Understanding the Ranking and Matching Behaviors During the 2023 and 2024 General Surgery Match Cycles: A Program Signaling Approach

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OBJECTIVE: General Surgery (GS) employed a static signaling practice with five signals per applicant in the 2022 to 2024 application cycles. Previous research demonstrated that signaling enhances a GS applicant's likelihood of being granted a residency interview. To understand the relationship between program signaling and ranking and matching outcomes in GS.

DESIGN: The analysis from the 2023 and 2024 Match data examined the relationship between signaling and three primary outcomes—inclusion on a program's rank order list (ROL), inclusion on the competitive portion of program ROLs, and matching. A multilevel model was utilized to explore how different factors impact an applicant's odds of being included on a program's ROL.

SETTING: This study is a collaboration between the NRMP, AAMC and NBME.

PARTICIPANTS: Participants are medical residents who participated in the 2023 ($N = 3903$) and 2024 ($N = 5057$) Match cycles.

RESULTS: Signaling increases the odds of being ranked, and applicants who signaled had higher percentages of being ranked competitively and matching; however, the majority of those on the ROL and who matched did not send a signal. The odds of being ranked increase when the applicant signals a program (OR = 5.63, 95% CI [5.31, 5.98]), is from the same state as the program (OR = 3.52, 95% CI [3.35, 3.70]) or has a Step 1 score one standard deviation above the mean (OR = 1.77, 95% CI [1.74, 1.81]). The odds of being ranked are lower for programs with a high signal-to-application ratio (OR = 0.76, 95% CI [0.71, 0.80]) and for Doctor of Osteopathic Medicine (DO) (OR = 0.50, 95% CI [0.48, 0.53]) or international medical graduates compared (US IMGs: OR = 0.11, 95% CI [0.10, 0.13]; Non-US IMGs: OR = 0.11, 95% CI [0.09, 0.12]) to U.S. MDs, though all applicants benefit from the use of signals.

CONCLUSIONS: Although signaling is not a requirement to be ranked, ranked competitively, or matched to a program in GS, those who signaled were ranked and matched at a higher percentage, with signals having the strongest effect on ROL inclusion. (J Surg Ed 82:103599. © 2025 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.)

KEY WORDS: general surgery, graduate medical education, matching, medical residency, program signaling, ranking

INTRODUCTION

Program signals have been implemented within graduate medical education (GME) as a way for applicants to express their interest in a program while also providing programs with a standardized metric indicating interest.[1-3] While work has described the impact of signaling on applicant receipt of interview invitations,[4-7] the impact signaling may have later in the transition to residency (i.e., transition to residency [T2R]; ranking and

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Matching outcomes) remains unclear. The GME community is eager to receive this data to inform the impact of signals and optimize student advising on effective ways to distribute signals.

Signaling originates from Economics to facilitate the job market application system between employers and applicants.[8] In GME, signaling was first introduced in 2020 by Otolaryngology, which employed a small signal structure in alignment with the Economic literature.[2,9,10] Signaling structures subsequently expanded from the small signal structures to include large and tiered (i.e., gold ["most preferred"] and silver signals ["preferred"]) structures, with each having its own benefits and drawbacks.[3]

To date, the signaling literature has largely focused on signal-to-interview conversion, or the impact of a signal on an invitation to interview, and prior research has shown that signals are associated with interview invitation rates in small, large, and 2-tiered approaches.[5,11-15] According to the Association of American Medical Colleges (AAMC) 2022 Program Director Reaction Survey report, specialties that participated in signaling, including General Surgery (GS), found signaling helped programs identify applicants who might have otherwise been overlooked.[16] Signaling was also shown to improve a candidate's chances of being invited for an interview across many studied medical specialties[4,7,17] and AAMC has instructed Program Directors to only use signals when deciding whom to interview because applicants' preferences may change after they apply.[3]

A limitation inherent in the signaling studies to date is that among the specialties that have multiple years of signaling data, some specialties have changed their signaling structure over time, making signaling difficult to examine longitudinally. GS maintained a consistent small signaling structure from 2022 to 2024, allowing five signals to be allocated by applicants each cycle and as such, was an ideal specialty to explore the impact of signaling on ranking and matching outcomes.[4,18,19] However, it should be noted that in 2025 GS transitioned to a larger, 15 signal structure. Although not directly applicable to the 2025 cycle, this study provides quantitative data on how program directors considered signals in their initial iteration for GS. The data may also offer insights for other specialties with a similar number of signals.

