The Residency Match: Escaping the Prisoner's Dilemma

Eric J. Warm, MD
Benjamin Kinnear, MD, MEd
Anne Pereira, MD, MPH
David A. Hirsh, MD

In December 2020, the Association of American Medical Colleges sent an unprecedented letter to program directors, student affairs officers, designated institutional officials, and medical students describing residency interview hoarding and maldistribution. The letter highlighted that students in the highest tiers of medical school were receiving a disproportionate number of interview invitations, leaving fewer opportunities for other students.[1] The COVID-19 pandemic exposed fault lines across society between the haves and have nots,[2] and medical education was no exception. Behaviors such as hoarding (eg, hand sanitizer, interviews) can be predicted by inherent inequities in systems like the residency Match within which people act in their own self-interest.

The term "match" denotes both the process of connecting 2 things and a contest in which people or teams compete against one another. Current participants in the residency Match spend ever-increasing amounts of time, energy, and money for diminishing returns, often displaying behaviors rooted in fear and half-truths.[3] Despite multiple calls for reform, the problem continues to worsen.[4,5] Most proposed solutions do not fully address the underlying motivators and at best offer limited improvements.[6,7] Building on the recent discourse in the medical literature,[5,8–12] we use the concept of the "prisoner's dilemma" to explore drivers of student, program, and institutional behaviors. Although others have used this framing in the past, we delve further into underlying motivations behind the actions we see in the Match and suggest a different path forward. We challenge academic medicine to devalue *normative comparison* in favor of high-level *reproducible competence* as the criterion for medical school graduation and residency selection.

Game Theory as a Lens for Examining the Match

In the 1940s, Neumann and Morgenstern developed game theory after considering differences in strategies between chess, a game with "perfect information" in which all potential pieces and moves are visible, and poker, a game of "imperfect information" in which players hide their liabilities and assets to gain advantage.[13] Medical schools, applicants, and residency programs play games of imperfect information every year. For example, applicants may prioritize location, curricular flexibility, or prestige, but infrequently share this information with programs. Residency programs rarely list interview criteria in the public domain,[14] and medical schools have long produced documentation that program directors find unhelpful.[15]

Temptations and Suckers

In the 1950s, Flood et al described the *prisoner's dilemma*, a set of behaviors and outcomes common to games of incomplete information.[16] In the story of the prisoner's dilemma (FIGURE), 2 suspects are arrested and taken to separate jails. Jailers have enough evidence to convict each suspect on lesser charges, but they need a confession or an accusation by either suspect to convict the other of a major crime. There are 4 possibilities. Jailers tell the first suspect that the second suspect has already defected or "ratted him out," and if this first suspect "holds out" and cooperates with the other suspect, he will receive 20 years in jail, while the second suspect will receive only 1 year. The second suspect is told the same thing about the first. If both suspects cooperate with each other, they will each receive only 2 years in jail, but if they each defect on the other, each receives 16 years in jail. The best outcome (1 year) is called the *temptation*, and the worst outcome (20 years) is known as the *sucker's payoff*. Most studies of rational players show that in a prisoner's dilemma, mutual defection is the dominant strategy, not mutual cooperation even when the players agree beforehand to cooperate.[17,18]

Residency Match and the Prisoner's Dilemma

We characterize 3 prisoner's dilemmas in the Match—each arises from human impulses and powerful forces within the US medical education system.

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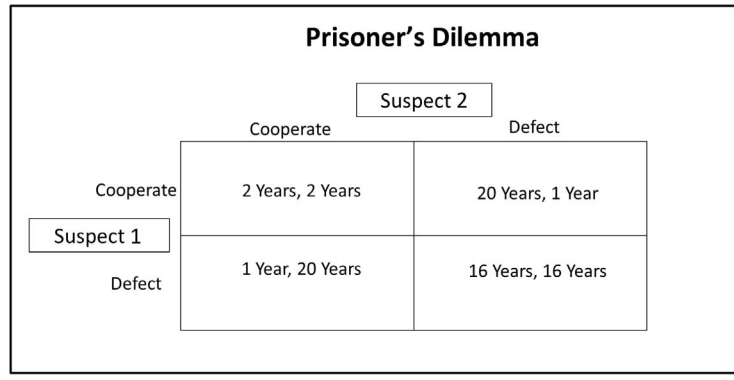

FIGURE
The Elements of a Prisoner's Dilemma

Note: 1 Year = The Temptation, 20 years = The Sucker's Payoff, 2 Years = Mutual Cooperation, 16 years = Mutual Defection. In each respective box, the first number represents suspect 1's fate, and the second number represents suspect 2's fate. In a prisoner's dilemma, mutual defection is the dominant strategy.

