Designing the “match of the future”: challenges and proposed solutions in the interview and match phase of the UME–GME transition

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Abstract
This review focuses on the interview and match process with the purpose of broadly reviewing challenges in the current surgical residency selection process, detailing potential solutions, and identifying future avenues of investigation.

Keywords  Residency selection · Interview · Virtual interview · Graduate medical education · Undergraduate medical education

Introduction
The interview and match phase of the transition from medical school to surgical residency is a competitive process that presents a number of challenges to applicants, residency programs, medical schools, and specialties. These issues have prompted a call from prominent medical educators to modify the match process [1, 2]. In 2020, the COVID-19 pandemic was a catalyst in accelerating a transition from in-person interviews to a primarily virtual interview process. Concurrently, there have been a number of proposed modifications to address issues of equity, interview optimization, and cost. One group, the Coalition for Physician Accountability, published a 276 page document aimed at comprehensively improving the UME–GME transition for all specialties [3]. Twelve of the 34 final recommendations pertained to the interview and match process. Given unique aspects of surgical training and the surgical profession, the Graduate Surgical Education Committee of the Association of Surgical Education convened a working group to address the UME–GME transition from the surgical perspective with the aim of publishing a series of reviews to synthesize challenges and potential solutions to different phases of a student’s journey from medical school to surgical residency. This particular review focuses on the interview and match process with the purpose of broadly reviewing challenges in the current surgical residency selection process, detailing potential solutions, and identifying future avenues of investigation.

Challenges in surgical residency selection
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Challenges | Proposed solutions (may address more than one challenge) | Coordinated, specialty-level interventions
--- | --- | ---
High competitiveness and increasing application numbers | Transparetly publish selection criteria Create publicly available, high-quality websites and program information | Create a standardized calendar of deadlines and interview invitations Establish an interview/application cap Allow preference signaling Adopt a waiting period before interview offers can be accepted
Financial burden to applicants, programs | Employ virtual interviews | Establish an interview/application cap
Environmental cost of interview travel | Employ virtual interviews | Establish an interview/application cap
Inequitable selection processes | Employ holistic review Establish and train faculty in standardized interviewing best practices Track and audit selection, interviewing, match practices to identify concerning trends Do not offer more interview invitations than slots | Adopt a waiting period before interview offers can be accepted Establish an interview/application cap Asynchronous/decoupled rank list certification
High attrition | Create publicly available, high-quality websites and program information | Allow preference signaling Asynchronous/decoupled rank list certification

available was 1.1 [4]. Consequently, a large proportion of students applying to general surgery remain unmatched. Among students who ranked general surgery as their only specialty of choice in 2021, 10.6% of MD seniors and 23.9% DO seniors went unmatched [4]. From the program side, the general surgery fill rate remains nearly 100%, a figure that has not changed despite an increasing number of categorical positions [4].

Fear of not matching and inadequate guidance in data-driven advising can often lead to application bloat in a system that currently has no limitation on the number of programs to which an applicant can apply. Within the past several years there has been a substantial increase in the number of applications per candidate—in the 2021 NRMP data, the self-reported median number of applications was 56–84 and in the 2020 AAMC data showed a similar trend with an average of 60 programs applied to per applicant [5, 6]. The number of applications is increasing despite AAMC data on the diminishing returns beyond a certain number of applications, for example 39 applications for an applicant with a Step 1 score above 223 [7]. The rise in application number is highly consequential with detrimental effect on both cost and equity.