This study represents a collaboration of the National Resident Matching Program (NRMP), the AAMC, and the National Board of Medical Examiners (NBME) to elucidate how program signaling impacts steps in the transition to residency after screening and interviewing: signal-to-ranking and signal-to-matching. The specific aims of the study are to determine the impact of program signals on applicant placement, including competitive placement, on a program's rank order list (ROL) and to determine signal impact on match likelihood.

METHODS

Setting and Participants

This study examined applicants to GS residency programs during the 2023 and 2024 Match cycles, utilizing primary source data from three collaborating organizations. The NRMP provided data on program ROLs, applicant characteristics and Matching data, the AAMC contributed application and signaling data, and the NBME offered United States Medical Licensure Examination (USMLE) Step 1 score data.

After filtering programs with a minimum ROL length of 30, the analytic dataset for 2024 included 284 programs, 5057 applicants, and 305,454 applications with 93% program retention. The final dataset contains 2592 seniors or graduates of U.S. allopathic medical schools (U.S. MD applicants), 832 seniors or graduates of osteopathic medical schools (DO applicants), 792 U.S. citizen graduates of international medical schools (U.S. IMG applicants), and 841 non-U.S. citizen IMGs (non-U.S. IMG applicants). The 2023 dataset excluded applicants with missing data for any of the variables in the regression (Table 1). While DO applicants with Step 1 scores were included in the 2023 sample, COMLEX scores were not available to analyze.

Outcomes Measured

The analysis examined three primary outcome variables related to the T2R: 1) applicants included on a program's ROL (yes/no), 2) applicants ranked competitively (i.e., in the top quartile [25th percentile] of the program ROL; yes/no), 3) applicants matched to the program (yes/no).

Variables at both the applicant and program levels were analyzed (Fig. 1). At the applicant level (Level 1), key predictors included whether a signal was sent, applicant type (U.S. MD, DO, U.S. IMG, non-U.S. IMG), geographic location (applicant undergraduate medical education [UME] and program in the same/different state), and most recent USMLE Step 1 score. At the program level (Level 2), the main predictor was the signal-

TABLE 1. 2023 and 2024 Dataset

Variable	2023	2024
Programs (Minimum ROL: 30)	256	284
Applicants	3903	5057
Applications	221,712	305,454
Program Retention (%)	91%	3%
U.S. MD Applicants	2483	2592
DO Applicants	605	832
U.S. IMG Applicants	503	792
Non-U.S. IMG Applicants	312	841

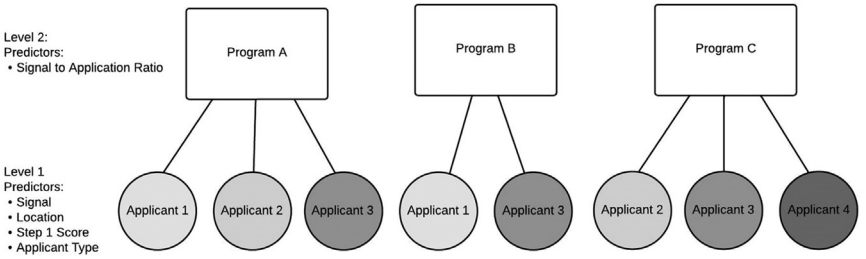

FIGURE 1. Multilevel modeling data structure.

to-application ratio (i.e., number of signals received by a program: total number of applications submitted to that program).

Analytic Approach

Descriptive analyses were utilized to investigate how signaling influenced the percentage of applicants achieving the three significant outcomes variables for 2023 and 2024 data. Multilevel modeling (MLM) was utilized to explore how different factors impacted an applicant's odds of being included on a program's ROL. This approach accounts for the grouping of applications by programs and allows for an analysis of the variation between individual applicants and programs. The MLM analysis was conducted using 2023 data. This cycle maximized the inclusion of applicants with Step 1 scores as 2024 included a more mixed cohort with scores and pass/fail outcomes only. The 2023 cycle offers a completer and more standardized sample in which the influence of USMLE performance on residency selection decisions was likely more consistent. Variables were added to the model in the following order: signal, applicant type, location, Step 1 scores (standardized), signal-to-application ratio (standardized), signal x location interaction, and signal x applicant type interaction. Ultimately, the model that included all five variables and the two interaction effects exhibited the best model fit. All MLM models were run using the GLIMMIX procedure in SAS Enterprise Guide Version 8.4.[20] This study was not subject to IRB approval as it does not meet the definition of human subject research.