Medical School Versus Medical School

Medical schools compete with one another. Facing pressure to match medical students to the "best" residency programs (the temptation) and to have no students fail to get a desired match (the sucker's payoff), schools produce untrustworthy assessment data that do not reliably predict future performance.[19–21] Several reasons for this behavior exist.[5,8,22] Grading systems based on normative comparisons, especially in the clinical years, produce perverse incentives for learners. Students show only strengths to their teachers to get the best possible grades or recommendations; in contrast, sharing the need for growth, or sharing that growth has even occurred, are perceived as weaknesses.[23] Even if a school's assessment system can capture a student's weaknesses, sharing this information with residency programs represents risk if other schools do not share similar information about their students. Some schools will not terminate students for academic reasons unless serious non-remediable professionalism issues arise, leading to the well described "failure to fail" phenomenon.[24] Medical schools *could* cooperate and share a more complete truth about their students, but if some schools choose not to, those schools would have an advantage over schools that share, and so nearly all schools defect.

Applicant Versus Applicant

Applicants compete directly with one another. Most applicants could apply to fewer programs, as the vast majority eventually match within their top 6 choices.[25] However, fear of not matching, the sucker's payoff, may underlie students' sense that those who do apply to fewer programs risk being greatly disadvantaged. The resulting mutual defection leads to a vicious cycle. The "best applicants" (idiomatically stated) get the most interview applications, crowding out the "weaker applicants."[1,26] This leads the weaker applicants to apply to more programs. Stronger applicants then feel the need to apply to more programs, which in turn leads weaker applicants to do the same, and so on.

Program Versus Program

Residency programs also compete. Programs have accommodated the increase in applications by conducting more interviews,[5] and the vast majority of programs match well above the bottom of their list.[25] Programs could cooperate and decide to interview fewer applicants, but programs that decide not to cooperate gain the theoretical advantage of having more applicants to choose from, and so nearly all programs defect.

Escaping the Prisoner's Dilemma

A prisoner's dilemma ends when the temptation diminishes and/or the sucker's payoff improves. Can the temptations of the Match be reduced? Empirical studies of dominance hierarchy, a core primate behavior, show that members of social groups competing for limited resources often form ranking systems to reduce conflict.[27] At present, participants in the residency Match employ a similar strategy. As each participant vies for the "best" outcome, they face pressure from multiple sources, some clearly external, such as medical school advisors pushing students toward higher ranked programs, and others less visible, including a student's sense of worth tied to school status or future salary of a desired specialty.

"Best" programs need to know who the "best" applicants are, otherwise how would they define themselves as "best"? "Best" applicants need to know they are "better" than other applicants, otherwise how would they know they are "better"?

Many have suggested strategies to reduce temptations of the Match, but if we are correct in our description of the Match as a prisoner's dilemma, these approaches may not succeed.[6,7,28–30] Changing the United States Medical Licensing Examination (USMLE) Part 1 to pass/fail will almost certainly increase pressure on students to excel on USMLE Part 2.[22] Similarly, making USMLE Part 2 and/or medical schools entirely pass/fail will shift the pressure: residency programs may create their own examinations, rely more heavily on the historical prominence of students' medical schools or undergraduate colleges, or even ask for Medical College Admission Test (MCAT) scores or Scholastic Aptitude Test (SAT) scores. Strategies such as limiting applications or interview slots,[10] creating multiple Match rounds,[29] or preference signaling[12] (TABLE) will all advantage the "best" applicants, and sorting "best" from "worst" will simply occur in a new way. The temptations of prestige, opportunity, pay, and self-worth are too great to be removed or even reduced.

