Operative Team Familiarity and Specialization at an Academic Medical Center

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Objective: To propose a framework for quantification of surgical team familiarity.

Background: Operating room (OR) teamwork quality is associated with familiarity among team members and their individual specialization. We describe novel measures of OR team familiarity and specialty experience.

Methods: Surgeon-scrub (SS) and surgeon-circulator (SC) teaming scores, defined as the pair's proportion of interactions relative to the surgeon's total cases in the preceding 6 months were calculated between 2017 and 2021 at an academic medical center. Nurse service-line (SL) experience scores were defined as the proportion of a nurse's cases performed within the given specialty. SS, SC, and nurse-SL scores were analyzed by specialty, case urgency, robotic approach, and surgeon academic rank. Two-sample Kolmogorov-Smirnov tests were used to determine heterogeneity between distributions.

Results: A total of 37,364 operations involving 150 attending surgeons and 222 nurses were analyzed. Median SS and SC scores were 0.08 (interquartile range: 0.03–0.19) and 0.06 (interquartile range: 0.03–0.13), respectively. Higher margin SLs, senior faculty rank, elective, and robotic cases were associated with greater SS, SC, and nurse-SL scores ($P < 0.001$).

Conclusions: These novel measures of teaming and specialization illustrate the low levels of OR team familiarity and objectively highlight differences that necessitate a deliberate evaluation of current OR scheduling practices.

Keywords: operating room, efficiency, teamwork, surgeon, nurse, familiarity

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Conducting an operation has been a team event since the advent of the modern surgical era. There is evidence that effective teamwork is essential to prevent patient harm and that poor teamwork is associated with surgical errors and adverse events.[1,2] The quality of teamwork has also been connected to healthcare worker well-being, performance, team process, cognition, and affect.[3–5] Recognizing the critical importance of teamwork, several initiatives such as TEAM-STEPPS, Six Sigma, and other process-driven measures have been attempted with variable success in operating rooms (ORs) across the country.[6–10]

The core domains of effective teamwork include both individual and shared experience, skills (technical, decision-making, adaptability, interpersonal), and communication.[4] Collaborative experience promotes the development of shared mental models of team cognition, which in turn enhances efficiency.[4] Thus, fostering team familiarity is a critical domain in improving teamwork. Consistent physician-nurse teams in ambulatory settings are an example of maximizing team familiarity to reduce patient harm and improve communication in a healthcare setting.[11,12]

There is a critical gap in understanding and measuring team familiarity in the OR. Evidence suggests that increasing surgical team familiarity improves efficiency and safety, while also reducing waste.[13–17] However, the definition of team familiarity and methods described for assessing it are heterogeneous, making meaningful comparisons difficult and limiting generalizability. At present, we have insufficient tools for analyzing teams based on prior collaborative experience such that there is neither a commonly accepted approach to quantifying surgical team familiarity nor a benchmark for what surgical teaming should be at large medical centers. This study addresses this critical gap and describes simple, dynamic measures of interprofessional, and specialty-specific experience that can be used to measure surgical team familiarity and better understand opportunities for improvement.

METHODS

Data Sources, Collection, and Study Population

Data were collected as part of a quality improvement project (19-161) and was deemed exempt by the University of Chicago Biological Sciences Division Institutional Review Board. Data for all surgical procedures performed between January 1, 2017, and July 15, 2021, at the University of Chicago Medical Center were extracted from electronic medical records and deidentified through an automated data query. In conjunction with the University of Chicago Center for Research Informatics, this query was then utilized to create a prospective data mart providing weekly data refreshes on recently completed surgical procedures.

Procedure Characteristics

Case date and time, case timestamps, clinical service line (SL), primary attending surgeon and nursing or technician staff involved, procedure type, and urgency status were extracted.

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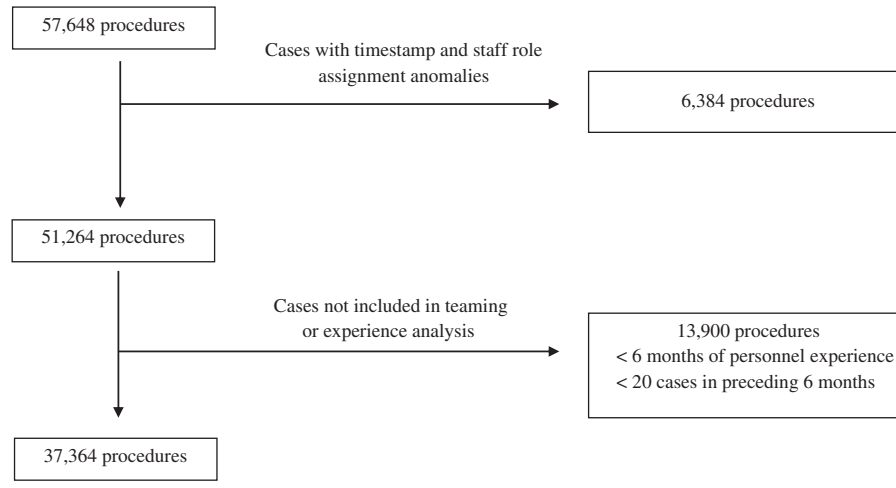

FIGURE 1. Flow diagram of case inclusion.

Both elective and urgent/emergent cases were included. Case urgency classifications were designated at the discretion of the surgeon and indicate the maximum expected time before patient entrance into the OR. Class A cases indicate a target patient-to-OR time within 30 minutes of case listing, class B within 2 hours, class C within 6 hours, and class D within 8 hours. The medical records also designate a primary attending surgeon for instances of multiattending surgeon cases.

The OR nurse manager maintains at least 1 room and surgical team available at all times for emergent trauma cases and another available for urgent add-ons, both of which are staffed independently of the elective case schedule. Case assignments for elective cases are initially made the day prior, with allowance for same-day adjustment in case of cancellations or staff call-offs. Cases with missing data were excluded.

Team Characteristics

At our institution, scrub technicians are not permitted to act as circulators per institutional policy, while registered nurses are able to fulfill either role during a single case. Both technicians and nurses are collectively referred to as "nurses" hereafter. Furthermore, "service line" and "specialty" will be considered interchangeably. Residents, fellows, and physician assistants were not included in team analyses.

For each case, the primary circulator and scrub nurse was defined as the individual who was present for the greatest amount of time in the respective role. In the event of a tie, the nurse recorded as present at the earliest time was designated as primary. Cases in which any individual (surgeon, scrub, or circulator) performed <20 procedures or whose first procedure was within 6 months were excluded from the teaming analysis to reduce bias in teaming introduced by very low-volume surgeons and newly hired staff.