In the setting of high application numbers, it is unsurprising that the overall costs incurred when applying for general surgery residency are substantial both to the residency programs and to the applicants. On the residency program side, the average cost per position filled was $18,648 and average cost per interviewee was $1,221 in 2017 [8]. The costs include personnel effort with screening and reviewing applications, time for the actual interviews, food, beverages, social events, tour guide fees, and room reservations. For the applicants, costs include the ERAS application fees as well as the licensing fees for the USMLE in addition to the costs of traveling to an in-person interview. The total average cost of travel for general surgery residency interviews in 2015 was $4,264. Some applicants also are encouraged to do away/audition rotations, which in 2015 added an average additional cost of $1,839. When surveyed, 79% of applicants agreed or strongly agreed that travel costs were burdensome and 58% stated that financial considerations influenced the decision to attend interviews. The top 3 ways that applicants paid for these costs were personal savings, family savings, and additional federal loans [9].

In addition to time and money, an often overlooked historical cost of the in-person interview is the environmental cost of travel. A Canadian study in the 2019–2020 cycle found that general surgery applicants visited an average of 10 cities. In a model where interviews were regionalized, there would be a 43.2% reduction in carbon dioxide emissions [10]. Similarly, Stanford’s entire graduating class in the same time period (2019–2020) found that the median
number of interview flights was 8, with students applying for neurosurgery residency having the highest mean CO2 emissions and family medicine having the lowest mean CO2 emissions. Using a standard environmental economic conversion factor, the estimated environmental cost for the Stanford medical student class was approximately $5000 per student [11].

Beyond financial, time, and environmental costs, the increasing number of applicants that a given program receives creates a hurdle to holistic review, which is a key component of ensuring equitable selection for interviews and has been shown to improve the diversity of selected applicants without negative consequences on “objective” measures of achievement or program attrition rates [12]. Holistic review is supported by data showing that the relationship between test performance and clinical skills is inconsistent and variable [13, 14].

Yet even if an applicant is selected to interview, heterogeneous interview practices may systematically disadvantage students who are underrepresented in surgery including women and students of color. Non-standardized interview practices pose significant threats to equitable selection and subsequently, diversity and inclusion, as the interview is often cited by residency program leadership as the most important factor in making a rank list [15].

Finally, it is important to identify that despite the competitiveness and high cost of the resident selection process, the outcomes of the interview and match process are not always favorable. In general surgery, the attrition rate at a national level is still as high as 20%. A longitudinal prospective study of categorical general surgery interns that were followed from 2007 to 2008 through June 30, 2016 demonstrated that after four years of residency, the attrition rate was 21.9% for women vs 16.3% for men [16]. While other estimates of surgical attrition are less grim, they still suggest that over 1 in 10 residents will leave surgical training. A meta-analysis of data from 1980 to 2016 estimated the yearly attrition rate to be 2.4% with a 5-year attrition rate of 12.9% [17]. While attrition can be due to lack of professionalism or poor performance, a systematic review demonstrated that the majority of residents who leave surgery do so voluntarily, with a portion of residents switching to another general surgery program [18]. Importantly, it has been established that improving the selection process may influence the risk of attrition [12, 19, 20].

### Proposed guiding principles for “match of the future”

It is important to articulate the guiding principles and goals that would inform specific changes to the current resident selection process to inform the optimal “match of the future” (Table 2). We posit that the purpose of the surgical residency selection process is to optimally match students to training programs that will support their short- and long-term personal and professional goals, while aiming to meet the population needs for well-trained surgeons. Additionally, we propose that effective selection processes must increase the likelihood that students match to compatible programs while also promoting diversity, equity and inclusion (DEI) and limiting financial, educational, and environmental costs. With regard to DEI, selection processes should not disadvantage individuals based on a broad range of demographic factors including race, ethnicity, gender, sexual orientation, or socioeconomic class. Costs that should be minimized in the optimal selection process include financial and time burden on both applicants and programs, the environmental footprint of the application process, and disruption of the final year of their medical school training. In a sense, efficient selection processes minimize the resources expended to fill each training position. Finally, we propose that any changes to the residency selection process operate from the assumption that there are sufficient, qualified candidates to fill surgical training positions. Ideally, changes to the match process would reverse the current patterns of discrimination, over-application, and interview hoarding/maldistribution while maintaining the near 100% rate of filling categorical surgical training positions.

