Transition Experiences in MD–PhD Programs

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ABSTRACT

MD–PhD training takes, on average, 8 years to complete and involves two transitions, an MD-preclinical to PhD-research phase and a PhD-research to MD-clinical phase. There is a paucity of research about MD–PhD students' experiences during each transition. This study examined transition experiences reported by 48 MD–PhD students who had experienced at least one of these transitions during their training. We purposefully sampled medical schools across the United States to recruit participants. Semistructured interviews were audio-recorded and transcribed for analysis; items focused on academic and social experiences within and outside their programs. Using a phenomenological approach and analytic induction, we examined students' transition experiences during their MD–PhD programs. Five broad themes emerged centering on multiple needs: mentoring, facilitating integration with students in each phase, integrating the curriculum to foster mastery of skills needed for each phase, awareness of cultural differences between MD and PhD training, and support. None of the respondents attributed their transition experiences to gender or race/ethnicity. Students emphasized the need for mentoring by MD–PhD faculty and better institutional and program supports to mitigate feelings of isolation and help students relearn knowledge for clinical clerkships and ease re-entry into the hospital culture, which differs substantially from the research culture.

INTRODUCTION

Physician-scientists, who pursue research and hold either MD or MD–PhD dual degrees, are an integral part of the biomedical research workforce (Rosenberg, 1999; Zemlo *et al.*, 2000). MD–PhD dual-degree programs are designed to train physician-scientists to pursue cutting-edge research and provide patient care (Goldstein and Brown, 1997; Varki and Rosenberg, 2002), and acceptance to these programs is very competitive. The research and clinical skills that MD–PhD researchers develop to address scientific questions aimed at improving patient care make them invaluable members of the biomedical research workforce (Varki and Rosenberg, 2002).

MD–PhD training takes, on average, 8 years to complete (Jeffe and Andriole, 2011; National Institutes of Health [NIH], 2014), with 2 years of medical school preclinical training, 4 (and sometimes more) years of graduate school research training, and then 2 years of clinical training to prepare students for residency (Brass *et al.*, 2010). A survey study of 24 MD–PhD programs in the United States reported that 95% of MD–PhD graduates from these programs entered residencies; 67% of these alumni were employed full-time in academia (88% of whom were in clinical departments), 4% in research institutes (e.g., the NIH), and 8% in industry, while 16% of the remaining alumni were in private practice. MD–PhD programs are invaluable in producing research-trained faculty in medicine; more than 80% of MD–PhDs who choose academic careers conduct research that takes up to 50–75% of the time working in a position, and more than 60% have identifiable research funding (Brass *et al.*, 2010).

Although MD–PhD graduates comprise a small proportion of all physicians, they make unique contributions to advance the field of medicine through research. More than half of the individuals awarded Nobel Prizes in Physiology or Medicine (1997–2013) were MD–PhDs (Bonham, 2014). MD–PhDs differ from their MD-only counterparts in that they have a greater planned career involvement in research at the time of graduation (Andriole *et al.*, 2008), and in a survey of MD–PhD students enrolled in 15 programs nationally, most chose research at academic institutions, especially disease-oriented research, as their future primary activity (Ahn *et al.*, 2007).

Given the structure of MD–PhD programs, students are required to transition between different phases of training: transition 1, from medical school preclinical (basic science) training to graduate school research training; and then transition 2, from research back to medical school clinical training to prepare students for residency. However, MD–PhD students face several challenges during their transitions between phases of the MD–PhD program. Insight into these critical transition points within the MD–PhD program is important to better understand how those medical students who also are pursuing basic science or clinical/translational research training navigate across the preclinical, research, and clinical program phases and make recommendations for smoother transitions.

Although MD–PhD programs are often well funded, attrition of MD–PhD students poses a significant challenge to medical schools and funding agencies. MD–PhD students do not always complete their entire training and may end up completing only the requirements for the MD or the PhD (National Institute of General Medical Sciences [NIGMS], 1998; Jeffe *et al.*, 2014a). The MD–PhD SAGE (Students' Attitudes, Goals, and Education) survey reported that nearly one-fourth of students then currently enrolled in MD–PhD programs seriously considered leaving the program, which did not account for those who already had dropped out (Ahn *et al.*, 2007). Other studies reported average attrition rates of 10%, ranging between 3 and 34% in a survey of 24 schools (Brass *et al.*, 2010), and of nearly 30% nationally among Association of American Medical Colleges (AAMC) Graduation Questionnaire respondents between 2000 and 2006 (Andriole *et al.*, 2008) and among a national cohort of MD–PhD program matriculants from 1993 to 2000 who were followed through July 2011 (Jeffe *et al.*, 2014a). Thus, not all MD–PhD enrollees complete their program. For national cohorts (1995–2000), ~86% of MD–PhD noncompleters still completed their MD training after deciding not to complete requirements for the PhD (Jeffe *et al.*, 2014a).

In contrast, the MD attrition rate has been documented at 3% (Garrison *et al.*, 2007), and data from 1982 to 2012 showed that more than 96% of all matriculants in U.S. medical schools completed their degree within 10 years (AAMC, 2017). However, the PhD completion rate from 1992 to 2004 in the life sciences was 63% (Sowell, 2008). Biomedical science PhD students reported a decreased interest in academic careers as they proceeded through their doctoral programs during the 2003–2013 period (Fuhrmann *et al.*, 2011; Austin and Alberts, 2012; Sauermann and Roach, 2012).

Although many aspects of MD–PhD training pose challenges for students, few studies have investigated student experiences or support systems during the different phases of the dual-degree program (Ahn *et al.*, 2007; Goldberg and Insel, 2013). A national survey of MD–PhD students indicated that satisfaction was lowest during the research (thesis) phase, with its inherent lack of predictability of completion time; and students in small (compared with medium and large) MD–PhD programs reported less satisfaction with the coordination between MD and PhD program phases (Ahn *et al.*, 2007). A commentary also was published about a reimmersion program designed to help MD–PhD students navigate the transition from research to clinical training (Goldberg and Insel, 2013). But neither of these two studies represented an in-depth examination of students' experiences during the MD–PhD program transitions. Given the limited research that has been conducted specifically on the transition experiences, we sought to examine MD–PhD students' experiences during their transitions between different phases of the program and the support systems that were available during those transitions. We sought to become better informed about ways to improve students' MD–PhD program experiences during the entire length of the program and ultimately find ways to increase students' retention in the program.