RESULTS

Impact of Signal on Inclusion on Program ROL

For all the boxplots in this study, analyses were first conducted at the program level then aggregated across programs. In all three outcomes there was variability across programs, specifically for the signal group. In 2024, 5.4% of applicants that did not send a signal were ranked, compared to 21.6% of applicants that signaled and were ranked; the 2023 data show similar results (Fig. 2). This difference highlights applicants who signal have a greater rate of being included on a program's ROL compared to those who do not signal. Despite this, most program ROLs were still comprised of applicants that did not signal (76.4% in 2024 and 80.4% in 2023); only 23.6% and 19.7% were signalers in 2024 and 2023, respectively (Fig. 3). This demonstrates that even though sending a signal increases the chances of being ranked, many GS applicants were ranked regardless of a signal.

Impact of Signal on Ranking in a Competitive Position of Program ROL

Signalers had a slightly higher percentage of being ranked competitively compared to non-signalers. Among ranked applicants in 2024 who signaled a program, 32.4% were ranked competitively versus 27.7% who did not signal (Fig. 2). The 2023 data demonstrate a similar pattern (Fig. 2). Although signalers had a higher percentage of being ranked competitively, the majority (73.5% in 2024; 78.9% in 2023) of the competitive portion of program ROLs consisted of those who did not signal (Fig. 3).

Impact of Signal on Matching to a Program

Among ranked applicants who did not signal the program in 2024, 6.8% matched to the program. In comparison, 15.6% of ranked applicants who signaled the program successfully matched. Similar trends were observed in 2023 (Fig. 2). These data suggest that ranked applicants who signal have more than double the rate of matching to the program compared to those who do not.

Furthermore, in 2024, 41.6% of matched applicants sent a signal to the program, whereas 58.4% of matched applicants did not send a signal, showing a similar but more pronounced difference than in the previous year (Fig. 3). Despite the observed trend of signaling seen in Fig. 2, most matches were filled by applicants who did not signal, suggesting that while sending a signal

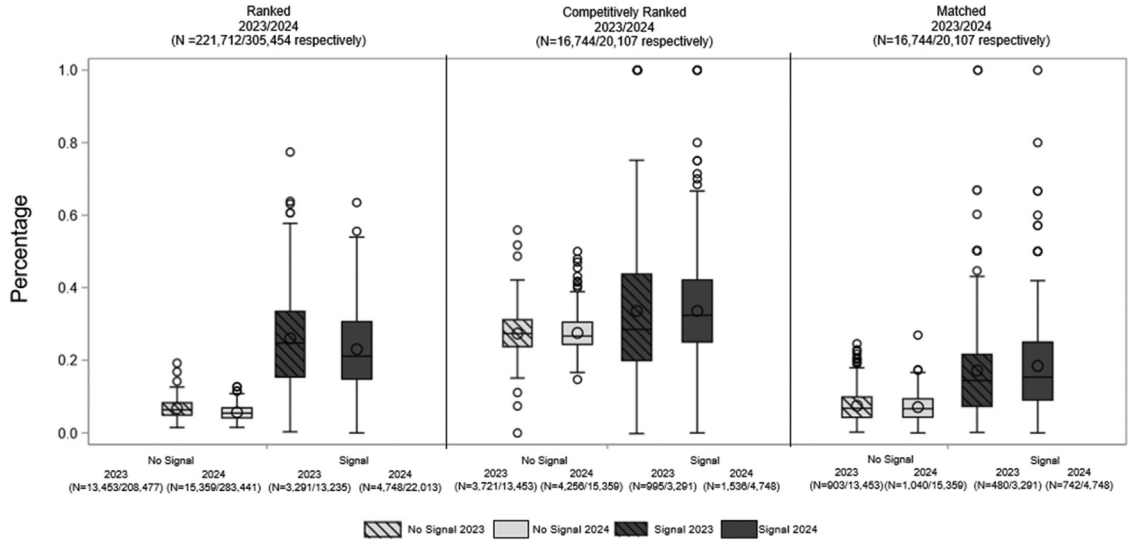

FIGURE 2. The percentage of total applications ranked, percentage of the ROL ranked competitively, and the percentage of the ROL that Matched to a program by signal status respectively for General Surgery in 2023 and 2024.