Teaming Score Calculation

Surgeon-nurse teaming scores for each case were calculated as follows. For a given case i with primary scrub nurse j, the *surgeon-scrub* (SS) teaming score is defined as: $SS_i = \frac{n_{ij}}{m_i}$, where n_{ij} is the total number of joint cases for the surgeon-nurse pair in the preceding 6 months and m_i is the total number of cases performed by the primary surgeon of case i in the past 6 months. Similarly, the *surgeon-circulator* (SC) teaming score for a given case i with primary circulator j is defined as: $SC_i = \frac{n_{ij}}{m_i}$ using the same dynamic timeframe.

Analogous to the teaming scores, the scrub-SL and circulator-SL experience scores were defined for each case to represent nurse familiarity with a given specialty. For a given case k with primary scrub nurse j, the *scrub-service* experience score is defined as: $SServ_k = \frac{n_{kj}}{m_j}$, where n_{kj} is the total number of cases within service k in which scrub j was the primary scrub over the past 6 months and m_j is the total number of cases in which scrub j was the primary scrub (across all services) over the past 6 months. Similarly, the *circulator-service* experience score is defined as $CServ_k = \frac{n_{kj}}{m_j}$.

Both surgeon-nurse teaming scores and nurse-service experience scores can range from 0 to 1. A case with an SS score of 0 implies that it is the first time that nurse has collaborated with the surgeon (at least in the scrub role) in the preceding 6 months. Conversely, if a surgeon has worked exclusively with 1 scrub nurse in the past 6 months, the SS score of the current case will be exactly 1. A case with a scrub-service experience score of 0 indicates that the nurse has not worked a case in the given service in the scrub role within the last 6 months. Both surgeon-nurse and nurse-service "interactions" in the distant past (ie, over 6 months before a given case) were assumed to be forgotten and therefore have negligible impact on the present case.

Case-specific Variables

All surgical cases were categorized into SLs as designated by the medical center. SLs were further separated into high-margin services (HMS: cardiac, neurosurgery, orthopedic, thoracic, transplant, and vascular) and non–high-margin services (NHMS: colorectal, general, gynecology, otolaryngology, plastics, trauma, and urology). These designations were based on existing clinical SLs and prior literature.[18]

Cases were categorized as robotic or nonrobotic since robotic procedures require additional nurse training and certification. Services with <100 robotic cases within the study period were excluded from this subgroup analysis.

TABLE 1. Summary of Total Number of OR Personnel and Case Status for Included Surgical Procedures

Personnel	n
Physicians	150
Nurses and technicians	222
Scrub	205
Circulator	157

Case status	n (%)
Elective	30,836 (82.5)
Urgent	6528 (17.5)
Class A	1225 (3.3)
Class B	1238 (3.3)
Class C	1143 (3.1)
Class D	2540 (6.8)
Transplant	382 (1.0)

Service	Cases	%	Robotic Cases	%	Surgeons	Scrubs	Circulators
Cardiac surgery	2510	6.7	549	21.9	7	49	71
Colorectal surgery	2142	5.7	97	4.5	10	142	116
General surgery	6123	16.4	788	12.9	33	168	130
Gynecology	3309	8.9	865	26.1	29	152	125
Neurosurgery	2749	7.4	26	0.9	8	123	108
Orthopedic surgery	5614	15.0	930	16.6	21	143	120
Otolaryngology	3748	10.0	24	0.6	15	163	124
Plastic surgery	3038	8.1	0	0.0	14	156	121
Thoracic surgery	968	2.6	41	4.2	4	61	77
Transplant surgery	874	2.3	14	1.6	10	115	112
Trauma surgery	570	1.5	0	0.0	18	117	98
Urology	3307	8.9	1690	51.1	11	143	113
Vascular surgery	2412	6.5	0	0.0	9	142	115

Nurses may act in either scrub or circulator roles and therefore the same individual may be counted in both the total number of scrubs and circulators. Nonelective cases are classified by degree of urgency with class A designation being the most emergent and class D being least urgent while still being nonelective.

Surgeon-specific Variables

To analyze surgeon-level factors associated with teaming, cases were dynamically categorized as either low or high volumes within each SL. Low-volume surgeons were defined as those below the 25th percentile in terms of caseload among all surgeons in their SL in the preceding 6 months. Surgeons in the 75th percentile or above within their SL in the same rolling time frame were considered high volume. Stratifying operative volume by SL partially accounts for natural differences in surgical volume between surgeons of different specialties (eg, cardiac vs orthopedic surgery).

To ascertain the degree to which surgeon rank may influence the degree of teaming for a given case, a subgroup analysis of cases from January 1 to July 15, 2021, was performed after classifying all surgeons according to their current academic appointments as a senior (section chiefs and professors) or junior faculty (clinical associates, assistant professors, and associate professors).

Statistical Analysis

Data analysis was performed in RStudio, version 1.2.5033 (RStudio, Boston, MA). Surgeon-nurse teaming and nurse-specialty experience scores were reported as medians and interquartile ranges (IQRs). Distributions of teaming and expertise scores were represented as either histograms, normalized histograms, or density plots as indicated. While histograms effectively illustrate distributions for comparing categories with similar numbers of observations, normalized histograms and density plots facilitate the comparison of distributions with dissimilar counts between categories and better illustrate proportionality. Two-sample Kolmogorov-Smirnov test was applied at the 5% significance level to determine statistical heterogeneity between distributions.

RESULTS

Of the 57,648 cases performed during the study period, 37,364 remained after eliminating those with timestamp and nursing assignment-related anomalies and filtering by exclusion criteria (Fig. 1). These remaining cases were primarily elective and involved a total of 150 attending surgeons and 222 nurses (Table 1). Among surgeons, 113 (75.3%) operated exclusively within 1 specialty, 35 (23.3%) performed cases classified in 2 different specialties, and 2 (1.3%) operated in 3. General surgery comprised the largest number of cases, surgeons, scrubs, and circulators (Table 1).

Teaming Scores

Overall, median SS and SC scores for all cases were 0.083 (IQR: 0.031–0.190) and 0.059 (IQR: 0.026–0.133), respectively. The majority of SLs demonstrated a right-skewed distribution of both SS and SC teaming scores per case indicating the regularity of low-familiarity teams (Fig. 2A).

Across all cases, the median nurse-specialty scores were higher for scrubs than circulators [0.450 (IQR: 0.139–0.772) and 0.265 (IQR 0.103–0.614), respectively]. Nurse-specialty experience scores across SLs were overall greater and more variable than individual surgeon-nurse teaming scores for both nursing roles, with scrub nurses having higher specialty experience scores than circulators in all SLs (Table 2, Fig. 2B).