THEORETICAL FRAMEWORK

This study is guided by Vincent Tinto's student integration model (1975) and interactionalist theory in higher education (Tinto, 1993, p. 136) to understand how individuals integrate while interacting with institutions in a variety of formal and informal settings. While Tinto's research examined undergraduate attrition, we use this framework to examine the interactions and integration approaches specific to MD–PhD programs, with a focus on persistence in MD–PhD programs. Tinto's model (1975) posits that the key to persistence in a program depends on the extent to which students assimilate or integrate into their programs. In this case, we are concerned with MD–PhD students' social and academic integration into the medical and scientific communities at their MD–PhD institutions. Such assimilation is guided by several factors, including both subject learning and socialization experiences. Therefore, it is important to understand how these processes of formal and informal interactions between MD–PhD students and both faculty and peers are effective in helping MD–PhD students successfully transition through different phases of the program.

To facilitate this understanding, we conducted in-depth interviews with MD–PhD students, asking them to expound upon the array of transition experiences that they faced while training, thereby securing a rich understanding of their experiences through students' own narratives (Golde, 2000). Using organizational socialization theory and the integration theory of attrition, Van Maanen and Schein (1977) posited that members of an organization are assimilated into and assume roles in an organization based on the fit between personal values and the organization's culture, ideology, and ethos. Similarly, we sought to gain insights into how MD–PhD students are acculturated into both medicine and scientific research fields and how they transition between these two worlds.

Socialization theory has been used as a framework for understanding doctoral students' attrition from their PhD programs (Golde, 2000), whereby a student who is not well integrated into a program would be expected to be more likely to drop out (Golde, 2000, 2005). Because attrition rates are higher during the PhD-training than MD-training phase of the program (Garrison *et al.*, 2007; Sowell, 2008; AAMC, 2017),

examining students' experiences during the research phase of the MD–PhD program could help identify targets for intervention aimed at increasing persistence in the program and, ultimately, in the biomedical research workforce.

METHODS

This paper is based on an analysis of MD–PhD student interview data that focused on transition experiences during different phases of the program. We conducted a large-scale, qualitative study titled "Transitions in the Education of Minorities Underrepresented in Research (TrEMUR)" to better understand the educational and professional experiences of individuals who were training or had completed training in medicine and the biomedical sciences. Between 2011 and 2013, following IRB approval from the University of Virginia and Washington University in St. Louis, we purposefully sampled U.S. academic institutions and medical schools to interview individuals pursuing biomedical research and medical careers. We interviewed 217 individuals (students, postdoctoral researchers, residents, and faculty) from MD, biomedical science PhD, and MD–PhD programs who were, at some point, interested in pursuing a biomedical research career; we oversampled from groups underrepresented in biomedical research. The schools were selected based on their location nationally, public/private ownership, and Carnegie Classification as a doctoral/research institution or institution with high or very high research activity (Carnegie Classification of Institutions of Higher Education, 2017). We mailed posters and flyers to various campuses based on our contact information and asked medical and graduate school deans to email students and faculty about the study. Interested participants contacted us, and interviews were scheduled after written consent was obtained. We used "snowball" sampling, in which participants could identify other potential participants and provide contact information (Miles and Huberman, 1994; Marshall and Rossman, 2006). Participants were assured that they would not be identified in presentations or publications.

Interviews

All participants completed one semistructured telephone interview, each lasting ~60 minutes. During the interview, participants were asked number of open-ended questions that broadly addressed the study aims, eliciting their reasons for entering a joint MD–PhD program or a PhD-only or MD-only degree program in pursuit of a career path in biomedical research and their reasons for subsequent career decisions. Several interview questions were the same for all participants regardless of career stage (e.g., demographic information, reasons for entering specific degree programs and career decisions, supports received [or not received], barriers to degree program completion, and interactions with colleagues and peers); other questions differed based on a participant's career stage (student, faculty/research, former student, or former researcher) and, if they changed their career path, reasons for this decision. This paper is based on an analysis of MD–PhD student interview data that focused on their transition experiences during different phases of the program. Thus, we include herein analysis of data from MD–PhD students who were at least in their third year of training (and thus had experienced at least one transition). We analyzed responses from the following questions asked of current MD–PhD students:

1. How does moving between the phases of the MD–PhD program work?
2. Beyond any programmatic rigor, tell me about any specific barriers that you felt you needed to overcome to succeed in your program.
3. Tell me about your experiences with advising or mentoring from professors or peers in your program so far.

Interviews were audio-recorded and transcribed verbatim for analysis. Participants did not receive compensation for their time. We read each entire interview transcript before coding, and then specifically focused on the transition experiences. Participants described their transition experiences between the different phases of the MD–PhD program, sometimes in response to another question, or shared their transition experiences in relation to the mentorship they received (or did not receive). We included analysis of responses to other questions as well, if the narratives were responsive to our specific research focus on describing MD–PhD students' transition experiences.

In our literature review, only one survey study examined student satisfaction during MD–PhD program transitions from preclinical to research phases and from research to clinical phases (Ahn *et al.*, 2007). However, the study did not examine students' experiences during the transitions. Transition experiences during MD–PhD represent a sparsely investigated topic. While qualitative findings are not generalizable, qualitative research can uncover the phenomenon or mechanisms of decision making by gathering information from participant perspectives (Marshall and Rossman, 2006). Phenomenological inquiry, especially through interviewing, is an effective method of doing so (Kvale and Brinkmann, 2009). Interviews conducted for phenomenological inquiry emphasize the past, present, and essential personally lived experiences surrounding the phenomenon of interest, allowing the researcher to make sense of data collected through interviews through emergent themes (Marshall and Rossman, 2006). Interviews yield rich narratives from students immersed in the program who can help illuminate where challenges exist. This knowledge can be used to design interventions to mitigate some of the challenges that MD–PhD students experience during the transitions and to generate hypotheses for evaluating the effectiveness of these interventions. Therefore, we purposefully selected interviews as the sampling method to gather data from the participants, because interviews would provide us with a deeper understanding of the process of transitioning from one phase to the next in an MD–PhD program.