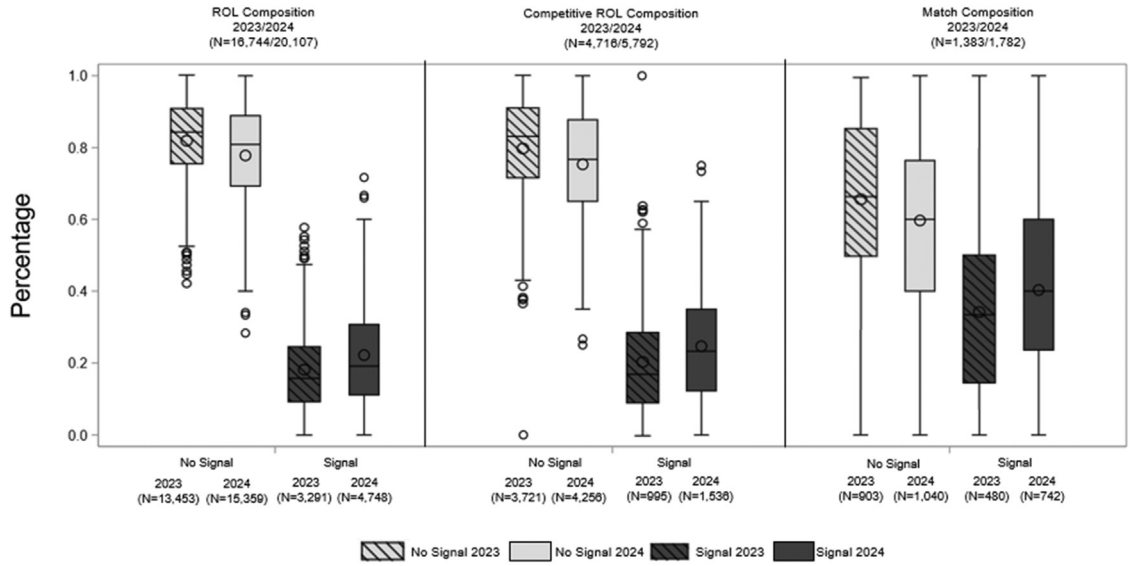

FIGURE 3. The composition of the ROL, competitive ROL, and matches by signal status respectively for General Surgery in 2023 and 2024.

increases the rate of being ranked, ranked competitively, and matching to the program, many applicants in GS achieved the same outcome without sending a signal.

Factors Influencing Applicant Placement on a ROL

The 2023 MLM analysis (Table 2) found that signals, location (i.e., the applicant's UME and the program being located in the same state), and Step 1 scores (one standard deviation [SD] above the mean) were statistically significant positive predictors of being ranked. Meanwhile, having an applicant type other than U.S. MD and applications to programs with a signal to application ratio one SD above the mean were significant negative predictors of ranking.

Applicants who sent a signal had 5.63 times greater odds of being ranked compared to those who did not (OR = 5.63, 95% CI [5.31, 5.98]). At baseline DO, U.S. IMG, and non-U.S. IMGs applicants had lower odds of being ranked than U.S. MD applicants (DO: OR = 0.50, 95% CI [0.48, 0.53]; US IMGs: OR = 0.11, 95% CI [0.10, 0.13]; non-US IMGs: OR = 0.11, 95% CI [0.09, 0.12]). Applicants enrolled in a medical school in the same state

TABLE 2. MLM results for General Surgery 2023

Variable	Odds Ratio	95% CI
Signal	**5.63**	[5.31, 5.98]
Applicant Type		
DO	**0.50**	[0.48, 0.53]
Non-US IMG	**0.11**	[0.09, 0.12]
US IMG	**0.11**	[0.10, 0.13]
Location	**3.52**	[3.35, 3.70]
Step 1	**1.77**	[1.74, 1.81]
Signal Application Ratio	**0.76**	[0.71, 0.80]
Signal x Location	**0.41**	[0.36, 0.46]
Signal x DO	**1.16**	[1.02, 1.33]
Signal x Non-US IMG	**1.73**	[1.35, 2.23]
Signal x US IMG	**1.48**	[1.15, 1.91]

Bolded values represent $p < 0.05$. For applicant type, US MD applicants are the reference point.

as the program had 3.52 times greater odds of being ranked compared to those in a different state (OR = 3.52, 95% CI [3.35, 3.70]). A Step 1 score one SD above the mean was associated with 1.77-fold greater odds of being ranked (OR = 1.77, 95% CI [1.74, 1.81]). However, applicants to programs with a higher signal-to-application ratio (one SD above the mean) had 24% lower odds of being ranked compared to those in programs with a lower ratio (OR = 0.76, 95% CI [0.71, 0.80]).