Can the sucker's payoff be mitigated? In theory, it should be possible, and precedents in other industries offer guidance. In the late 1960s, tobacco companies Phillip Morris and RJ Reynolds competed in a classic prisoner's dilemma. If each advertised heavily on television and radio, they would both make less money than if they did not, as advertisement dollars ate into profits.[18] They could have agreed to stop advertising, but if one company defected on this agreement, it would take in significantly more revenue than the other. Predictably, each advertised heavily with lower returns. In 1970, President Nixon signed the Public Health Cigarette Smoking Act banning cigarette ads from television and radio, and both Phillip Morris and RJ Reynolds significantly *increased* their profits.[18] Regulation had immediately removed the sucker's payoff. Plea bargaining in legal cases accomplishes essentially the same result by improving the sucker's payoff.

Practices such as regulation and plea bargaining have consequences, and each solution to a particular prisoner's dilemma creates its own set of winners and losers. The same holds true for medical education. The TABLE lists a set of potential solutions to the prisoner's dilemma of the residency Match and describes the trade-offs and possible behaviors and consequences of each approach.

The Promise of Competency-Based Medical Education and a Criterion-Based Approach

It is unlikely that participants in this medical education dilemma would tolerate many of the concepts presented in the TABLE, and this may be why the Match has been so difficult to reform. Currently, the US population is not receptive to limiting choices or to relying solely on chance. In this context, we wonder if medical education's embrace of competency-based medical education (CBME) holds promise for addressing our prisoner's dilemma.[31] CBME does not rely on normative comparisons and instead shifts from "better than" to "great enough." CBME defines high bars for criterion referencing requirements. We imagine this CBME approach applied to the Match. Would residency programs fear the sucker's payoff if every medical school graduate had guaranteed requisite knowledge, skills, and attitudes to begin residency? Would applicants apply to 30 programs if they knew every program was demonstrably great enough to meet their needs? Would medical schools obfuscate information about students if they knew their graduates were competent and would go to capable programs?

Getting to "and"

Johnson suggests that, when faced with polarities, such as normative comparisons versus criterion referencing, those who wish to solve the conflict should maximize the upsides of each pole ("and" instead of "or").[32] In the current normative-dominant world, identifying and achieving the "best" outcomes in the Match from everyone's perspective is the temptation, and accepting less is the sucker's payoff. In a criterion-based world, every applicant and program would be great enough, and the sucker's payoff would be eliminated—an ideal, but unrealistic possibility. Applying Johnson's framework of polarity management, can we imagine a world where the best *and* worst are both fully competent, and the sucker's payoff is reduced? In this framing, the bar of "pass" would be high enough that it makes "the best" irrelevant, and the terms "pass" and "good enough" would not be pejoratives but would be accepted, high level, meaningful standards for students and programs alike. Although comparison of health care to aviation is overused and oversimplified, the example works here to illustrate this point: there probably is a best airline pilot, but identifying this person is irrelevant if every plane lands safely every day.

Currently, the residency Match is mired in multiple prisoner's dilemmas in which people cannot improve their own strategy unilaterally, and we all defect. In

TABLE
Potential Solutions to the Prisoner's Dilemma of the Residency Match With Possible Effects and Feasibility

Strategy	Lens of the Prisoner's Dilemma	Possible Resultant Behavior	Possible Considerations
Cap the number of applications allowed per applicant	Reduces the possibility of applying to massive numbers of programs, but does nothing to the actual temptations[a] of the Match (eg, prestige, opportunity, salary, and self-worth); increases the perception of the sucker's payoff (not matching) for students	Schools, programs, and students could increase back-channel contacts to facilitate matching; students and programs could consider opting out of the Match, and pressure for alternatives could arise	Currently, the US population is not receptive to limiting choices; both the ERAS and the NRMP have financial incentives to maintain or increase application volume
Cap the number of interviews students can accept	Reduces the possibility of interviewing at massive numbers of programs, but does nothing to the actual temptations of the Match (as above); increases the sucker's payoff for residency programs as "lesser programs" could potentially have a higher chance of going unfilled	Highly competitive programs (as defined by ranking, reputation, and scarcity of residency positions) may welcome the change as they would still have enough excellent applicants to fill their spots, but other programs would fear not filling and could opt out of the Match	Currently, the US population is not receptive to limiting choices; could threaten the Match entirely
Implement preference signaling mechanisms (eg, a student tells a limited number of programs they are in their top 3 choices)	Does nothing to the temptations of the Match; increases the feeling of a sucker's payoff as many students and programs will still be rejected despite preference signaling	"Best" programs will receive a disproportionate share of applicants who signal a preference for these programs, and most applicants will be rejected. "Lesser" programs will receive preference signaling from many applicants for whom the program may be beyond their reach, and these applicants will be rejected; some programs will receive very little preference signaling "Best" students will have a distinct advantage over other applicants (as they do now); some students may feel compelled to signal their home programs in the top 3 even if they don't want to in order not to lose a safety net; some students may choose an official number of programs to signal, but then feel pressured to use unofficial means to inform other programs of their interest	Current NRMP guidelines are set up in favor of student protections and forbid forcing applicants to tell programs about preferences. Students may not want to give up these perceived protections; when applicants fall to programs that they didn't preference signal, programs will know the student didn't desire the program as a top choice
Develop an early acceptance program (create 2 matches, a small one early and a larger one later)	Does nothing to the temptations of the Match; increases the perception of the sucker's payoff for students who may fear going unmatched twice (early and late match)	Creates many of the same pressures and behaviors of preference signaling; applicants who do not match early will be driven to apply to a larger number of programs in the later match, driving up total applications; programs may not fill equally in the early match as there is no guarantee that any student will choose them early; programs in this position will feel compelled to interview even more people in the second round	Like preference signaling, applicants and programs that match in the second round may presume neither was a top choice of the other