Data Analysis

Using a phenomenological approach to aid our understanding of MD–PhD students' perspectives about their transition experiences (Kvale and Brinkmann, 2009) and analytic induction (Huberman and Miles, 1994), two experienced researchers (D.C. and D.B.J.) read and coded the transcripts line by line, looking for similarities and differences across the transitions into different program phases. Coding discrepancies were addressed and resolved through a consensus. The first author (D.C.) then reanalyzed all 48 transcripts for deeper understanding of transition experiences, either the MD-to-PhD or PhD-to-MD phases of the program. Through an iterative process of analysis (Miles and Huberman, 1984), we categorized transition experiences into themes that emerged from the data. In reporting the results, we include quotes that exemplified specific

themes (Miles and Huberman, 1994). We added content in brackets to clarify participants' narratives in the context of the relevant themes.

RESULTS

Of the 217 participants in the larger study, 68 participants were enrolled in MD–PhD programs at the time of the study. Forty-eight of these currently enrolled MD–PhD students from 20 different programs were at least in their third year of training and had experienced at least one transition; therefore, data from these 48 students were included in our analysis. Participant demographics are presented in Table 1.

Most of these 48 students echoed the sentiment, "Transitions are difficult and poorly handled. That is a source of stress." This was viewed as a "consequence of not having a special category [of student] that is 'MD–PhD student.' It is not a graduate student, not a medical student." MD–PhD training was challenging due to the multifaceted nature of the program. There was a perceived lack of support while transitioning between phases, which was challenging, because these transitions involved "understanding both [research and then clinical phases] well enough to really move smoothly between the different ways of thinking" about mastering clinical skills for the MD phase and research skills for the PhD phase. Many students expressed an overall disconnect between the program phases that made navigating the transitions difficult. Continuity between the phases was deemed important, so that

> [in] your research you can keep in mind the types of patients that you would see. Kind of have more contact with those [patients with the condition you are studying]. Because after the first couple of years [of research], you start forgetting about the patients.

In the following sections, we present findings that centered on five broad themes that emerged from the students' narratives.

TABLE 1. Participant demographics.

Characteristics	*N* = 48
Gender	
Female	25
Male	23
Self-reported race/ethnicity	
White	25
Asian	8
Black	7
Hispanic	4
Multiple races/ethnicities	4
Number of years in the program	
3	8
4	13
5	6
6	4
7	11
8	2
9	3
10	1
Mean age (range) in years	28.4 (23–36)

These themes focused on multiple needs during each transition, including mentoring, facilitating integration with students in each phase, integrating the curriculum to foster mastery of skills needed for each phase, awareness of cultural differences between MD and PhD training, and support. Illustrative examples of quotes from each theme are provided in Table 2. None of the participants attributed their transition experiences to their gender or race/ethnicity.

Mentoring

Transitions were challenging because "there wasn't a lot of advice or counsel about how to balance the different phases." Participants wanted a better and more holistic understanding of "what all is really needed, like mentally, in PhD versus MD [phases of the program]… [Each phase requires] a totally different way of thinking in many ways." For example, while the MD phase required memorization of the study material, the PhD phase required more critical and in-depth thinking.

Mentoring from MD–PhD Faculty. Given the realized importance of early mentorship, when available, participants sought career guidance from MD–PhD faculty who had trained in a similar dual-degree program to guide them during the transitions from preclinical to research training and back to clinical training. They also sought mentorship to learn how to balance research and clinical work. MD–PhD faculty's familiarity with the transition points made them valuable mentors. They were able to offer advice about "who you need to talk to in setting up who you are going to choose as your major PI [principal investigator]." These MD–PhD mentors, many of whom had joint appointments in the medical school and a graduate school department, were not only knowledgeable about how to cope with transitions, but also helped to create alignment between medical school and graduate school training. These attributes made them fitting role models who offered "hope" to the MD–PhD students about being able to move through the different phases of the program.

Mentoring from MD-Only or PhD-Only Faculty. When MD–PhD faculty were not available, participants worked with mentors who were trained as MDs or PhDs, depending on the phase of the program. However, this was not fully beneficial. While some PhD mentors focused on topics not relevant to medicine, MD mentors could not connect MD–PhD students' clinical training with their research expertise. PhD advisors and MD advisors were not always familiar with the MD–PhD programs and "the different hoops [through which MD–PhD students have to jump]." As a result, the PhD mentors "advised on graduate school-specific things, but that's not always what I need to know when I'm going through the [MD–PhD] program." Many mentors "don't really have any idea what I'm going through as an MD–PhD [student]." Overall, there was a disconnect between the training phases in terms of coursework, research topics, and mentoring styles. Students had to figure out on their own how the different phases of the program were connected. Some MD mentors insisted that medicine was more important than research, while some PhD mentors (especially junior faculty) were not trained to advise MD–PhD students with a different career focus in clinical and patient-oriented research and

TABLE 2. Most prevalent emergent theme, frequencies, and representative quotes.