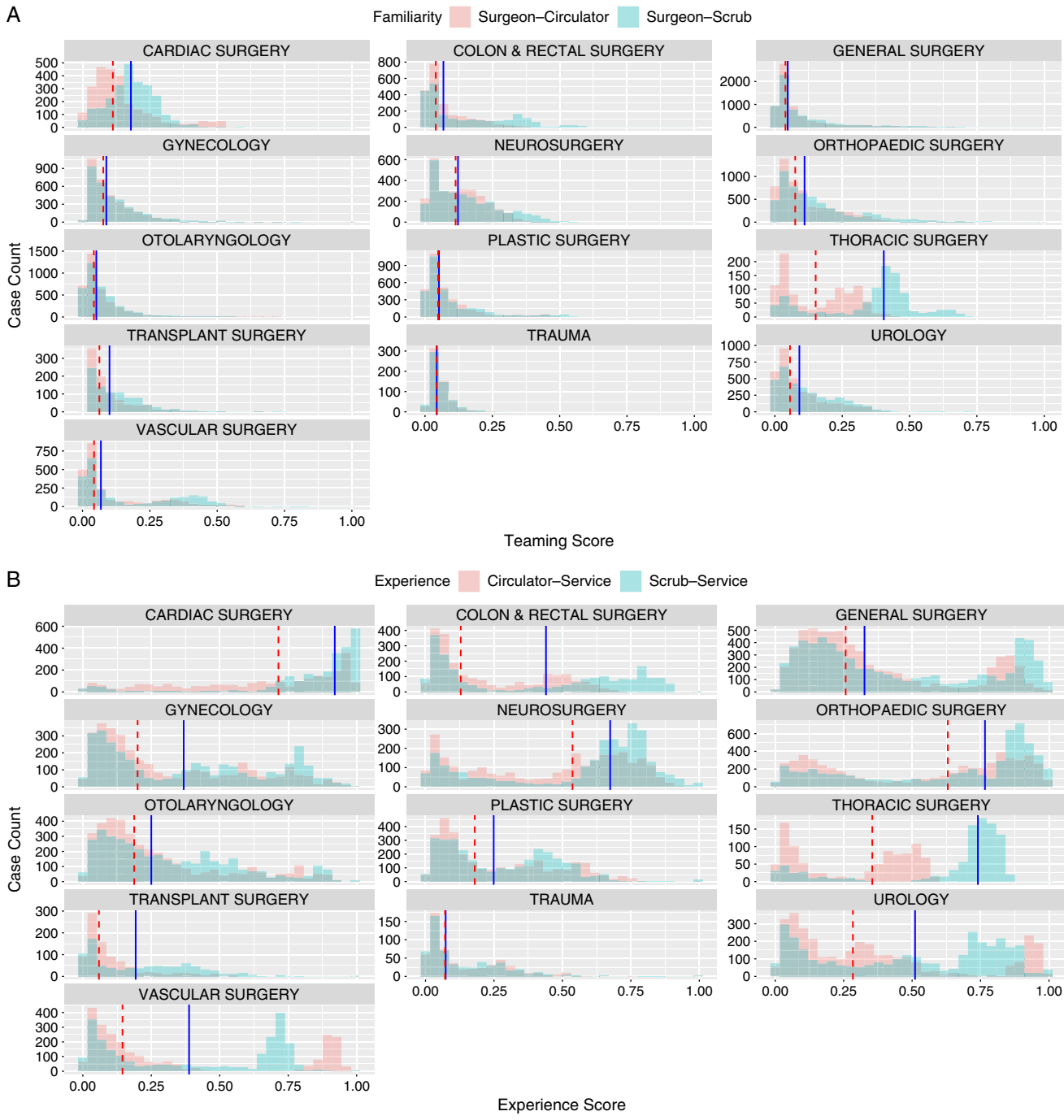

FIGURE 2. Variation in teaming and nurse specialization across services. Distributions of surgeon-nurse teaming scores (A) and nurse-service experience scores (B) are shown for each SL. Vertical lines indicate median values. Scatter plots of mean surgeon-nurse teaming scores (C) and nurse-service experience scores (D) illustrate that high-margin SLs tend to have more specialized nurses and that scrub nurses tend to be favored over circulators. Solid black line set to 45 degrees.

Service Characteristics

HMS demonstrated greater overall teaming than NHMS (Fig. 2C). Median SS and SC teaming scores ranged from 0.068 to 0.404 and 0.043 to 0.152, respectively, for HMS compared with 0.043 to 0.091 and 0.039 to 0.077 for NHMS (Table 2). Nurses in HMS were also generally more specialized and dedicated to the particular SL (Fig. 2D) with median scrub-service and circulator-service experience scores ranging

