Topics in Training

The Future of the Orthopaedic Clinician-Scientist

Part I: The Potential Role of MD-PhD Students Considering Orthopaedic Surgery

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Background: There is currently a severe shortage of clinician-scientists, who fill a vital role in musculoskeletal care. One way to address this shortage is to recruit more MD-PhD students into orthopaedics. We analyzed data from a national survey of MD-PhD students to assess this potential.

Methods: A total of 868 students from thirteen MD-PhD training programs were requested to fill out a multiple-choice online survey concerning their education and future goals.

Results: We achieved a response rate of 56.7% (492 of 868). Seven (1.4%) of the 492 respondents listed orthopaedics as their primary clinical interest, and thirty (6.1%) listed it as one of their three strongest clinical interests. Among the thirty respondents, seven (23%) were senior students, five (17%) were women, and none were minorities. In comparison, 33% of the 462 respondents in the nonorthopaedic cohort were women and 12.1% were a member of a minority group ($p < 0.05$). Among twenty-three students who had a secondary orthopaedic interest, only one-third had a primary surgical interest. Both the thirty with a strong clinical interest in orthopaedics and the others without a strong interest in orthopaedics showed similar intent on becoming physician-scientists (a score of 2.73 and 3.30, respectively) and an interest in an academic career (90.0% and 90.3%, respectively) ($p > 0.05$ for both). The orthopaedic group showed significantly greater interest in clinical care as a primary activity than did the nonorthopaedic group (63.3% compared with 30.7%; $p < 0.0005$). Eighty-seven percent of those in the orthopaedic group reported research as their most likely primary or secondary activity.

Conclusions: This study suggests that there is a relatively strong interest in orthopaedic surgery (patient care and research) among MD-PhD students nationally, creating the potential to recruit approximately 100 new orthopaedic clinician-scientists every eight years (the average MD-PhD training period). Extrapolation indicates that there is the ability to double the number of orthopaedic clinician-scientists in the United States over the next fifty years. Therefore, efforts should be made to attract these students (especially women and those in underrepresented minority groups) to orthopaedic surgery. The study further suggests recruiting broadly—we should not be biased toward students late in training and just those with surgical interests.

Clinician-scientists, by virtue of being physicians active in research, have enormous potential to apply scientific discoveries to patient care. Leaders in medicine and orthopaedic surgery have been lamenting the current dearth of and decline in the number of these bridge-building physicians[1-13]. Historically, orthopaedic surgery has been among the least successful disciplines in recruiting and developing clinician-scientists[3].

The U.S. National Institute of General Medical Sciences increasingly continues to implement and support MD-PhD medical scientist training programs whose goal is to train physicians who will bring the research bench

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TABLE I Primary and Secondary Clinical Interest of 492 MD-PhD Student Respondents

	First Choice*	Top Three Choices*
Traditional fields†	283 (57.5)	424 (86.2)
Surgical fields‡	69 (14.0)	184 (37.4)
Orthopaedic surgery	7 (1.4)	30 (6.1)

*The values are given as the number of respondents with the percentage in parentheses. †Includes internal medicine, pediatrics, pathology, and neurology. ‡Includes neurosurgery, urology, general surgery, plastic surgery, obstetrics/gynecology, ophthalmology, orthopaedic surgery, and otolaryngology.

to the bedside[14]. Numerous studies have shown that MD-PhD trainees have found academic success (e.g., the attainment of extramural funding, progression in academic rank, and publication in peer-reviewed journals)[14-21]. However, one long-term follow-up study (and the only one of its kind) indicated that a disproportionate few went on to orthopaedic careers in particular and surgical careers in general[3].

Fields such as orthopaedic surgery have much to gain by vigorous recruitment efforts because clinician-scientists are relatively rare. In addition, after current orthopaedic residents, who represent the greatest pool of potential clinician-scientists, medical students with strong interests in research and orthopaedics arguably provide the next largest population from which to draw. However, before these efforts are made and the resources are utilized, we need to better understand the potential for recruitment ("Are there enough interested students to make this effort worthwhile?" "Do the ones interested in orthopaedics want to be clinician-scientists?" "Whom and when should we target?"). We previously reported on our findings at a single academic institution, which suggested that there was a strong surgical interest among MD-PhD students and a desire to integrate research into their practice at a rate similar to that among MD-PhD students interested in nonsurgical fields[22]. Our current study provides insight at the national level and should represent a large enough sample of all MD-PhD students to be broadly generalizable.