### Table 2 Proposed guiding principles for resident selection

| Principle                                      | Comment                                                                 |
|------------------------------------------------|-------------------------------------------------------------------------|
| Meet population needs of well-trained surgeons | Ensure number of positions will satisfy national surgical workforce needs |
| Alignment of student–program goals            | Optimally match students to programs that support their short- and long-term personal and professional goals |
| Improve diversity and inclusion               | May improve national attrition rates                                    |
|                                               | Adopt holistic review with standardized interviewing                   |
|                                               | Eliminate selection processes that systematically disadvantage particular students based on gender, race, sexual orientation, socioeconomic class |
| Minimize cost                                 | Increase efficiency by considering financial, time, and environmental costs |
Proposed changes to the surgical residency selection process

A number of modifications to the surgical residency selection process may help achieve the goal of successful pairing of students and programs while simultaneously combating negative application trends. We describe actions that can be immediately adopted by individual programs in the next interview cycle as well as innovations that would require a coordinated effort across programs and surgical organizations (Table 1). We also acknowledge the numerous challenges to implementing any changes to current practices.

Program-level improvements

Individual residency programs can adopt immediate changes to their selection processes that would improve the overall process for applicants. These changes can be characterized as increasing the quality and quantity of information available to applicants and adopting established best selection practices.

First, individual programs should be transparent about key aspects of their selection procedures including application deadline, dates of interview offers, dates of interviews, number of interviews that will be offered, and number of positions available. Other information useful to applicants in deciding whether to apply to a program includes ability of the program to provide visa sponsorship, its application review processes, and its interview criteria. Finally, core program features including rotation sites, resident salaries, vacation policies, parental leave policies, call burden, operative case volume, case logs, research opportunities, fellowship match outcomes, and post-graduate employment of graduates should also be publicly available to applicants so that they do not apply to programs that are not aligned with their values and needs [21, 22]. Platforms to increase the quality and quantity of information include program website, social media accounts, webinars, online forums, and virtual subinternships.

Residency websites have increased in prominence during the COVID-19 pandemic, though the quality of surgical training program websites varies significantly in terms of providing information such as resident research requirements, mentorship, evaluation methods, resident demographics, or diversity information [23–26]. Surgical training programs have also increased their presence on social media platforms such as Twitter and Instagram to disseminate information about their programs, both discrete information about operative experience and resident research output, but more qualitative materials regarding resident culture, camaraderie, and social life [27–31]. Online platforms such as Slack and Reddit can also be used to provide applicants with information regarding programs, allowing an asynchronous Q & A that is visible to all applicants [32, 33]. To help inform applicants about the physical space and environment where they will be training, programs may wish to employ virtual reality tours, edited videos, or real time video tours to better convey where their trainees spend the majority of their time [34, 35]. Webinars may be another way for applicants to gain a sense of a program, though we recommend that they be recorded so that applicants do not need to be available at the time of the webinar to view the material, and that programs do not use webinar attendance as a surrogate for program interest [35]. Finally, programs can consider offering a virtual subinternship for students to get a more in-depth exposure to their program. Surgical specialties including urology, otolaryngology, plastic surgery, and neurosurgery all developed virtual subinternships in response to the pandemic as a way to try to compensate for the loss of the away rotation, with initial results suggesting that students who participated did feel they gained insight into resident life at host departments [36–39]. Interestingly, faculty and residents reported more neutral responses when asked if they were able to assess characteristics of virtual subinternship participants, suggesting that the information benefit is primarily for applicants and not for programs, which may influence a department’s interest in offering a virtual subinternship [37]. As programs develop content for their websites and other platforms, they may wish to incorporate concepts of branding when considering how to showcase the ways in which their program is differentiated from others and thereby attract applicants aligned with their particular mission and purpose [40].