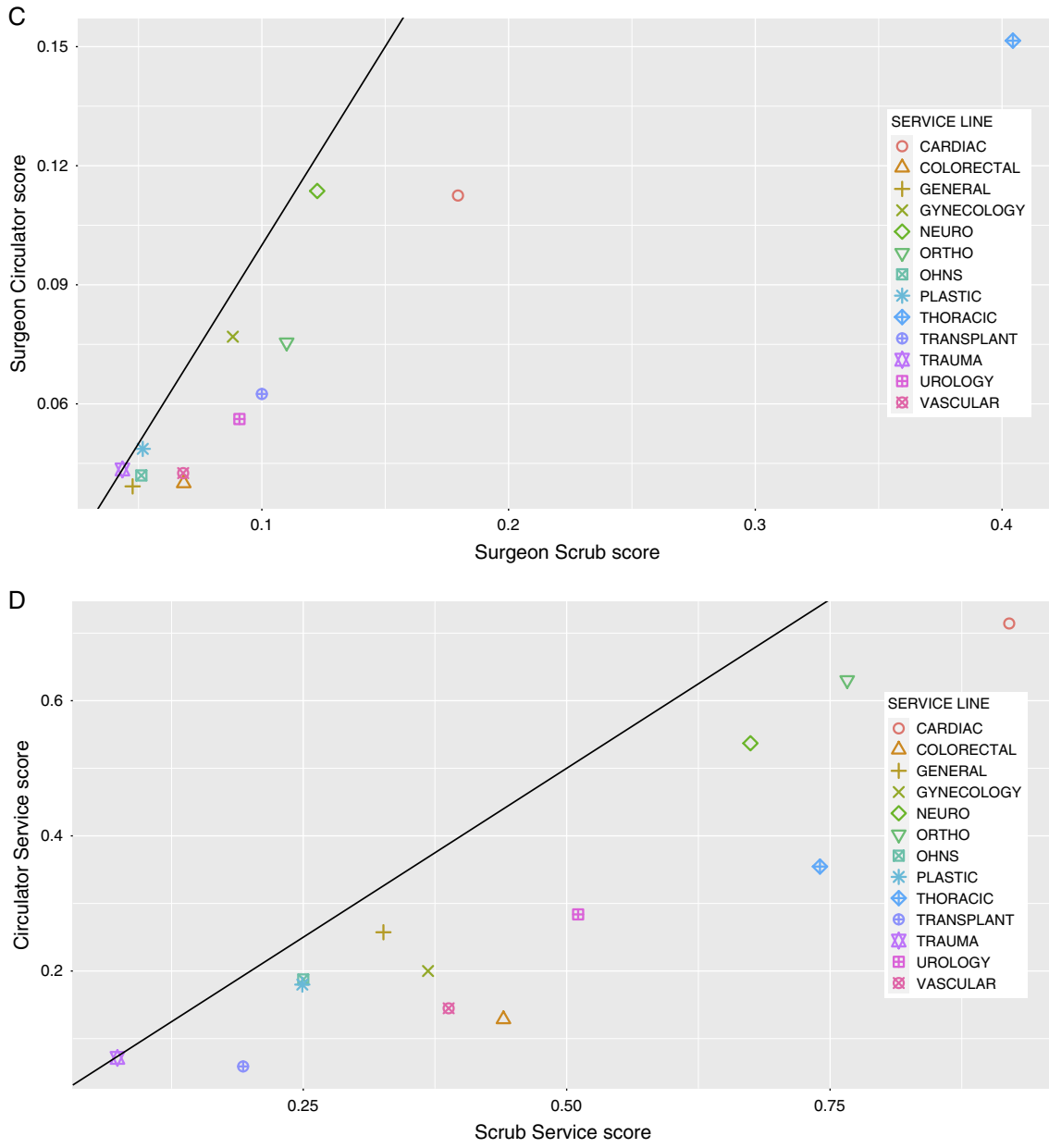

FIGURE 2. (Continued).

from 0.193 to 0.920 and 0.059 to 0.714, respectively, versus 0.074 to 0.511 and 0.071 to 0.284, respectively, for NHMS (Table 2).

Case Characteristics

Robotic procedures comprised 13.4% (n = 5024) of all cases with only 5 of 13 SLs performing >100 procedures (Table 1). Robotic cases had greater surgeon-nurse teaming and nurse-specialty expertise scores within each service ($P < 0.001$ for both roles, Figs. 3A, B).

Elective operations had greater degrees of teaming and nurse-specialty experience than urgent cases ($P < 0.001$ for all) except for semiurgent organ transplantation cases, which had greater median SS ($P < 0.001$) and SC teaming scores ($P < 0.001$) than elective cases (Table 2, Figs. 3C–F).

Surgeon Characteristics

Surprisingly, cases performed by low-volume surgeons in each SL had similar or greater median SS and SC teaming scores than those by high-volume surgeons, except in orthopedic and thoracic surgery (Figs. 4A–D). Only in these 2 HMS were both median SS and SC teaming superior for high-volume compared with low-volume surgeons. High-volume surgeons regularly collaborated with nurses with greater specialty-specific experience (Figs. 4C, D).

In a subgroup analysis of 4117 elective cases from January 1 to July 15, 2021, junior surgeons (n = 70) performed 46.8%

TABLE 2. Summary of surgeon-scrub and surgeon-circulator teaming scores as well as nurse-specialty experience scores for all specialties and case urgency classes

	Interprofessional				Specialty-specific Experience			
	SS		SC		Scrub-service		Circulator-service	
Service	Median	IQR	Median	IQR	Median	IQR	Median	IQR
High-margin SLs								
Cardiac surgery	0.179	0.127–0.238	0.112	0.066–0.176	0.920	0.783–0.977	0.714	0.394–0.915
Neurosurgery	0.123	0.045–0.227	0.114	0.040–0.190	0.674	0.317–0.766	0.537	0.169–0.692
Orthopedic surgery	0.110	0.045–0.213	0.075	0.030–0.168	0.766	0.296–0.893	0.630	0.171–0.833
Thoracic surgery	0.404	0.291–0.453	0.152	0.032–0.272	0.740	0.658–0.786	0.355	0.058–0.476
Transplant surgery	0.100	0.049–0.176	0.062	0.036–0.120	0.193	0.032–0.361	0.059	0.029–0.132
Vascular	0.068	0.024–0.354	0.043	0.020–0.178	0.388	0.075–0.711	0.145	0.063–0.832
Non–high-margin SLs								
Colorectal surgery	0.068	0.020–0.272	0.040	0.019–0.105	0.440	0.061–0.714	0.129	0.056–0.440
General surgery	0.048	0.022–0.125	0.039	0.022–0.083	0.326	0.162–0.778	0.257	0.149–0.494
Gynecology	0.088	0.045–0.160	0.077	0.041–0.143	0.368	0.102–0.649	0.200	0.094–0.533
Otolaryngology	0.051	0.021–0.100	0.042	0.020–0.088	0.250	0.115–0.469	0.188	0.101–0.360
Plastic surgery	0.052	0.025–0.124	0.049	0.024–0.104	0.249	0.094–0.435	0.180	0.079–0.423
Trauma surgery	0.043	0.026–0.073	0.043	0.026–0.069	0.074	0.030–0.230	0.071	0.029–0.243
Urology	0.091	0.032–0.192	0.056	0.024–0.133	0.511	0.149–0.767	0.284	0.098–0.482
	SS		SC		Scrub-service		Circulator-service	
Case Class	Median	IQR	Median	IQR	Median	IQR	Median	IQR
Elective	0.096	0.035–0.211	0.065	0.028–0.143	0.520	0.171–0.791	0.306	0.116–0.645
Urgent	—	—	—	—	—	—	—	—
Class A	0.043	0.024–0.083	0.04	0.023–0.075	0.129	0.046–0.298	0.109	0.045–0.267
Class B	0.042	0.020–0.096	0.038	0.020–0.080	0.139	0.062–0.352	0.129	0.070–0.249
Class C	0.035	0.020–0.075	0.035	0.019–0.067	0.136	0.059–0.299	0.132	0.070–0.250
Class D	0.049	0.022–0.110	0.042	0.021–0.100	0.242	0.093–0.690	0.186	0.088–0.581
Transplant	0.139	0.069–0.200	0.077	0.040–0.132	0.385	0.191–0.764	0.146	0.054–0.480

Class A cases are of the highest priority, while class D are the least urgent while still being considered nonelective.

(n = 1925) of cases and had lower median surgeon-nurse teaming scores (SS: 0.079 vs 0.100, $P < 0.001$; SC: 0.051 vs 0.063, $P < 0.001$) and nurse-service scores (scrub-service: 0.539 vs 0.622, $P < 0.001$; circulator-service: 0.283 vs 0.395, $P < 0.001$) compared with senior surgeons (n = 51, Figs. 4E–H).

Impact of Coronavirus Disease 2019 Pandemic

Overall, median teaming scores were significantly lower (SS: 0.083 vs 0.072, $P < 0.001$; SC: 0.056 vs 0.049, $P < 0.001$) when comparing the 27,656 cases performed before March 1, 2020 and the subsequent 12,645 cases in the sample. A smaller magnitude, but significant, decrease in nurse-specialty scores was also evident (scrub-service: 0.445 vs 0.443, $P < 0.001$; circulator-service: 0.269 vs 0.260, $P < 0.001$).