Emergent theme	Representative quotes
Mentoring (*n* = 34)	"I felt very shy about [approaching a PhD mentor and] saying something and then having them think I was stupid. Especially because I came in as an MD–PhD student and the MD side is very different…[The MD, preclinical coursework is] much more fact memorization and regurgitation rather than in-depth critical thinking [required for research]." "They [advanced students] came over and talked to me about their miserable experiences in the operating room and the fact that they were still alive. They made it through and I would too." "I don't think I knew what I needed to look for in a mentor, and I'm not sure that was conveyed very well."
Facilitating integration with students in each phase (*n* = 21)	"I felt like I was always sort of an outsider to that PhD student class. I never really felt like I was included in their [graduate school] social circle." "I felt very behind the curve in terms of my grad school peers." "You feel more like a peer with the residents and the attendings [when returning to clinical training after the PhD], but they don't view you as a peer. So it's like you just don't have any place."
Integrating the curriculum to foster mastery of skills needed for each phase (*n* = 20)	"I felt like one of the real challenges was that in the first years of med school, like, that your objectives for every day are very clear, and it's kind of like, if you show up and do the work, then you will move on. There was definitely an adjustment to the process of, like, forming my own objectives and deciding my own progress and the independence that's associated with going on to graduate school." "I earned my PhD. It was not just given to me. I spent years, blood, sweat and tears earning it, and now I'm treated like I haven't earned anything. So that was really hard. The lack of knowledge was hard, the fact that you don't know what you're doing. The status decline is really hard, and you're starting from the beginning again in another profession." "You're going from one research area that you're highly specialized in into this very general medical knowledge field. If you haven't really maintained your knowledge base or your skill set, that can be a really rough transition for students." "The transition from second year [medical school preclinical training] to third year [medical school clinical training] by itself is very intense in terms of how you're interacting with patients. You're in the hospital all the time, and with a 4-year break [for research training] … I can forget all … [the] stuff I learned in second year."
Awareness of cultural differences between MD and PhD training (*n* = 17)	"The cultural transition from medicine to science was a very hard one." "[The transition was a] culture shock and probably the single hardest transition that an MD–PhD will make during their training. There isn't that same egalitarianism and intellectual free exchange of ideas." "People do not treat medical students well on the wards. I'm not saying I wanted to call attending [physicians] by their first name. I'm just saying it's indicative of the culture."
Supports (*n* = 15)	"I think having the time at NIH working as a full-time research assistant was a huge advantage, because I really knew what I was getting into on the research end of things. I think that made the transition to grad school easier. I knew what I was going to get into." "We don't have an [MD–PhD] administrator. We don't have a financial aid person. So you have to go around talking to multiple different people getting little bits of information and trying to put it all together yourself."

provide career-development advice. Mentoring was "somewhat limited and somewhat colored" when offered by MD-only or PhD-only mentors.

Mentoring from Advanced MD–PhD Students. In addition to faculty mentoring, mentoring from advanced MD–PhD students, both formally and informally, was valuable, because "it's very relieving to have people at the end of that stretch to tell you how they got through their time in the program." MD–PhD student mentors advised on how to work with faculty mentors during different phases of training. In the case of particularly challenging transitions, one participant declared, "the only people who totally understand the system are the other MD–PhD students who have gone through it. So they were invaluable in trying to figure all of that out. Sort of working off their experiences makes life considerably easier."

Specific Mentoring during MD-to-PhD Transition. The MD-to-PhD transition from the "more technical aspect to the deeper cognitive piece of science" was very hard. For some

students, the more challenging aspect of the PhD compared with (preclinical) coursework was determining a research focus and finding a PhD mentor. Students lacked the self-confidence to approach a PhD mentor to work with them. In lieu of MD–PhD mentors who may not have been available in some graduate schools, more advanced PhD students advised younger trainees with less research experience. They "held meetings, answered questions, and provided one-on-one mentorship for facilitating the transition [from MD to PhD]." This additional mentorship from advanced PhD students also was viewed favorably.

Specific Mentoring during PhD-to-MD Transition. PhD mentors who trained MD–PhD and PhD-only students similarly over the course of 6 to 7 years often caused delays in MD–PhD graduation from an already overly long program. Some students returning to clinical training were advised by their PhD mentors, "Don't tell attendings that you're in the [MD–PhD] program. Just tell them you took some time off to do research and that you're just starting in the clinic again."

This is because many attendings viewed the MD–PhD program negatively.

There was a perceived disconnect between the PhD projects one worked on, which stemmed from a mentor's research interest, and the "field of medicine a lot of the candidates end up really working in." Many struggled to find continuity between their research and clinical interests. For example, "I studied Alzheimer's disease for my PhD. I continued that into radiology. But I have no radiology background in my research at all. It was another big shift where you sort of have to start over." This left the student feeling that "you haven't done anything to bridge the chasm [between the two programs]. All you've done is train a person in two different areas and said, 'Okay, now you figure it out.'"

Developing new relationships with MD mentors during clinical training was very challenging. A student attributed this challenge to the break in MD training after 2 years and explained, "You don't have a 4-year mentoring experience with some physician in the hospital." Given the different phases of the program, there was a lack of opportunity to develop a long-term mentoring relationship with MD faculty.

As students transitioned back to clinical training, a transition that was considered "rough," many lacked mentoring support from advanced students, there was "little or no access to students in more advanced years" for advice, and their MD-only peers, with whom they started in medical school, had already graduated. For those who found more advanced medical students to connect with, it was helpful to informally interact with these "near peers" "who have just gotten through something that feels like you might not make it through, and to realize that they felt the same way a year ago and they made it through, so it's gonna be okay." For those transitioning from PhD to MD and beginning their clinical clerkships, "students currently in the third and fourth year in that school will hold a meeting and try to help along that transition and answer any questions, provide insight for that." Many students found the PhD-to-MD transition more challenging, because "you have to relearn how to see a patient, it is one of the biggest adjustments to make." The more advanced students were "phenomenal about helping students get through it," along with advising them about how to study for examinations. The MD–PhD students felt supported knowing that they were not alone making a transition into clinical clerkships. Both MD–PhD students and MD students have to make a transition, either from several years of research or from preclinical, basic science training, respectively, "to actually interacting with patients" during clinical clerkships.

In summary, the importance of mentoring from both MD–PhD faculty and fellow students was the most widely discussed theme. Students wanted to be mentored by faculty who had also gone through the same experience of moving between the different phases of MD–PhD program. Mentoring from MD-only/PhD-only faculty seemed inadequate, as these faculty mentors had not experienced the same transition challenges during their training that MD–PhD students experienced. These faculty also had the same expectations for MD–PhD students as for MD- and PhD-degree students, respectively, without regard to the different demands of and prior training received within the MD–PhD program itself. It was evident that faculty with MD-only and PhD-only degrees may not be as aware of the unique challenges posed by the transitions between phases in the MD–PhD dual-degree program. Advanced MD–PhD students were valuable resources in providing mentorship that alleviated some of the transition challenges, along with reducing anxiety, isolation, and loneliness for MD–PhD students. Students learned study techniques, research skills, and strategies to integrate into clinical clerkships after several years of research training from these advanced MD–PhD students, and sometimes from advanced MD students.