In addition to increasing transparency regarding selection procedure and increasing the quality of information available to applicants, programs can adopt best practices for resident selection. It is critical for programs to consider the ways in which their interview selection practices may systematically disadvantage women or URM students, especially in the context of evidence that women are more frequent targets of illegal and inappropriate interview questions and that URMs are underrepresented among applicants selected for interviews [41, 42]. Beyond gender and race, there is evidence for discrimination based on applicant obesity, physical attractiveness, and sexual orientation [43, 44]. To combat these biases, programs can turn off photos when selecting applicants for interview and use holistic review in interview selection. Holistic review, which de-emphasizes numeric cut-offs and instead emphasizes academic performance in the context of an applicant’s unique characteristics and experiences, has been shown to improve diversity of interviewed
and matched applicants both within and outside of surgery [12, 45–47]. Holistic review toolkits have been published by the AAMC, and the APDS has also created materials to assist surgical educators in pursuing diversity, equity, and inclusion [48, 49]. In addition to holistic review, strategies to mitigate bias include anti-bias training of all faculty involved in interviewing and recruitment, expanding the inclusiveness of the interviewing team, and using structured interviewing practices [12, 46, 50–52]. One added benefit of the structured interview may be reduced attrition, which may be explained by increasing the compatibility between the program and the matched applicants [20]. Programs should evaluate their own selection practices and track the characteristics of screened, interviewed, ranked, and matched applicants to identify any concerning trends.

With regard to mechanics of virtual interviewing, others have published on how programs can effectively administer interviews over a virtual platform [52–55].

**Coordinated innovations**

Potential modifications to improve the interview selection process that would require cooperation and buy-in across surgical training programs include a standardized calendar for selection procedures, interest signaling, application/interview caps, and asynchronous rank list submission.

One of the suggested improvements to combat interview maldistribution includes a standardized interview calendar in which programs agree on an application deadline, date of initial interview offer release, defined interview season, and defined procedures regarding number of interview offers relative to available interview slots and interview scheduling. Under this modification, programs would plan to release interview offers on a single day or week so that applicants have more information on which to base their decision to accept or decline an interview offer, perhaps permitting them to focus on accepting interviews from programs in which they have a sincere interest. Proponents of this change speculate that competitive applicants may be less inclined to accumulate or “hoard” interviews, thus allowing these interview offers to be extended to other students and consequently leading to the more even distribution of interviews across applicants [56]. In general surgery, it has been noted that 6% of all applicants completed 28% of all interviews, which demonstrates how a small number of applicants can come to control an outsized proportion of interviews [57]. Applicant motivations for accumulating excessive interviews include not knowing their interview status at other programs and a concern that even if offered an interview, they may not reply quickly enough to secure an interview slot. In a survey study of 786 fourth year medical students, a majority of students acknowledged that they had accepted an interview offer with the knowledge that they would likely cancel it in the future as a way to hedge against not receiving an invitation from other programs [58]. Additionally, over a quarter of students applying to surgical specialties reported that they had lost the opportunity to interview at a program due to timing of their response.

There are some data that standardized interview release dates and procedures can change applicant behavior by addressing these concerns. In 2019, The Association of Professors of Gynecology and Obstetrics (APGO) outlined standards for interview release dates which included a 72-hour waiting period before applicants could accept or decline an interview offer. In a survey study that included 505 American MD applicants to OB-GYN during that match cycle, there was a decrease in excessive interviewing that was associated with receiving interview offers from programs participating in the standardized calendar [59]. These results are consistent with the hypothesis that students will exhibit a decrease in excessive interviewing behaviors when they receive coordinated interview offers that do not employ a “first come first served” procedure for interview scheduling. Students report that over-application is driven by a concern by a desire to match [60]. Perhaps if interview maldistribution improves, over-application behaviors will also improve as students recognize that they do not need to apply to an extreme number of programs to attain a sufficient number of interviews for a high likelihood of matching. In OB-GYN there is already evidence that standardized calendars and procedures can alleviate applicant anxiety, though students have reported desiring even more radical changes to the application process [61]. Currently, the APDS has recommended interview release dates for the 2023 residency application cycle to help applicants understand their interview options and potentially combat interview hoarding.