Materials and Methods

Participants and Recruitment

After institutional review board approval, we recruited subjects for our study by e-mailing a questionnaire to all MD-PhD students enrolled in fifteen participating combined degree programs (approximately one-quarter of all MD-PhD students in the U.S.) during the spring of 2003[16]. Five raffle prizes valued at $100 each were offered as an incentive. Institutions were chosen to represent a variety of program sizes (eight to 161 students; average, sixty-seven students), funding structures (nine of thirteen programs with funding from the Medical Science Training Program[23]), geographic locations (four in the East and three each in the Midwest, South, and West), and local environments. The questionnaire, which had twenty-nine closed-ended questions, collected information regarding student demographics, satisfaction with various aspects of the MD-PhD educational experience, future residency and career goals, and attitudes and views concerning the physician-scientist model. At the completion of data collection for the thirteen participating programs (two programs were excluded because of nonadherence to our e-mail recruiting protocol), we obtained a final response rate of 56.7% (492 of 868 students).

Stratification of Participants

The data were stratified for analyses with use of the primary clinical interests of the students (following

TABLE II Preferred Primary Professional Activities and Settings of Orthopaedic and Nonorthopaedic MD-PhD Student Respondents

	Percentage of Nonorthopaedic Respondents* (N = 462)	Percentage of Orthopaedic Respondents* (N = 30)
Preferred primary professional setting		
Academic†	90.3	90.0
Nonacademic†	1.5	3.3
Industry	0.43	0
Research	2.4	6.7
Government	2.4	0
Preferred primary professional activity		
Research‡	58.2	26.7
Patient care‡	30.7	63.3
Teaching	6.49	10.0
Policy	0.87	0
Administrative	0.43	0

*Nonorthopaedic respondents included students who did not list orthopaedic surgery as one of their three clinical interests, and orthopaedic respondents are students who listed orthopaedic surgery as one of their three clinical interests. †Academic and nonacademic settings within a clinical practice setting. ‡The difference was significant (Fisher exact test, $p < 0.0005$).

TABLE III Selected Characteristics of Orthopaedic and Nonorthopaedic MD-PhD Student Respondents

	Mean Age *(yr)*	Percentage of Respondents Who Had Completed Thesis	Relative Satisfaction*	Professional Intent†	Percentage of Respondents with Debt of <$50,000
Nonorthopaedic respondents‡ (n = 462)	26.6	22.1	2.66 ± 1.75	3.3 ± 1.92	50.0
Orthopaedic respondents‡ (n = 30)	26.4	23.3	2.43 ± 1.89	2.73 ± 2.05	56.7
P value	0.662	0.173	0.267	0.083	0.120
Statistical test	Student t test	Fisher exact	Mann-Whitney	Mann-Whitney	Fisher exact

*The values are given as the mean score and the standard deviation. The scores were based on a scale of 1 (most satisfied) to 8 (least satisfied). †The values are given as the mean score and the standard deviation. The scores were based on a scale of 1 (most likely) to 8 (least likely) that respondent would become a clinician-scientist. ‡Nonorthopaedic respondents were students who did not list orthopaedic surgery as one of their three clinical interests; orthopaedic respondents were those who listed orthopaedic surgery as one of their three clinical interests.

traditional residency training options). *Traditional* specialties include internal medicine, pediatrics, pathology, and neurology[14]. *Surgical* specialties are designated to include general surgery, neurosurgery, obstetrics-gynecology, ophthalmology, orthopaedic surgery, otolaryngology, plastic surgery, and urology. Other groupings based on specialty interest are explained in the text as needed.

Statistical Analysis and Nonresponders

Statistical analysis was performed with use of a commercially available statistical package. Comparisons were made with the Student t test for normal and continuous variables, rank-sum tests (Mann-Whitney U test) for non-normal or continuous variables, and contingency table analysis for proportional data (Fisher exact test). Satisfaction and agreement scores are reported as averages. Standard deviations and confidence intervals (95% confidence interval) and p values are reported as indicated (the level of significance was set at $p < 0.05$). As a test of the general internal consistency of subjective responses, we calculated the Cronbach alpha for twelve items in the questionnaire that asked students to rate their satisfaction with various aspects of their education. A value of 0.90 was achieved, suggesting a relatively high level of consistency (where >0.70 is considered acceptable). Removing the students interested in orthopaedic surgery did not change the alpha value.