Facilitating Integration with Students in Each Phase

MD–PhD students felt unable to compete with their peers in PhD-only or MD-only programs as they transitioned to research and clinical phases. Students felt that the programs were structured in such a way that they were prohibited from easily assimilating into either the PhD or MD program culture. Lack of social support caused feelings of alienation and a sense of being judged by MD-only and PhD-only peers.

MD-to-PhD Transition. Because MD–PhD cohorts were smaller, students lacked MD–PhD peer support and had to depend on MD-only and PhD-only peers for support. But this presented difficulties. The PhD-only peers already had completed 2 years of classes, had formed their cliques, and did not interact with MD–PhD students. This led to perceptions of being a social pariah. Transitioning to graduate school also meant losing the MD–PhD social circle.

Owing to the tightly structured phases of the MD–PhD program, many MD–PhD students finished their PhDs faster than PhD-only students. Thus, some PhD-only peers viewed MD–PhD students as getting a "fake PhD." Such attitudes caused MD–PhD students to feel alienated, which was compounded frequently by being the "only MD–PhD student" in one's PhD program. During medical school, "you do everything together. It's not like everyone's in a different lab with different problems. We all were dissecting the same dead body, cramming for the same tests. You become very close very quickly, and we bonded very quickly." Additionally, during preclinical training in medical school,

all the MD–PhD students have an office together, and so we end up spending a lot of time studying together and doing social things together. I'm very close with the people in my year and pretty close with the people who are 1 year older than me and 1 year younger than me.

However, during PhD training, "I felt like I was always sort of an outsider to that PhD student class. I never really felt like I was included in their [graduate-student] social circle."

Another participant added, "Everybody gets spread out because we all go to different grad programs. No one from my year of MD–PhD joined the immune-biology program. No one from my year of the combined program is with me now." An interesting perspective was shared by another student:

The PhD students didn't really understand what I had just been through. We were on very different paths. There was some animosity. People would say either to my face or to [other] people, "Oh she's getting a PhD, it has to be fake because they finish so quickly."

PhD-to-MD Transition. Students reported spending anywhere from 4 to 6 years to finish the PhD, and coming back to medical school for clinical clerkships after that was a challenge because they felt less well prepared than the younger MD-only students at the beginning of clerkships:

> We'll be joining those who have just finished taking (United States Medical Licensing Examination [USMLE]) Step 1, and all the pharmaceutical knowledge and physiology and anatomy and histology will all be fresh in their minds. Whereas we would've taken 4 years off, and none of that would be fresh in our minds.

Age differences also limited interactions with much younger MD-only classmates. This sentiment was expressed by a student in her 30s: "So many of them are in their early 20s. They go out and get drunk every weekend, whereas I spend my spare time giving my kid baths and putting him to bed. I'm in a different life stage." Additionally, MD-only peers expected that "I would be more social and hang out with them, and have a more relaxed attitude," which made integrating with MD-only peers very difficult.

Integrating the Curriculum to Foster Mastery of Skills Needed for Each Phase

Owing to lack of curricular integration, participants felt that the research component was "segregated from the medical school, although a lot of people do end up doing some [research] work during their clinical years, especially if they're finishing things up in lab, getting final papers out and that kind of thing." Participants wanted more integration between the PhD and MD curriculum to smooth the transitions.

Similarly, each phase required mastering a different set of skills. To many students, the program phases seemed extremely disjointed, requiring entirely different skill sets to succeed in each phase, and students felt underprepared and unsupported during the transitions.

MD-to-PhD Transition. Curricular differences and lack of integration between MD and PhD phases created several challenges during the MD-to-PhD transition. The medical school preclinical curriculum was primarily focused on didactic learning of the basic sciences. Learning objectives and content matter were clearly stated, and test questions often had one correct answer. The PhD curriculum was less standardized and more open-ended, with a longer, unspecified duration of training based on one's research progress. Content learned during medical school preclinical training did not necessarily inform PhD-training experiences, and professors' areas of research expertise during the PhD phase were often not aligned with students' research interests. Further, designing a research study required students to think critically and work independently, rather than depend on rote memorization. However, the transition was made somewhat easier when certain courses taken in medical school also counted for graduate school, bringing down the overall course load and saving time. "That helps, because some of our medical school coursework also counts for the grad school coursework. When you take biochemistry and neuroscience, it counts, and that helps shave off some time." Although, as noted earlier, this led some PhD students to express animosity toward MD–PhD students who might complete the PhD sooner.

PhD-to-MD Transition. Many participants considered the PhD-to-MD transition harder than the MD-to-PhD transition. A gap of about four or more years during PhD research training occurs before resuming clinical training for the MD. Transitioning to the clinic after being away from medicine for several years was particularly challenging. One participant noted,

> You haven't been in medical school for about 3–4 years. So having to relearn and actually see a patient and how to deal with a patient, it's one of the biggest adjustments you have to make. It probably was the hardest part of this program.

Therefore, the PhD-to-MD transition was challenging to students, who struggled to relearn and apply medical knowledge during their clerkships. Returning MD–PhD students felt that they lacked the same clinical skills that MD-only students appeared to have, especially doctor–patient communication skills, which made the transition feel more difficult. A participant added that MD–PhD students have a hard time going back to the clinic, not only because "the other students are already on top of all the knowledge, and we have to relearn it or get reaccustomed to [it]," but also because of the years without working with physicians in the hospital and interviewing patients. "Everything I learned was so many years ago. My first 2 years of med school were a long time ago. I didn't have the same skills my MD-only colleagues [had]." This student added that having to relearn crucial knowledge lost while completing the PhD led to perceptions of "just feeling so dumb and inadequate all the time, the fact that you don't know what you're doing, you're starting from the beginning again in another profession."