DISCUSSION

This paper presents a novel approach for analyzing the collaborative and specialty-specific experience of surgical team members, both of which are easily quantifiable and trackable as potential key operational metrics. This work leverages the granularity and wide coverage of these data to describe the degree of surgeon-nurse team stability and the consistency of nurse-specialty assignments across many surgical specialties at a large academic institution. To our knowledge, no such institutional or cross-specialty analysis of OR teaming has been published to date. Importantly, this study both offers a framework for quantifying operative team familiarity and demonstrates that unfamiliar teams are commonplace at a large academic medical center. Literature on OR teaming stands to benefit from incorporating surgical team dynamics by considering these distinct interprofessional relationships as they relate to relevant outcome measures.[19]

Interesting trends are apparent upon examining distributions of teaming by SLs and surgeon characteristics. Senior surgeons, HMS, and specialized elective (ie, robotic) cases tend to have greater teaming, but likely for different reasons and with different implications for hospital operations. The greater team stability and nurse specialization observed in operations by higher ranked surgeons and in more profitable SLs may reflect similar underlying forces influencing nursing assignments on the basis of political clout. In contrast, the greater team familiarity for cases involving robotic platforms is likely due to the smaller pool of certified nurses able to scrub robotic cases.

Anecdotally, it is reasonable to expect high-volume surgeons to command higher consistency surgical teams, potentially due to more predictable operating schedules, although this did not appear supported by the data. One possible explanation is that simply having a greater caseload leads to a dilution effect in teaming scores as the number of nurses a surgeon works with increases, even if many of those cases are performed with a core team. Regardless, high-volume surgeons were typically assigned nurses that are relatively more experienced in the specialty of the given case and is consistent with prioritization of nursing assignments made by OR nurse managers. The relationship between surgeon caseload and academic rank could not be addressed given the relatively small sample of cases in which these appointments were known with confidence. Therefore, it remains unclear whether faculty rank or operative volume more significantly influences differences in teaming. Nonetheless,

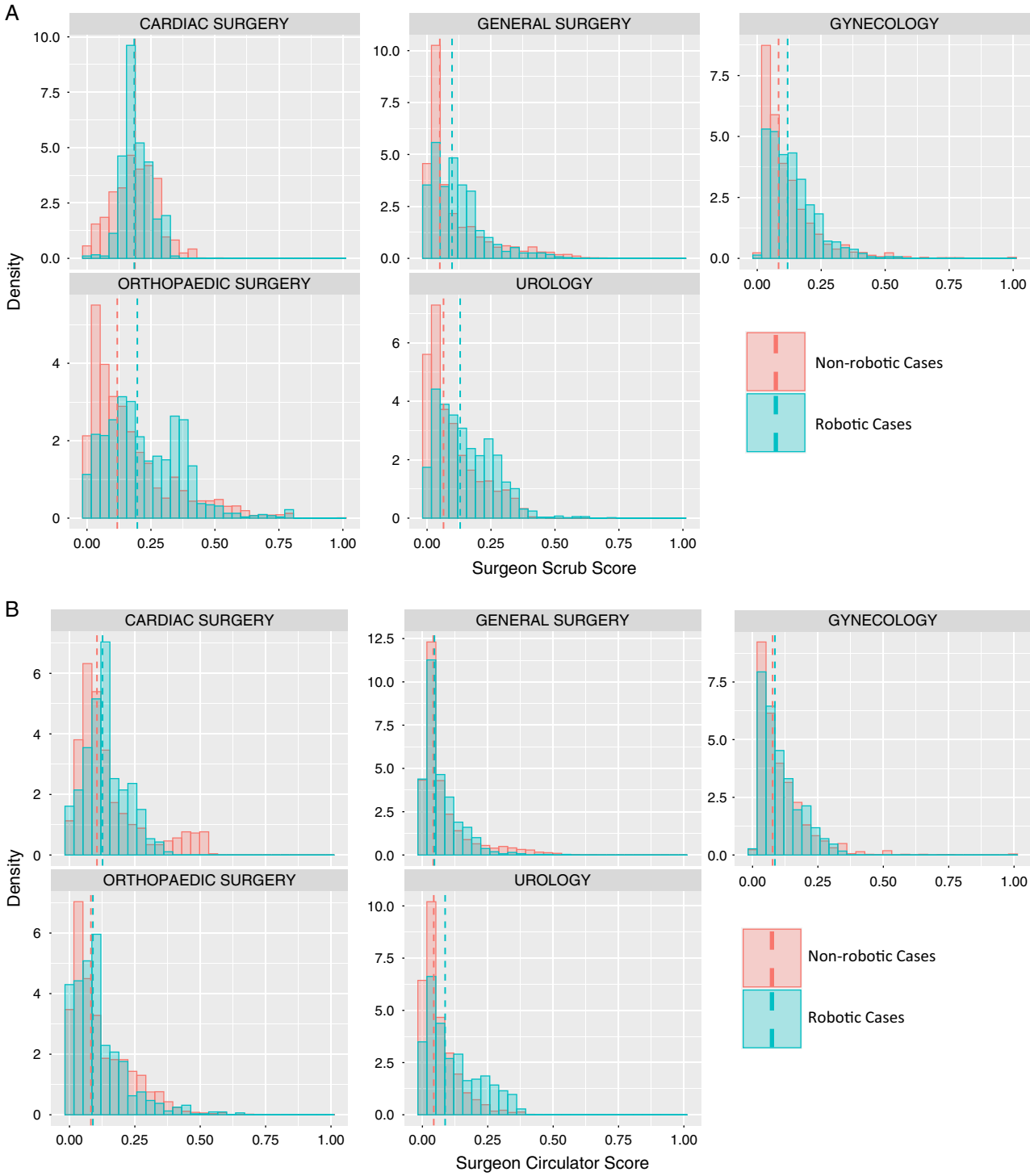

FIGURE 3. Differences in teaming associated with case characteristics. Distributions of scrub (A) and circulating nurse-service experience (B) for robotic and nonrobotic cases in SLs with >100 robotic procedures within the study period. Although robotic surgeries comprise only 13.4% of all cases, they have relatively higher degrees of team familiarity ($P < 0.001$ for both). Density plots of SS (C), SC teaming scores (D), scrub-service (E), and circulator-service experience scores (F) stratified by case classification. Urgent cases have lower overall degrees of teaming than elective or scheduled cases. Color-coded vertical lines indicate median values.

