maximums. Surgeons reported quality degradation at high patient loads, but these perceptions lack outcome validation. This study will provide evidence-based staffing data, inform local decisions, support advocacy, and generate data for future implementation trials.

Innovation

Quasi-Experimental Design: Patient-to-surgeon ratios vary day-to-day primarily because patient volume fluctuates unpredictably and is unrelated to staffing changes. Unpredictable volume surges and lulls create natural variation in ratio exposure that is exogenous to any individual patient's outcome. Within-center comparisons further strengthen causal inference by controlling for all time-invariant institutional factors, allowing each center to serve as its own control during high versus low ratio periods.

Several additional features strengthen the rigor and feasibility of this study. Real-time census and staffing measurement via prospective data collection eliminates recall bias and ensures temporal precision in exposure. Hospital LOS serves as the primary outcome because it is objective, clinically meaningful, routinely collected, and administratively actionable and makes findings directly translatable to staffing policy. Simultaneous examination of trauma, EGS, and SICU services allows identification of service-specific thresholds while controlling for institutional factors. Finally, our existing 32-center Weight of Care study enables rapid site activation with engaged local champions and demonstrated feasibility, substantially de-risking the proposed timeline.

Impact
This study will provide the first causally rigorous, outcome-based evidence for appropriate patient-to-surgeon ratios in trauma, EGS and SICU, directly informing staffing policy across U.S. trauma centers.

Study Design
This prospective, multi-institutional, quasi-experimental study will enroll 10 Level I/II trauma centers through existing networks and will collect data for 12 months. Centers will provide geographic diversity, varying volumes, and are all in academic settings. Each will designate a local champion for weekly staffing data collection and EMR data extracts. The study exploits natural variation in patient-to-surgeon ratios as quasi-experimental exposure both at the center level and the study level. Unpredictable census fluctuations, both surges and lulls, create natural experiments where centers experience high and low ratios at different times, allowing within-center comparisons controlling for time-invariant institutional factors.
Exposure: Daily patient-to-surgeon ratio for each service (trauma, EGS, SICU), calculated as daily admitted census divided by attending surgeons covering each service that day.
Primary Outcome: Hospital LOS (days from admission to discharge) from EMR.
Secondary Outcomes: ICU LOS, discharge disposition, 30-day readmission, mortality.
Unit of Analysis: Patients nested within institutions and cumulative ratio-days above threshold.

STUDY DESIGN, METHODS, AND ANALYTICAL PLAN
Data Collection
Intervention Variable: The intervention variable is the daily patient-to-surgeon ratio for each service line (trauma, EGS, SICU), calculated as the daily admitted census (maximum) divided by the number of attending surgeons covering that service. Daily maximum census will be captured via automated EMR extract or manual extraction and will include both admitted and consulted patients. Attending staffing, along with junior resident (PGY1/2), senior resident (PGY3+), and APP complements will be captured weekly via REDCap data collection tool distributed to local site champions.
Outcome Variables: The primary outcome is hospital LOS, measured in days from admission to discharge via EMR extraction. Secondary outcomes include ICU LOS, discharge disposition, 30-day readmission and mortality. All five outcomes are collected as part of the National Trauma Data Standard (NTDS) or in the EMR and require no incremental data collection.
Covariates: Patient-level covariates include age, sex, injury mechanism, Injury Severity Score (trauma), Charlson Comorbidity Index, and operative management, all standard NTDS elements. For EGS/SICU patients outside existing registries, administrative data will be used. Institutional covariates include trauma center level, academic status, annual volume, and resident/APP presence, which are available through NTDS or require minimal incremental collection (weekly data collection).

Statistical Analysis
Primary Analysis: We will use competing risks regression to estimate the effect of patient-to-surgeon ratios on hospital length of stay, with time from admission to discharge as the primary outcome and in-hospital death as a competing event. Results will be reported as subdistribution hazard ratios (SHR) with 95% confidence intervals, where SHR <1 indicates delayed discharge. We will present cumulative incidence curves for discharge stratified by exposure level (low, medium, high ratio-days above threshold) to visualize the clinical impact of high census. Analyses will be service line specific.

Threshold cutoffs will be 20, 30, 40 and 50 patients for EGS and Trauma (or combined teams) and 10, 15, 20, 25 patients for SICU.

Primary Exposure: Average cumulative ratio-days above threshold, calculated as the mean daily excess (daily census/attending surgeons - threshold) across hospitalization, counting only days above threshold. This metric captures both intensity (how far above threshold) and duration (proportion of stay above threshold) while avoiding time bias so patients with inherently longer LOS do not artificially accumulate more exposure. Covariates will include age, sex, ISS (trauma), comorbidity (National Trauma Databank), operative management, admission month, day of week and weekly available workforce (resident / APPs) and will include robust variance estimation with clustering at institution level. Data for patients outside the NTDB (EGS and SICU) will be collected from administrative EMR data.

Sensitivity Analysis: We will test different census threshold cutoffs and perform an analysis where census is a continuous variable to see if inherent cutoffs exist. Restricted cubic splines will model non-linear dose-response and identify inflection points.

Within-Center Analysis: The primary analysis will use stratified competing risks regression with center-specific baseline hazards, allowing each center to serve as its own control during high versus low ratio periods. This within-center structure controls for all time-invariant institutional factors and is central to our causal inference strategy. For binary secondary outcomes (discharge disposition, 30-day readmission, mortality), logistic regression with a random intercept for center will be used.

Sample Size: We will enroll 10 Level I/II trauma centers selected from our existing 32 to ensure diversity in staffing models, patient populations, and geographic regions. With a median daily census of 15-20 patients per service across 3 service lines and 10 centers, and assuming median LOS of 5-7 days, we estimate approximately 65-120 discharge events per day across all centers, yielding approximately 24,000-44,000 discharge events over the 12-month study period. This substantially exceeds the approximately 1,700 discharge events needed to detect a subdistribution hazard ratio of 1.15 (reflecting ~15% prolongation in median LOS) with 80% power at alpha=0.05, accounting for 3-5% in-hospital mortality as a competing event and clustering within institutions. The additional discharge events provide robust power for inclusion of multiple confounders in the model.

Preliminary Studies

Our group has established the empirical foundation for this proposal through a series of multicenter studies. We first defined a 1.0 cFTE in acute care surgery and this was followed by investigating early career acute care surgeons' priorities. We subsequently applied a standard 1.0 cFTE to 40 trauma centers in the U.S and demonstrated that nearly 80% of U.S. trauma centers operate understaffed. Most directly relevant to the present study, our same EAST multicenter mixed-methods investigation found that surgeons perceive maximum safe ratios of 20 patients for independent coverage and 40 with full team support on trauma/EGS, with lower thresholds on SICU services depending on staffing, yet over 70% of centers exceed these self-reported maximums. Surgeons reported quality degradation at high census, but these perceptions have never been validated against objective patient outcomes. The proposed study fills this gap and leverages our existing 32-center Weight of Care infrastructure, enabling rapid site activation and robust statistical power. Weight of Care measures the differential intensity of the diverse clinical work performed by acute care surgeons. Collectively, this work positions our team uniquely to determine whether patient-to-surgeon ratios above service-specific thresholds causally worsen patient outcomes.