Awareness of Cultural Differences between MD and PhD Training

Each phase had a different cultural climate, with different expectations from the students during different phases. Culture was largely influenced by the structure of the program. As one participant put it, "The medical years are not flexible at all. It is pretty much a rigid 4 years. Graduate school, though, pretty much everywhere, is very variable." As a result, the structure of PhD training differed from medical school training "in terms of the expectations and the benchmarks for progress and success." Participants wanted the expectations for each phase to be clearly delineated before the transitions occurred.

Owing to cultural differences, many MD–PhD students were not viewed as "real" MDs or PhDs by their respective program faculty, peers, and administrators. Participants often felt caught between ongoing political battles between medical and graduate schools in which the MD–PhD program was often not viewed favorably. As a result,

> You kind of find yourself proving to people in both populations that you have the medical knowledge that you need to become a physician, but you also have gained the research experience that you need to become a scientist. There's often a different standard for MD–PhDs to sort of prove their credentials within each area.

MD-to-PhD Transition. This first transition was difficult for MD–PhD students because they were leaving their cadre of peers behind, the group of students with whom they spent the first 2 years of medical school studying and socializing. Medical school fostered a climate of teamwork. As they transitioned into the next phase, they found that research activities often involved a considerable amount of independence, and the climate changed. Some PhD-only students resented these MD–PhD newcomers to their PhD program. During transition to the lab, many participants were treated "differently, and not necessarily in a good way." The transition to lab was considered difficult, because "you're basically done with medical school at the height of your clinical knowledge, and all of a sudden you go to lab, and you're totally stupid all over again." Many participants did not expect that the transition to lab and the cultural transition from medicine to science would be so difficult.

PhD-to-MD Transition. Transitioning back to MD training had its own set of challenges and became harder when PhD training did not finish on time. Sometimes, unanticipated delays occurred because graduate school committee members wanted MD–PhD students to pursue additional research ideas. One student said, "The interaction [with committee members] got to be almost adversarial at times."

After completing the PhD requirements, students moved from lab research to clinical training. A student shared the surprise of this transition in "realizing how variable people are compared to mice. You just can't control them [people] the same way you can control an experiment in the lab." Another student spoke about the culture shock of the transition to clinical training and

> the fact that I was an established professional now being told that I really wasn't established at all. I think it is the hardest transition that we go through during the combined training. It's hard to leave your MD class and go to the lab after your first 2 years of med school. But this is way, way harder for me.

Other participants also talked about the hierarchical nature of medicine, where there were not the same "egalitarianism and intellectual free exchange of ideas" as during their research years. After developing collegial relationships with PhD faculty who "encourage you to call them by their first name," many students noted that they needed permission from professors for everything and even reported being verbally abused and mistreated, which was indicative of the culture. Another participant noted that the transition back to MD was a huge cultural shift. During PhD training,

> I was considered a junior colleague. They [the mentors] would send me their articles to review. I would send them mine. I was very much considered being groomed to be a peer, and when I finished my PhD, I was a peer.

Additionally:

> You become an established scholar. You're an expert in your field. You might even have published and be known more broadly, known nationally for what you do. I presented at the NIH. I am a serious, well-established scholar in my field.

However, the student added that, in medicine,

> You're never a peer until you're the same age as an attending, but there's always somebody above you on the totem pole. It's about, "we have knowledge and we have wisdom, and we're gonna pass it down to you." That made it hard.

Support

Overall, social support for MD–PhD students seemed missing during both the research and clinical phases of the program, and navigating the transitions was viewed as a lonely journey. One student reflected, "You're a little bit isolated, and you kind of have to follow your own path."

Lack of Administrative Support. Many participants noted "a lack of communication between the graduate school and the medical school [administrators]." This was attributed to not having a cohesive program or an MD–PhD administrator. There were only MD administrators and PhD administrators. Different MD–PhD program phases also necessitated establishing different work relationships with different people. Participants reported a lack of administrative support and were often left to make the transition on their own, setting up payroll and signing up for courses. The transitions were "difficult and poorly handled [administratively] …, inefficient, and onerous. That is a source of stress."

Prior Research Experience for MD-to-PhD Transition. Students emphasized the benefits of prior undergraduate research experience in the transition from MD to PhD training. A student with undergraduate research experience explained, "You're managing between two degrees, and it's a long road. If you don't have solid undergraduate research background, it's gonna be very difficult for anyone. You're not gonna be competitive." Overall, any kind of prior research experience was perceived as beneficial, because it helped students understand what to expect and "know what you're getting into and being mentally and emotionally prepared for an 8-year training program."

Shadowing and Transition Programs for the PhD-to-MD Transition. Students addressed the challenge of starting clinical training after several years of graduate school by shadowing physicians and older medical students several weeks before beginning their clinical clerkships, which normally begins in the third year of medical school. A student described seeking "working on a team, the preclinical exposure, working like a third-year medical student in a more intimate setting, so I could get guidance and help with the various aspects of working in the hospital." Two students also described a useful resource that their school was developing for MD–PhD students: a transition program to provide longitudinal clinical experience during the PhD years. Another program organized yearly retreats to specifically address the transitions to and from graduate school, in which faculty within and outside the school were invited as speakers "to come in and talk to us about these transitions." One student participated in a weekly family medicine clerkship at the end of PhD, which eased the transition back into medical school. Overall, students recommended developing a timeline of what to accomplish

every year and the major transitions to expect for the following year.

DISCUSSION

MD–PhD training is lengthy and involves two significant transitions that are challenging to students and may contribute to attrition from the program (Ahn *et al.*, 2007). In this study, we closely examined the experiences of MD–PhD students during the transition points as part of an ongoing national dialogue about the training and support of clinician-investigators, which includes clinicians (with a variety of degrees and in different disciplines) who are also engaged in research (Hall *et al.*, 2017). In our literature review, only two studies addressed challenges experienced by MD–PhD students during their transitions from preclinical to research phases and from research to clinical phases of the MD–PhD program (Ahn *et al.*, 2007; Goldberg and Insel, 2013). However, these studies did not probe deeply into students' experiences during the transitions.