Preference signaling is another potential, coordinated intervention to combat “application fever.” Under a preference signaling system, applicants would have the ability to send a discrete number of signals to programs of particular interest. These signals would permit programs to more accurately discern sincere student interest and help a student stand out to their preferred programs. A computer model of preference signaling suggested that this modification to the interview offer process could increase the number of interview offers for a typical student in a competitive field [62]. For the 2021 match, the Otolaryngology Program Directors Organization (OPDO) implemented a voluntary signaling program in which students could indicate up to 5 programs to receive a preference signal [63]. Initial results from this pilot year demonstrated that a high proportion of both applicants and program directors favored continuing the signaling program. Additionally, it was found that students had a 58% chance of receiving an interview offer from signaled programs, compared to 14% of non-signal programs.
was found across all quartiles of student competitiveness, demonstrating the benefit was not limited to students who would typically receive a high proportion of interview invitations. While official match patterns have not been published, a survey study of 113 students who participated in the 2021 otolaryngology match found that over a quarter of students matched to a signaled program [64]. Applicants in the 2022 General Surgery Match had the option to participate in a new supplemental ERAS application program and submit preference signals to up to 5 programs, and research on the effect of this signaling program will be forthcoming [65]. Longer-term follow-up will reveal whether success of this signaling program in distributing interviews will result in a concomitant decrease in over-application and how to optimize the benefits of a signaling program. Importantly, organizations such as OPDO and APDS have indicated that signals should not be used in the final rank list order determination, although nearly 20% of otolaryngology program directors indicated that it was used in this way [63, 66].

While standardized calendars and preference signaling are intended to alter behavior of applicants and programs in ways that will eventually lead to reduction in over-application and interview hoarding, some have advocated for directly capping the number of applications and interviews an applicant can submit or accept. There has been a steady increase in number of programs that students apply to, with some surgical programs receiving over 150 applications per position and overwhelming the ability of program directors and involved faculty to meaningfully and holistically review all applicants [67]. Students who matched to general surgery in 2021 reported applying to a median of 56–84 programs [5]. Overapplication is driven by a desire to increase the likelihood of matching even though there is evidence that increasing application number past a certain point does not necessarily translate to an increase in match rate [7, 68]. These numbers are far above the number of contiguous ranks associated with a high match likelihood. For students in general surgery, there was a 90% chance of matching by ranking 11 programs and nearly 100% for 17 programs [69]. Some have argued that an application cap will force applicants to apply only to programs that they are sincerely interested in and simultaneously reduce the burden of program directors to provide meaningful review of applications, which will ultimately lead to less seemingly haphazard interview invitations [67, 70]. Additionally, capping applications would limit the financial costs to applicants and potentially level the playing field between applicants with greater financial means. Others advocate instead for interview caps as a method of combating the maldistribution of interviews described above [71–74]. Models have demonstrated that an interview cap would liberate interview offers for less competitive applicants, thereby increasing their number of contiguous ranks and match likelihood [72]. Additionally, proponents of the interview cap argue that applicants would prioritize interviewing only at programs in whom they have a genuine interest, which would improve the quality of match outcomes. Others have argued for a match process for interview offers that would optimize interview lists for both programs and applicants [75, 76]. Still others have proposed novel ticketing processes in which applicants “spend” a discrete number of interview tickets per season [71]. The goal of both an application cap and interview cap is to impose limits on selection process “waste,” i.e., applications/interviews to programs that students have little interest in and review of applicants that are unlikely to match to a program. The Association of University Professors of Ophthalmology piloted an interview cap of 20 interviews during the 2020–2021 cycle, then reduced this to 18 for 2021–2022 [77]. Importantly, there appears to be an appetite for application or interview caps from students themselves, who report that current processes are not equitable [78].