Regarding the interaction variables, the relationship between signaling and being ranked varies by applicant type and the location of the program relative to the applicant's medical school location (Fig. 4), with the effect of the signal being weaker for in state applicants (OR = 0.41, 95% CI [0.36, 0.46]) than out of state. Further, across all applicant types signaling was associated with increased odds of being included on a ROL. Specifically, the interaction effect suggests that signaling had a stronger impact for DO and IMG applicants compared to MD applicants (DO: OR = 1.16, 95% CI [1.02, 1.33]; US IMG: OR = 1.48, 95% CI [1.15, 1.91]; Non-US IMG: OR = 1.73, 95% CI [1.35, 2.23]). Fig. 4 displays the change in the predicted probability of ROL inclusion by signal status and location for each applicant type.

DISCUSSION

Although the majority of the ROL, competitive ROL and matched applicants were non-signalers, sending a program signal in GS is positively related to the inclusion of applicants on program ROLs and increases the rate of being ranked, competitively ranked, and matching. While signaling is not a deterministic factor for ranking and matching outcomes in GS, it has a strong effect, significantly increasing the odds of being ranked.

Signals, enrollment in a medical school in the same state as the program, and a higher Step 1 score are all positively related to being included on a program's ROL. This is consistent with prior research showing that signaling, USMLE Step 1 score tercile, and being an in-state applicant were positively associated with interview invitation.[4,21] Considering interview data is not included in this study, it is not possible to determine whether signaling independently impacts ranking decisions, or if signaling has effects on both the initial interview step and/or ranking. Similar to work in Otolaryngology,[10] LaFemina et al.[22] demonstrated that a larger proportion of signals are sent to the top tertile of programs based on number of applications and entering residents. The current data suggests that there is a relationship between the proportion of applicants who signaled a program and being ranked: with the odds of being ranked by a program increasing when a smaller proportion of applicants signaled that program. It was hypothesized that the value of signals in decisions for interview invitation may be reduced in programs receiving many signals,[22] future models could examine similar hypotheses for ranking.

DO and IMG applicants are ranked less frequently than their U.S. MD counterparts, echoing earlier findings that U.S. MDs are more commonly offered interviews during the T2R.[4] Signals improve the odds of being ranked across all applicant types, with a greater impact observed for DO and IMG applicants compared to U.S. MDs. Similarly, signals enhanced ranking probabilities for all applicant types, including IMGs and DOs, underscoring that the implementation of signals did not inadvertently disadvantage these applicant types. Recent data from the AAMC shows that in the 2023 ERAS cycle[3] applicants who sent a signal in a specialty with a high number of available signals (i.e., Orthopedics) had a 21% median likelihood of receiving an interview, compared to 1% of those who did not. Compared to GS, a small signal specialty, revealed that 29% of applicants who issued a signal received an interview, compared to 9% who did not.

This study has several limitations. The models did not account for all possible interactions or variables influencing the residency selection process, such as other application data, interview performance, away rotations, variability in applicant signal usage, and how programs value a signal. Additionally, underrepresented in medicine and birth sex were excluded due to sample size concerns, limiting the scope of the findings. The results also cannot be generalized to DO applicants without USMLE Step 1 scores, leaving gaps in understanding how such applicants fare in the selection process.

These limitations and changes in the residency selection landscape led to several avenues for future