Overall, critical unmet needs for MD–PhD students were described by our participants, including needs for mentoring, facilitating integration with students in each phase, integrating the curriculum to foster mastery of skills needed for each phase, awareness of cultural differences between MD and PhD training, and support. We also focused on specific experiences of students transitioning from MD to PhD and from PhD to MD phases of the program. The different transition experiences have implications for developing tailored transition-preparation sessions, restructuring the administration of some MD–PhD programs, and creating school supports that can play important roles in providing more seamless transitions across the different program phases.

The themes uncovered in this study are illustrative of Tinto's (1975, 1993) interaction and social integration theory, adding nuance to our understanding of the complexities of the transition experiences between the different phases of the MD–PhD dual-degree program. Examining MD–PhD program transitions helped us understand how students, faculty, and administrators interacted to facilitate MD–PhD students' assimilation in each phase of a program. Students' integration into the different phases of the program involved a lengthy process that was culturally complex and involved multiple transitions. To our knowledge, socialization and integration theories have not been used before to understand MD–PhD students' experiences during their transitions between program phases. Congruent with Golde's (2000) work on doctoral attrition, we found that students who were not well integrated in the MD–PhD program faced challenges and even considered discontinuing the program. As would be expected (Van Maanen and Schein, 1977; Golde, 2000; Weidman *et al.*, 2001; Weidman and Stein, 2003), the institutional culture and learning climate largely shaped the socializing experiences for students in different phases.

Socialization theory can help us understand how students experienced their integration into the different phases of the MD–PhD program, both socially and academically, by acquiring pertinent knowledge and skills (Brim and Wheeler, 1966; Lovitts, 2001; Golde, 2005) and using support systems needed to complete the program (Kong *et al.*, 2013). Socialization is viewed as a gradual process of integration into a community while engaging in various activities; the organizational culture as well as institutional and academic environments contribute to socializing experiences in professional communities (Weidman *et al.*, 2001; Weidman and Stein, 2003). Understanding these socializing experiences can explain how MD–PhD students transition through different phases of their programs and how they interact with faculty mentors, colleagues, administrators, and peers during the transitions.

Mentoring

Building upon Tinto's (1975) student integration model, which focused on undergraduate students' integration into the campus community to increase the likelihood of program completion, our study shows how such social integration in the competitive, MD–PhD dual-degree program environment can help MD–PhD students assimilate and succeed. Our participants identified both faculty and peer mentorship as beneficial for successfully transitioning between phases of the program. For example, in lieu of MD–PhD faculty, more advanced students guided and helped ease the transition between the program phases, illustrating how peer-mentoring opportunities assisted MD–PhD students transitioning into different phases of the program. Given the realized importance of mentoring from MD–PhD faculty and peers, purposefully pairing MD–PhD students with MD–PhD faculty and more advanced MD–PhD students may help in addressing some of the transition challenges that result from inadequate mentoring. Research on undergraduate life science researchers indicates that undergraduate students' development of a science identity and perceived improvement in their ability to think like scientists are enhanced through a variety of mentoring structures. While mentorship (including advice and psychosocial support) from both graduate students and postdoctoral researchers was beneficial, a closed-mentorship triad of undergraduates, graduate students/postdoctoral researchers, and faculty interacting directly with one another was considered most beneficial in terms of the undergraduates being able to think and work like scientists (Aikens *et al.*, 2016, 2017). Based on findings from these studies, it could be beneficial to purposefully construct closed-mentorship triads of new MD–PhD students, advanced MD–PhD students (or MD–PhD graduates pursuing graduate medical education for specialty board certification as residents or fellows), and faculty to interact, work, and socialize closely with one another. Such mentorship triads might be especially beneficial in the absence of MD–PhD faculty, in situations in which students are mentored by MD-only or PhD-only faculty who did not experience similar program transitions.

Facilitating Integration with Students in Each Phase

Owing to a lengthy and disjointed educational program, MD–PhD students found it challenging to integrate with their peers and balance the demands of training and personal life. Students often perceived a lack of programmatic support to integrate with their MD-only or PhD-only peers. Although personal-life challenges, such as family planning, seem to affect more women than men who pursue academic medicine and research careers (Andrews, 2002; Goldstein and Kohrt, 2012; DeCastro *et al.*, 2014; NIH, 2014), our participants did not mention this as a challenge in completing the MD–PhD program. In a national cohort study of MD–PhD program enrollees, women were neither more nor less likely than men to leave MD–PhD training before program completion after controlling for multiple other factors (Jeffe *et al.*, 2014a). Studies focusing on personal-life

challenges of MD–PhD students during training are generally lacking (NIH, 2014), and to our knowledge, gender differences as a reason for attrition from MD–PhD programs during training have not been specifically studied.

Although Tinto's (1975) integration model focused on undergraduate students' integration into campus life, we found that transitioning into a different phase of the MD–PhD program often came with the implicit expectation that students already shared the values of the culture and understood what was expected of them during that phase of the program, which may not always have been the case. For example, students transitioning into the PhD phase felt they were expected to "act" like traditional PhD students, and these same students felt they were expected to "act" like traditional MD students when they transitioned back into the clinical-training years to complete their MD degrees. Helping MD–PhD students to more quickly integrate into the different program phases remains a challenge, although some MD–PhD students in our study identified ways that other students helped them successfully navigate these transitions. Rather than placing the onus on the MD–PhD student alone to seamlessly "blend in" with other students in the PhD program (and subsequently with other students in the MD program), educating PhD-only and MD-only students and faculty about the unique and diverse research perspectives and skills that MD–PhD students bring to both the MD and PhD programs would ultimately benefit both MD–PhD programs and students participating in these programs.