TABLE
Potential Solutions to the Prisoner's Dilemma of the Residency Match With Possible Effects and Feasibility (continued)

Strategy	Lens of the Prisoner's Dilemma	Possible Resultant Behavior	Possible Considerations
Increase the cost of applications	Reduces the impulse to apply to massive numbers of programs, but does nothing to the actual temptations of the Match; increases the sucker's payoff for students (higher application fees mean higher costs if students go unmatched)	More affluent students will incur the higher cost but not change match behavior; less affluent students will take on more debt and not change behavior or become further disadvantaged; some students may opt out of the Match	Those supporting equity in medical education would oppose this approach; like most businesses, ERAS could develop tiered pricing to maximize profits, but this risks poor publicity and a potential exodus from the Match
Mandate specific program information that must be available to students during the application process (eg, desired USMLE score ranges, desired medical schools or degree type of applicants, membership of the selection committee)	Reduces inclination to apply to programs where applicants would not be competitive; increases the sucker's payoff for residency programs as "lesser programs" that indicate they accept or have residents with lower USMLE scores could potentially have a higher chance of going unfilled; this may also lead to a downward cycle of matching residents with ever-lower scores as applicants with higher scores avoid these programs	Highly competitive programs (ie, ranking and reputation) may welcome the change as they will still be able to attract enough excellent applicants to fill their spots, but other programs may resist or opt out of the Match	Radical transparency may escalate normative comparisons between programs and produce fear, shame, and temptations to obfuscate; to meet public-facing standards, programs may over-rely on statistics and have less incentive to innovate, take risks, or invest in unmeasured but valuable activities; certain applicants may be screened out
Mandate all medical schools and standardized testing adopt pass/fail grading	Does nothing to the temptations of the Match; increases the perception of the sucker's payoff from the perspective of residency programs	Residency programs may develop their own testing programs or require results of earlier testing (eg, MCAT, SAT); highly competitive residency programs will preferentially choose students from highly ranked medical schools; students at less competitive medical schools will be disadvantaged; away rotations will become more competitive and/or required; students with higher performance on testing will voluntarily share these results with programs if these scores are available to the student (eg shelf examinations)	Many highly competitive medical schools have already transitioned to pass/fail for large portions of their curriculum as the risk to their students is minimal (lower ranked students from highly competitive schools benefit from this change); less competitive schools will be slower to adopt this change as it disadvantages their top students; USMLE Step 1 has recently changed to pass/fail, shifting pressure to USMLE Step 2 or other standardized test scores
Mandate medical schools share all raw assessment data with residency programs	Does nothing to the temptations of the Match; potentially reduces the sucker's payoff for residency programs if the data are true, but could increase the sucker's payoff for students if it increases students' fear of assessment or supports their fixed/performance mindsets	Medicals schools would have to undergo a massive upgrade in assessment practices if raw data practices were made public; residency programs would have to develop shortcuts or increase capacity to review this data in the application process	Sharing raw data is anathema to growth mindset and programmatic assessment, as every data point may be perceived as high stakes, increasing student stress and maladaptive behavior; many medical schools would be unwilling to openly share their raw assessment practices; many residency programs would not be able efficiently make use of large volumes of data