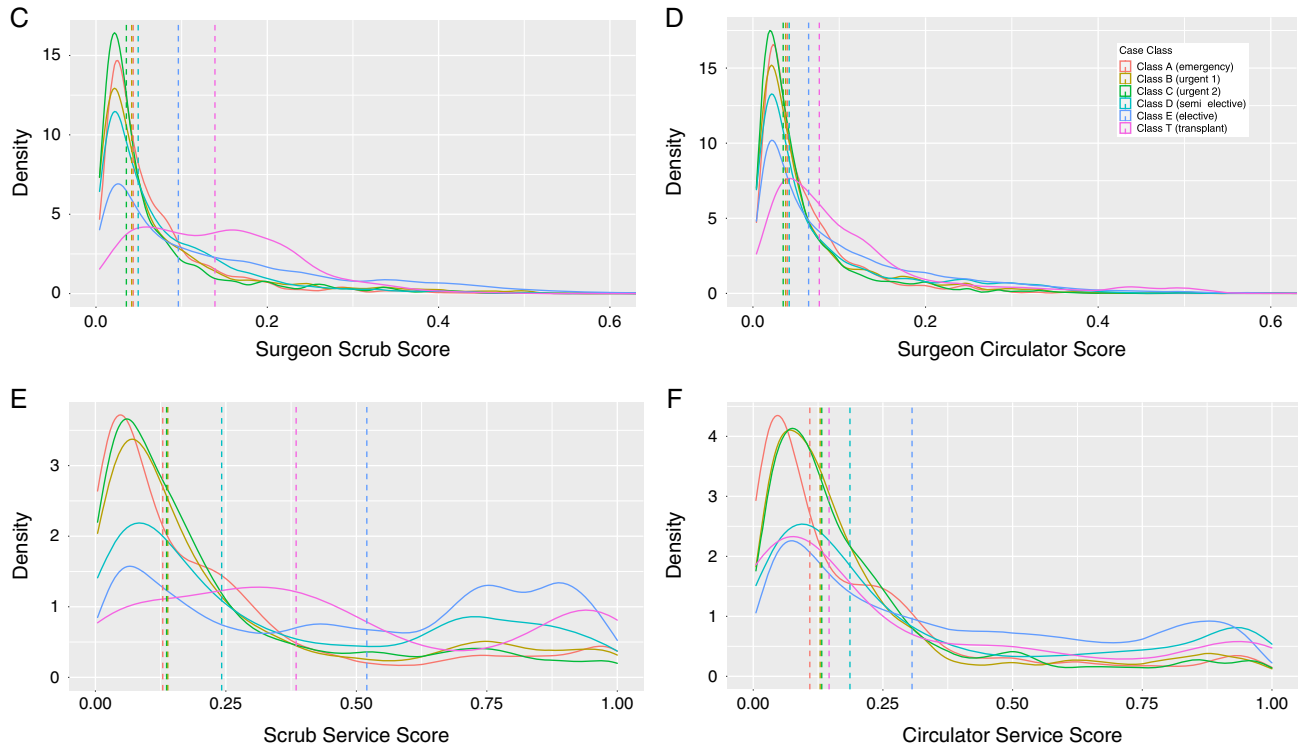

FIGURE 3. (Continued).

junior faculty appear to have significantly lower team stability and routinely be assigned less specialized nurses within their specialties, both of which may disadvantage them in terms of operative efficiency.[14,17,20] Although the clinical significance of these small differences is still being evaluated, these measures pose interesting questions regarding the reasons for differential teaming and pave the way for a more data-driven approach to OR staffing assignments.

Prior Approaches to Quantifying Team Familiarity

Prior research on OR teaming has been either case or specialty-specific and focuses only on certain team member interactions such as surgeon-surgeon,[21,22] surgeon-nurse,[16,17,23–27] or surgeon-trainee familiarity.[13,15,28] Investigators less frequently have expanded their definition of the team beyond these dyads to include additional staff.[20,29,30] The described approaches to quantifying familiarity between these individuals also differ substantially and have limitations. The most direct method involves analyzing cases by the number of prior team collaborations as a proxy for familiarity between individuals.[13–15,21,22,26] Alternatively, some authors have utilized the structural logistics of consistent team pairings through rotations or service structure to compare high-familiarity and low-familiarity teams.[24,26,28] A third approach is to stratify team members by the frequency with which OR staff perform cases in a given specialty or collaborate with a given surgeon in relation to their entire caseload, essentially capturing the proportion of that individual's time spent in a given specialty or with a particular surgeon.[16,25] Indirect methods for analyzing familiar and unfamiliar teams have involved categorizing familiar teams based on case start time as being during regular day shift hours or during the surgeon's typical block time.[23,30] Although scarce, some prospective trials have been conducted despite the significant administrative barriers to carrying out such studies.[20,29]

The analysis reported here makes use of distinct metrics based on direct prior collaborations between pairs of personnel (surgeon-nurse teaming scores) and the relative dedication of an individual nurse to a given specialty (nurse-service experience scores). Importantly, we do not dichotomize teams into familiar or unfamiliar as is commonly reported but describe the differences in distributions of teaming under various conditions.

Key Considerations and Challenges

It is important to consider teaming relationships in the context of the entire OR ecosystem and not merely through the lens of a single team or SL. A multitude of specialties must effectively share resources at large medical centers if operative services as a whole are to function efficiently. While it is intuitive to strive for optimization of the degree of familiarity of a single operative team, health systems must also maintain the adaptability and flexibility of the perioperative services needed to effectively address urgent and unexpected cases. It is also essential to allow flexibility for nurse professional development across specialties and technologies (ie, laparoscopic or robotic surgery) to allow for capacity and growth. Such cross-disciplinary flexibility stands to further improve the system's ability to adequately respond to unexpected staffing changes or shortages. Such disruptions in the healthcare workforce induced by the ongoing coronavirus disease 2019 pandemic have further highlighted the difficulties of promoting high-quality teaming in constrained settings. Innovative approaches to optimizing surgical teamwork are therefore essential as uncertainty in provider staffing continues.

There are substantial barriers to strategically improving surgical team familiarity and stability. Staffing assignments are