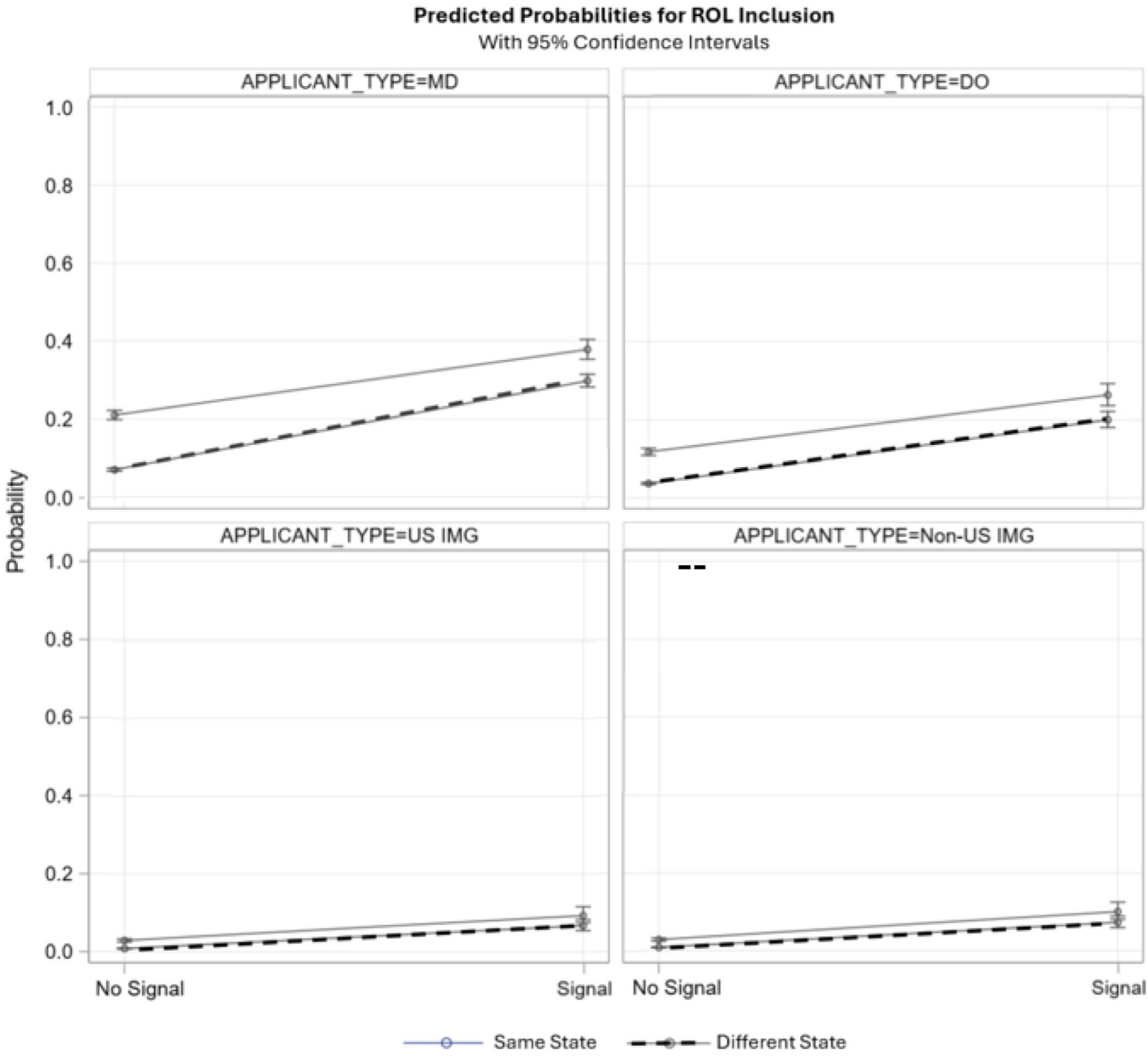

FIGURE 4. Predicted probabilities of ROL inclusion by signal status, location, and applicant type for General Surgery 2023.

exploration. This study included Step 1 scores given the timeframe applicants who had taken USMLE corresponded to a period where Step 1 featured prominently in the residency selection process. With the transition of Step 1 to pass/fail and growing evidence indicating program directors weighing Step 2 CK more prominently in residency selection, research on subsequent match cycles should investigate Step 2 CK's association with these outcomes. We hypothesize that Step 2 will show similar results/trends as we found for Step 1 in 2023. Additionally, the implementation of the newly implemented 15 signal structure for GS is one that needs to be explored as present results may not generalize to the 2025 cycle and beyond due to the increase in number of signals, in addition to other signaling structures that are available in other specialties. Thus, future studies within our collaboration intend to incorporate the applicant's home medical school data, as well as COMLEX and Step 2 CK scores, as well as different signaling structures, to enhance understanding of correlations with data currently used in residency selection.

CONCLUSIONS

In the 2023 and 2024 cycles, among applicants who signaled, a higher percentage were ranked, ranked in competitive positions, and matched compared to those who did not signal. In 2023 sending a program signal increased the odds of an applicant being on a program's ROL. The effect of the signal is stronger for applicants whose medical school is out of state, though overall, applicants from the same state as the program and those with a high Step 1 score have higher odds of being added to a ROL. Signaling also yielded a greater relative effect for DO and IMG applicants compared to U.S. MDs, though both applicant types are ranked less frequently than U.S. MD peers. While the effect of sending a signal is strong, there was variability in programs use of signals and signals were not required to be ranked or matched in this specialty which utilizes a small signaling paradigm, as the majority of applicants on the ROL and who matched did not signal the program.

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