TABLE
Potential Solutions to the Prisoner's Dilemma of the Residency Match With Possible Effects and Feasibility (continued)

Strategy	Lens of the Prisoner's Dilemma	Possible Resultant Behavior	Possible Considerations
Make medical schools free for all students (no debt load)	Reduces the sucker's payoff for all: students would not incur debt even if they fail; medical schools would have a decreased barrier to letting a failing student go; residency programs would match fewer students whom schools "failed to fail"	Medical schools may not be incented to invest in supporting marginal students; students would be disincentivized to persist in the face of hardship and could opt to leave school without the financial burden	Several well-funded medical schools are now tuition free; it is possible that after enough medical schools remove tuition, a mini-prisoner's dilemma could arise where all schools must remove tuition to attract students; however, the operating costs of academic medical centers and temptations of a medical career will create a market for students willing to pay; without debt, more students may leave medical school; lower paid specialty residencies may see an increase in applicants, and higher paid specialties may see a decrease
Mandate that medical schools must pay back tuition for students who fail to graduate	Reduces the sucker's payoff for students, but increases the sucker's payoff for medical schools	Medical schools would be less likely to take "risks" with students; for example, medical schools may become wary of students from lesser-known colleges or with lower test scores or apply other criteria which disadvantage particular students; schools may have incentive to not fail students in order to avoid having to pay back tuition	This approach furthers the conflict of interest between avoiding financial losses and matching all students into residency programs; more medical schools may fail to fail students who should not graduate; could exacerbate inequities in recruitment into medicine
Make residency a lottery within each specialty based on societal need (residency positions are allocated based on providing all people access to care in the ratios needed to provide that care)	Removes the reason to apply to residency programs; potentially increases the sucker's payoff for residency programs and students as neither may get their clearly desired choice	Students would no longer be incented to excel in order to be accepted by particular programs; residency positions would be based on societal need, and certain positions would increase or decrease in number; students would likely apply to multiple specialties, and schools would have to prepare them for these options	"Best" programs may resist accepting students from "lesser" schools or from the "bottom of the class" and "best" students may not accept being sent to "lesser" residency programs; lack of choice contradicts US cultural values; students and programs would save a significant amount of money in travel and recruiting costs
Dramatically reduce the pay gap among all physicians regardless of specialty and practice setting (academic, private, public)	Reduces at least one of the temptations in the Match for students (salary, but also possibly prestige and self-worth)	Match pressure would be reduced for the current high-paid specialties (eg, otolaryngology, dermatology)	Appears impossible in the current era given how many people and organizations would need to cede power, control, status, and income

TABLE
Potential Solutions to the Prisoner's Dilemma of the Residency Match With Possible Effects and Feasibility (continued)

Strategy	Lens of the Prisoner's Dilemma	Possible Resultant Behavior	Possible Considerations
Mandate standardized video interviewing and/or other tests (eg, situational judgement tests) of non-cognitive skills prior to residency interviews	Worsens the temptations of the Match for programs as many will desire high scores on both cognitive and non-cognitive assessments; potentially reduces the sucker's payoff for residency programs	Students and schools would seek to ensure students excelled in this skill set (ie, change recruitment, or funding for coaches or curricula); some medical schools would have less incentive to measure non-cognitive capacity believing residency programs would discount their reports in favor of proprietary testing	Emergency medicine residency programs have largely abandoned standardized video interviewing due to students perceiving risk over benefit; early adopter programs that ask students to complete such testing may appear to stand out in a negative way (students will avoid programs that appear to ask for time or work additions or put them at risk); students who score lower on these tests will feel pressured to apply to more programs
Guarantee a residency position at the time of medical school admission	Eliminates the need to apply to residency programs; potentially increases or decreases the sucker's payoff for residency programs and students	Competition for residency programs would occur at the time of medical school admission; some students might change their minds during medical school and switch career choice or be locked into a choice they don't want	Early pilot programs have shown feasibility, but it remains unclear if this approach could be scaled up for everyone; residency programs may not trust that students accepted at the time of medical school matriculation will become excellent residents who meet their program standards; some students could be mismatched for programs
Mandate that no foreign or international medical graduates could match until all US medical graduates have obtained a position	Reduces the need to interview at large numbers of programs, but does nothing to the actual temptations of the Match; decreases the sucker's payoff for students, but potentially increases the sucker's payoff for residency programs	US medical students would face less competition and may choose to apply to fewer programs	Currently, the US population is not receptive to limiting choices; some programs will be forced to spend more time on recruitment or, conversely, opt out of the Match and take a residency class entirely made of international medical graduates; programs will not want to miss opportunities to recruit future standouts in medicine and science from abroad
Eliminate the "all-in" policy (ie, in order to be in the Match, all positions offered in the Match must run through the NRMP)	Does nothing to the temptations of the Match or the sucker's payoff	Students may organize, with those likely to benefit from the Match advocating to maintain it, and those less likely to benefit arguing to abolish it; residency programs would similarly look out for their own interests	If enough programs and students were to choose this path the Match would collapse, and both the student protections and the limitations inherent to the Match would be removed