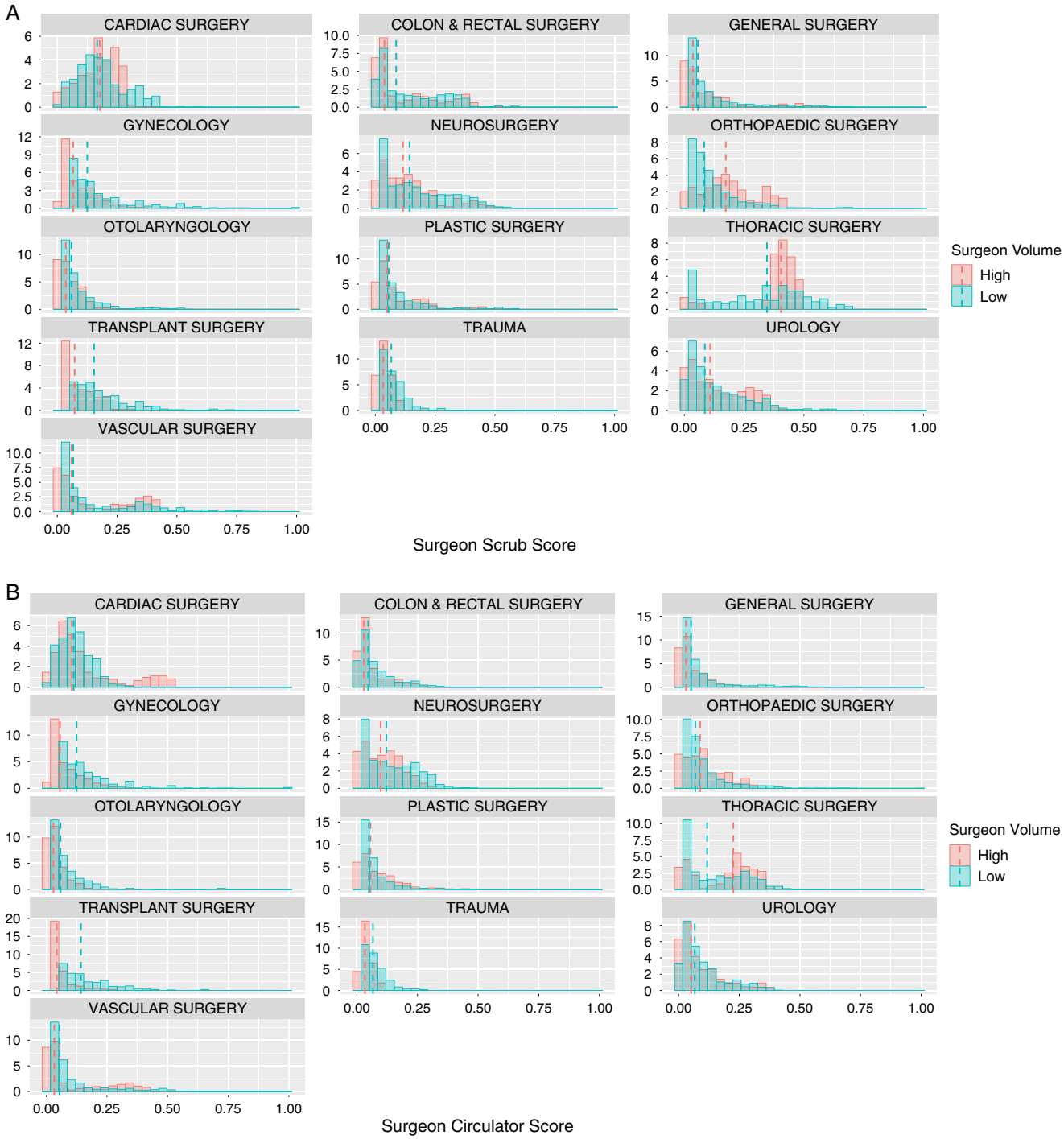

FIGURE 4. Differences in teaming by surgeon characteristics. Cases performed by high-volume surgeons in each SL do not generally have more familiar teams (A, B), but are assigned nurses who are more experienced in the respective specialty (C, D). Junior surgeons have lower teaming scores (E, F) and less specialized nurses (G, H) than senior surgeons ($P < 0.001$ for all). Color-coded vertical lines indicate median values.

frequently adjusted in the morning before the first start depending on unexpected staff call-outs, case cancelations, and/or additions. Other barriers to stable, high-consistency team assignments are scheduling limitations, especially when a single OR is scheduled for back-to-back cases in different specialties on the same day, thereby forcing nurse managers to compromise in terms of the allocation of surgeon-nurse familiarity and/or nurse-specialty experience for 1 or both cases. Furthermore, OR staff

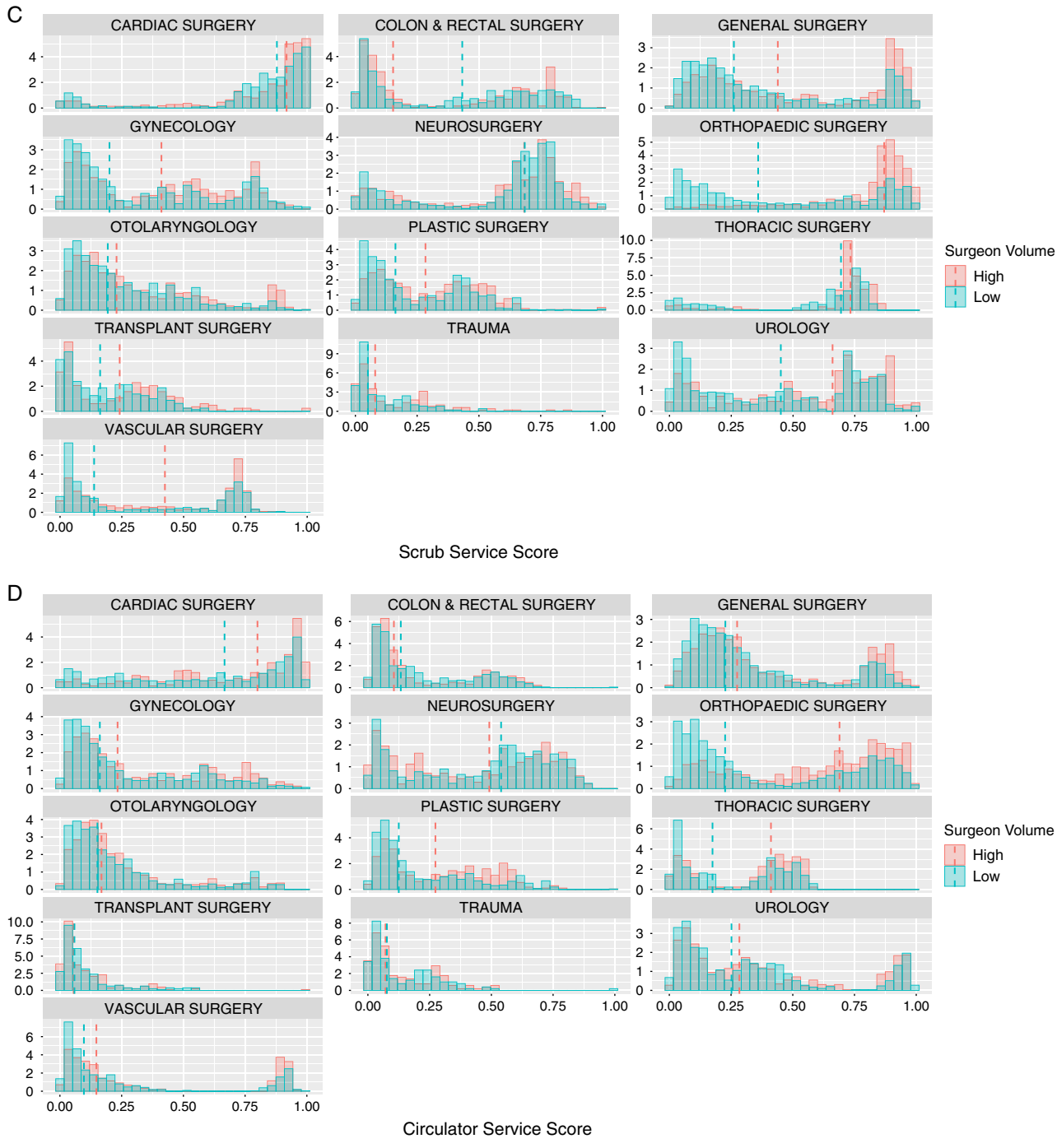

FIGURE 4. (Continued).

vary in clinical and technical skill, which must also be carefully considered for each individual assignment and in the context of all team assignments for a given day. While there is a tendency for some OR personnel (both pairs of nurses and surgeon-nurse pairs) to prefer to work with others with whom they typically collaborate, which does promote team familiarity at the individual level, this can also pose a challenge when these pairs cannot be kept together given staffing constraints elsewhere in the daily OR schedule. Finally, other institutional environmental factors such as policies or labor unionization can also impose additional logistical or administrative hurdles.