Integrating the Curriculum to Foster Mastery of Skills Needed for Each Phase

Owing to the time lag between the preclinical and clinical years in medical school, students forgot what they learned in the first 2 years of medical school, making it harder to catch up during clinical clerkships. To transition between multiple phases, MD–PhD students need more than social support; they need specific reintegration initiatives. While Tinto (1993) suggested group-specific interventions to help African-American and low-income undergraduate students more easily integrate into campus life, we and others (Goldberg and Insel, 2013) recommend reimmersion programs, especially to help students navigate the PhD-to-MD transition, as time away from the clinical environment regrettably leads to loss of knowledge gained during the preclinical medical school years. Reimmersion programs intended to help enhance MD–PhD students' skills and readiness to begin their clinical training may alleviate anxiety regarding the start of clerkships. Career-development programs, leadership-training workshops (Ciampa *et al.*, 2011), national networks (Hall *et al.*, 2017), and patient-oriented research programs for physician-scientists who may favor clinical over basic science research (Varki and Rosenberg, 2002) are other examples of group-specific interventions that would help MD–PhD students assimilate into new learning cultures and have more fulfilling training experiences.

Awareness of Cultural Differences between MD and PhD Training

Overall, the cultural and socialization differences between the MD and PhD phases were something that students did not feel prepared to handle, including the need to be more autonomous during research training and then having to relinquish that independence when returning to clerkships. Although Tinto's (1993) work focused on the need for academic and social integration for undergraduate retention, we emphasize the need for cultural integration as well, especially in MD–PhD programs that involve multiple phases having different cultures and expectations for their students. MD–PhD programs are much more than the sum of each academic MD and PhD phase; transitioning between phases is not the same as merely moving to another "classroom" but involves much more energy on the MD–PhD student's part in terms of academic, social, and cultural integration in each new environment and fitting in with new cohorts of students. Treating each phase as a discrete entity without consideration of what it may take to successfully transition between phases essentially trivializes not only the cultural differences between MD and PhD programs, but also the differences in cultural experiences MD–PhD students may have compared with their MD-only or PhD-only peers. One of our key findings is the isolation that MD–PhD students felt after transitioning to a new phase of the program. MD–PhD training programs could consider offering career-development and networking activities that help MD–PhD students understand the potential challenges of transitioning, integrating, and reintegrating into the cultures of each phase of training and also foster each student's identity as a physician-scientist in his/her field of study. The nature and quality of MD–PhD students' interactions with fellow students and mentors, as our participants described, played key roles in the socialization of students in the community of scholars and in developing confidence and expertise to be successful.

Support

Frustration with lack of program support and lack of support from faculty and peers to help MD–PhD students navigate the transitions between phases of the program was frequently voiced. Expectations for each phase of the program were not stated explicitly, and lack of communication between the medical school and graduate school administrators added to the challenges of moving between the program phases and feelings of isolation. Developing programmatic support systems for MD–PhD students to optimally navigate the transitions between program phases should serve to better promote these students' efforts to achieve their career goals as physician-scientists. Prior research experience during high school or college is important to enrollment in MD–PhD programs (Jeffe *et al.*, 2014b; Andriole *et al.*, 2015; Tai *et al.*, 2017) and to building and sustaining a more racially/ethnically diverse biomedical research workforce (Tai *et al.*, 2017). The present study shows that these prior research experiences, along with attracting more students to MD–PhD programs, also helped in students' transition from MD to PhD training.

Our study findings extend Tinto's (1993) work in other ways. Tinto's social integration model was used to examine the range of interactions among students and between students and their environment. In a complex MD–PhD program, where education and socialization experiences can occur in different educational environments (i.e., classrooms, labs, and clinics) and in different institutions, interactions between medical school and graduate school faculty and administrators to support MD–PhD students are essential, too. Thus, we would add to this integration model planned activities and improved

interactions between the medical school and graduate school faculty and administrators aimed at smoothing the transitions for MD–PhD students and helping them quickly integrate into their new environments at each phase of training without experiencing undue anxiety and feelings of isolation.

Strengths and Limitations

Description of our participants' experiences during the MD–PhD program transitions can help programs improve the quality of MD–PhD training. Other studies have focused on the factors affecting MD–PhD students' educational outcomes (Jeffe *et al.*, 2014a) and satisfaction with training (Ahn *et al.*, 2007) and career choices of MD–PhD graduates (Brass *et al.*, 2010). However, our study explored MD–PhD students' transition experiences in detail, which, to our knowledge, has not been done before. The strengths of our study include a diverse sample in which voices from both male and female students from different racial/ethnic backgrounds were represented. The participants interviewed were all currently in training, anywhere between the third and 10th year of training. However, we were unable to identify students who dropped out of the MD–PhD program before completion; these students could have shared whether their transition experiences influenced their decisions to leave the program. MD–PhD students tend to be less demographically diverse compared with their MD peers (Andriole *et al.*, 2008), but participants in this study did not attribute the transition challenges they experienced to gender, race, or ethnicity. Participants also completed only one interview, and we lack follow-up information about their educational outcomes. We also cannot generalize our findings to all MD–PhD students, programs, and schools, as we recruited a very small sample of MD–PhD students. As with all cross-sectional qualitative studies, we cannot make causal inferences from the narrative data.

Despite these limitations, this study makes an important contribution to an understudied area of educational research. Findings highlight MD–PhD students' perceived need for certain program interventions and raise some important questions for MD–PhD program structure and the nature of training activities. Should MD–PhD programs continue to follow the traditional 2–4–2 year structure, requiring two transitions between three phases of the program? How might programs intervene to improve MD–PhD students' integration in the PhD and clinical MD phases of the program?

The federal government, educational institutions, and MD–PhD students themselves have made significant investments in efforts to ensure that students successfully complete the program (Jeffe and Andriole, 2011). We highly recommend more focused research and efforts to improve transition experiences during training and the development of program support interventions to help MD–PhD students successfully make these transitions. Our findings offer important insights to help shape this work. Given the importance of MD–PhD graduates as physician-scientists in the biomedical research workforce, such interventions should be rigorously evaluated for their impact on reducing risk of attrition from MD–PhD programs.

It is noteworthy that, while our findings mostly focused on the difficulties or challenges of transition experiences, participants also shared supports that helped them navigate these transitions. Further research about these positive experiences may serve to support broad dissemination of supportive interventions that can alleviate stressful transition challenges experienced during MD–PhD program training.

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