TABLE
Potential Solutions to the Prisoner's Dilemma of the Residency Match With Possible Effects and Feasibility (continued)

Strategy	Lens of the Prisoner's Dilemma	Possible Resultant Behavior	Possible Considerations
Fully adopt CBME	Does nothing to the temptations of the Match but does reduce the sucker's payoff for schools, students, and residency programs	If medical schools could show that every student met agreed-on high standards and would be prepared for any residency program, then programs would not fear the sucker's payoff of a poor student and would not need to interview as many students; if every residency program graduated residents who met agreed-on high standards and were prepared for any fellowship or practice, then students would not fear the sucker's payoff of a poor residency program and would feel a reduced need to interview with so many programs	The past decade has advanced CBME, but medical education leaders have yet to fully achieve an ideal of CBME—criterion referencing—amid the pressures to maintain normative assessment; it is possible that fully realized CBME cannot exist in the context of performance based/fixed mindsets or dominance hierarchy connected to grades, rankings, and intense match competition

Abbreviations: ERAS, Electronic Residency Application Service; NRMP, National Resident Matching Program; USMLE, United States Medical Licensing Examination; MCAT, Medical College Admission Test; SAT, Scholastic Aptitude Test; CBME, competency-based medical education.
[a] Temptations: for students (match in desired specialty and residency); for medical schools (all students match to prestigious residency programs); for residency programs (match the best students possible). Sucker's payoffs: for students (match undesired program or specialty or go unmatched); for medical schools (students go unmatched); for residency programs (match undesired students, or go unfilled).

this context, human inclinations such as dominance hierarchy induce the prisoner's dilemma, and temptations of the Match appear to be irreducible. Short of drastic measures such as a lottery, the most promising way out of the prisoner's dilemma is to improve the sucker's payoffs. We believe CBME offers a concrete path to do so. This shift would require medical education to share a mental model of required skills, choose proven frameworks of assessment, determine thresholds of progress and competence, develop impartial clinical competency review teams, create coaching and other structures to support growth and performance, identify those who should not continue and facilitate their transition, link data and analytics across space and time, and provide longitudinal oversight of learners at all stages of the continuum.[33,34] We recognize what we suggest would be a substantive change for medical education; however, examples of each of these concepts exist now. Projects such as Educating Physicians Across the Continuum have connected these ideas and shown that competency-based promotion is possible.[35] To escape the prisoner's dilemma we must decrease investment in identifying the "best students" or the "best programs" and instead realize our ideals: all graduates are highly qualified to match and prepared to succeed, and all programs are able to meet graduates' needs.

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Eric J. Warm, MD, is Sue P. and Richard W. Vilter Professor of Medicine and Program Director, Department of Internal Medicine, University of Cincinnati College of Medicine; **Benjamin Kinnear, MD, MEd,** is Associate Professor of Medicine and Pediatrics, and Associate Program Director, Department of Pediatrics, University of Cincinnati College of Medicine; **Anne Pereira, MD, MPH,** is Professor of Medicine and Assessment and Coaching Expert, Department of Internal Medicine, University of Minnesota Medical School; and **David A. Hirsh, MD,** is Associate Dean, Undergraduate Medical Education, and Associate Professor of Medicine, Department of Medicine, Harvard Medical School and Cambridge Health Alliance.

Corresponding author: Eric J. Warm, MD, University of Cincinnati College of Medicine, warmej@ucmail.uc.edu, Twitter @CincyIM