Finally, one potential improvement to the resident selection process is asynchronous/decoupled rank list submission. This intervention has not been tested, though it holds a number of theoretical benefits. Assuming that residency interviews remain primarily virtual beyond the COVID-19 pandemic based on the benefits of cost and environmental impact, asynchronous rank list submission could permit a window of time for students to make in-person visits to programs for purely information-gathering purposes. The concept of an asynchronous rank list submission may be especially important for students applying to surgical specialties. Students may be hesitant to commit to a 5–7-year-long training program in a location they have never visited. Because program rank lists have already been submitted, students could use these trips to attain information on program characteristics that have been identified as important for rank order but that may be difficult to assess on the virtual platform without concern that their visit would become part of the selection process [55, 79–81]. Decoupled rank list submission may mitigate any advantages that applicants with increased financial means may have over those without, since an in-person visit would not be able to be interpreted as a signal of interest to a program. Students themselves may prefer that in-person visits be limited to after programs have certified their rank order lists. In a study of 84 students participating in the 2021 radiology match, a majority indicated a preference for on-site visits occurring after program rank list submission, whereas less than 25% indicated a preference for in-person visits throughout the entire interview season [82]. Importantly, the APDS has recently endorsed decoupled rank list submission as a potential avenue for programs to promote in-person visits without detrimental effect on equity.
Challenges

There are a number of challenges to implementing significant changes to the residency selection process. Establishing consensus and coordination from a large number of training programs and other stakeholders may be one of the greatest obstacles to implementing major modifications to the match process [63]. Importantly, stakeholders including students, residency programs, medical schools may have to shift from a “prisoner’s dilemma” or “arms race” mindset in which behaviors that appear to be self-serving result in globally less optimal outcomes [68, 83]. Additionally, changes will require cooperation from organizations such as the NRMP and AAMC/ERAS that could financially benefit from the fees generated by an increasing number of applications [21]. However daunting these hurdles may seem, there are examples of procedure based specialties that have successfully implemented major changes including interview caps, preference signaling, and a standardized selection calendar [63, 77, 84]. Organizations such as the Association of Program Directors in Surgery and the Association for Surgical Education may need to take the lead in advocating for specific changes, nurturing consensus among the varied stakeholders, and establishing assessment and evaluation programs to track whether adopted changes are having the intended positive effects.

Future work

Resident selection is an area in which continued investigation is paramount to improving surgical education. It will be important to evaluate outcomes related to any systematic changes in the match process such as the preference signaling introduced in the 2022 cycle. Relevant outcomes of note include reduction in over-application, improved distribution of interviews, match success rates, equityability of selection process, and cost of resident selection broadly defined including time, financial resources, environmental consequences, and educational disruption. Further research is also warranted into the efficacy of specific selection strategies including selection tools and interviewing practices and may even illuminate practices that reduce the risk of resident attrition. Understanding the long-term consequences of transitioning to virtual interview platforms, such as residency attrition rates, and the role of virtual interviewing after pandemic restrictions have eased will also be critical in creating a process of selection that is both more equitable and cost-effective. For example, if outcomes of the virtual match process are found to be poor, there may be justification for incurring the cost of an in-person process, though with increased attention to equity and environmental footprint. All of these research questions will inform how to continuously move toward a selection system that embodies the guiding principles outlined above.

Summary and conclusion

Surgical resident selection is competitive and can be a challenging and stressful phase of the UME–GME transition for all involved parties. The COVID-19 pandemic has accelerated changes to the interview and match process that are intended to address a number of long-standing challenges including equity, diversity and inclusion, cost, over-application, and interview maldistribution. Early results of adopted interventions have been promising, though long-term outcomes are still to be determined. Future research will illuminate characteristics to optimize the “match of the future”.

Data availability

Not applicable.

Declarations

Conflict of interest

The authors have no relevant financial or non-financial interests to disclose.

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