Limitations

There are various limitations to this study. Primarily, team familiarity as measured by our score is distinct from teamwork quality. Although promoting surgical team stability

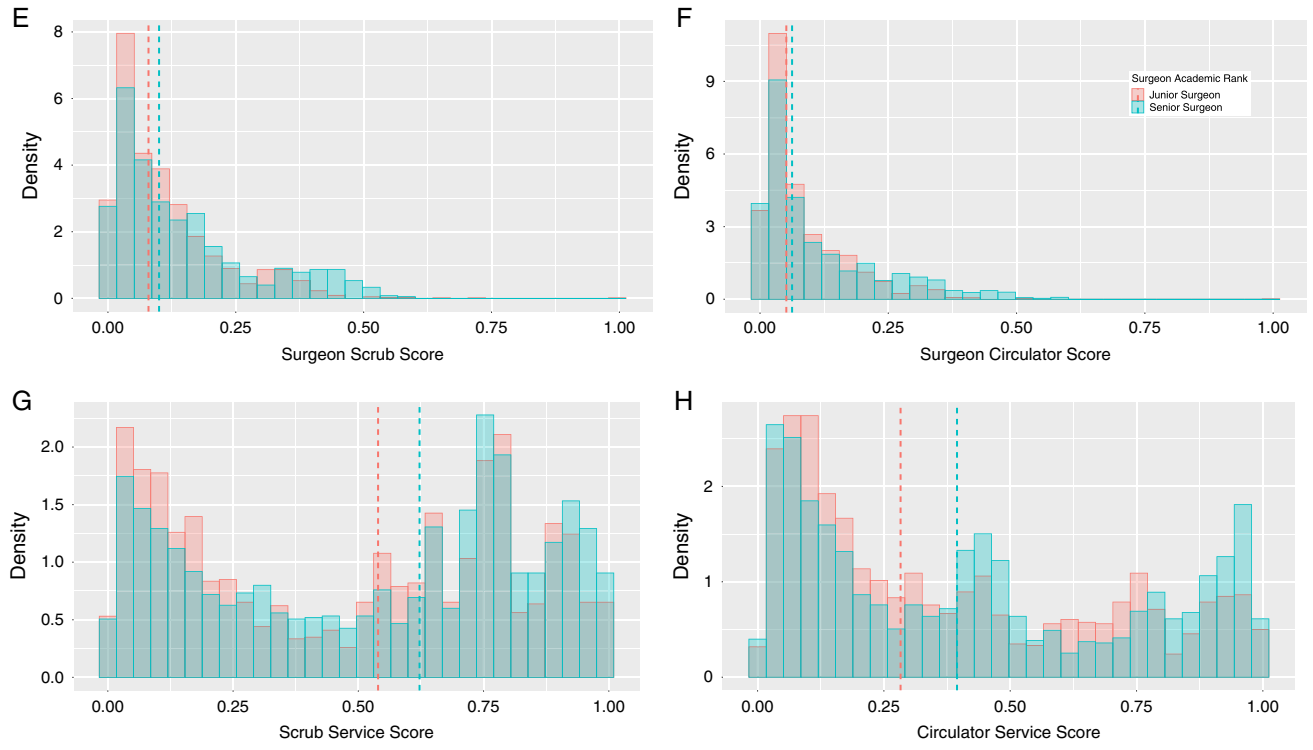

FIGURE 4. (Continued).

is one approach to improving operative teamwork, it does not replace the importance of maintaining a culture of safety and trust in the OR. Further research is necessary to understand how other factors, such as effective communication, influence the quality of teamwork in this setting. Even so, team familiarity can be easily tracked as a key metric using this framework. Teaming among very low-volume surgeons and newly hired OR staff are also not accounted for in this analysis. This teaming score framework was not applied to consider anesthesiologist teaming experience, which has been considered elsewhere.[20,29,31] Prior literature also suggests that surgical trainees affect operative efficiency.[13–15] We chose to exclude resident and fellow involvement for 2 reasons: first, graduate medical education should not be considered an intervenable variable in efforts to optimize the perioperative services at teaching institutions; second, trainees rotate through services in a manner distinct from the scheduling procedure underlying the team assignments considered here. In addition, nurse experience gained in one specialty may have spillover benefits into other specialties (eg, colorectal and general or cardiac and vascular surgery). Such spillover is not accounted for in the nurse-service scores, which may therefore understate a nurse's experience in a given specialty. Finally, our teaming scores may be artificially lowered by virtue of the fact that a surgeon's familiarity with the same nurse is counted differently depending on which role (circulator or scrub) s/he worked.

Recommendations to Improve Surgical Team Familiarity

This work has major implications for current staffing practices at our academic medical center and similar institutions. Despite an institutional emphasis on team-based care and existing measures shown to improve OR teaming and efficiency, such as dedicated rooms and staff for urgent/emergent cases,[32] awareness of these teaming metrics has identified substantial limitations in the current state of surgical teaming.

We strongly advocate that these limitations be addressed through the adoption of data-driven staffing recommendations. Such an approach is feasible due to the interconnectedness of health system electronic medical records, operational data, and staff shift scheduling systems. Leveraging the granularity and volume of these data sources could enable both the identification of systematic sources of inequality in surgical teaming and subsequent rectification by enabling algorithmic optimization of team assignments. This approach to assembling high-familiarity and high-consistency surgical teams could meaningfully augment the current manual process. Furthermore, targeting the quantity of teaming is less costly than interventions to address teamwork quality such as TEAM-STEPPS and Crew Resource Management.[6,8,33] Our group is therefore actively developing a decision support tool to aid OR managers in allocating surgical staff based on these scores with the intent of improving surgical efficiency.

In conclusion, this work demonstrates the characteristics of novel scores measuring surgical team familiarity and individual specialty-specific experience. Measurement of these scores should guide interventions to improve team familiarity and establish benchmarks to optimize surgical teaming.

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