The response rate to our survey was similar to rates reported for surveys of equivalent populations[24]. However, nonresponder bias remained a concern. Fifty nonresponders were randomly surveyed by means of multiple e-mail solicitations containing an abbreviated questionnaire to assess the likelihood of a so-called clinically important bias (determined a priori to be a difference of 1.5 on the 8-point scale for overall satisfaction, with >80% power with an alpha of 0.05 and a sample size of fifty) compared with the responders. The average satisfaction among responders (2.7 ± 1.8) and nonresponders (3.4 ± 2.2) was similar (<1.5 as explained above), suggesting no important responder-based bias. The two groups did not show significant differences with regard to sex and minority proportion, matriculation year, funding status, debt burden, field of PhD thesis,

TABLE IV Diversity Among MD-PhD Student Respondents with Regard to Sex and Membership in a Minority Group

		Respondents Who Were Female		Respondents Who Were in a Minority Group	
	No. in Group	Percentage	P Value*	Percentage	P Value*
Orthopaedic respondents†	30	16.7	–	0	–
Surgical (nonorthopaedic) respondents‡	55	25.5	0.146	11.0	0.066
Nonorthopaedic respondents†	462	33.3	0.027	12.1	0.025

*Result of Fisher exact test of the comparison with the proportions among the orthopaedic group. †Orthopaedic respondents were those who listed orthopaedic surgery as one of their three clinical interests, and nonorthopaedic respondents were students who did not list orthopaedic surgery as one of their three clinical interests. ‡Surgical respondents were all students who listed surgical fields as a primary interest but did not list orthopaedic surgery among their interests.

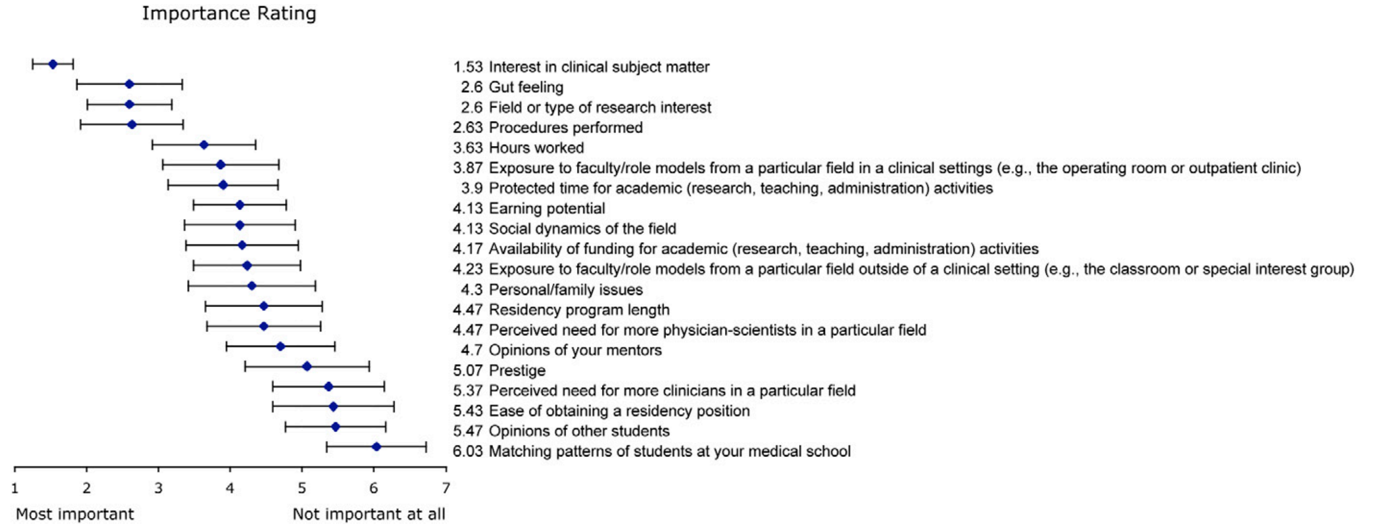

Fig. 1

Students ranked the importance of various factors in choosing their primary clinical field of interest on a scale of 1 (most important) to 8 (not important). The values are given as the average with standard error (bars) in decreasing order of importance.

stage in program, or primary clinical interest. Those who did not respond were, on the average, 0.9 year older than those who did ($p < 0.01$).

Results

Level of Interest

Although recent trends (including anecdotal evidence [data not shown]) may suggest some change in residency selection patterns[16,21], traditionally, the majority of MD-PhD graduates have entered postgraduate training in internal medicine, pediatrics, pathology, or neurology[3,14] (fields termed *traditional*). Consistent with this, the majority (57.5%) of the survey respondents had a primary clinical interest in traditional fields (Table I). Fourteen percent were primarily interested in pursuing the *surgical* fields of orthopaedic surgery, neurosurgery, urology, general surgery, plastic surgery, gynecology (and obstetrics), ophthalmology, and otolaryngology, whereas 1.4% desired orthopaedic surgery (Table I). Combining the "top three" interests solicited revealed that 86.2% of the respondents were considering careers in traditional fields; 37.4%, in surgical fields; and 6.1% (thirty respondents), in orthopaedics (Table I). Students in all three groupings had similar levels of certainty in their choice of clinical preference (with a median score of 3, on a scale of 1 to 8, for all groups; $p > 0.05$).

Future Practice Characteristics

As seen in Table II, when the orthopaedic students were asked to select the type of setting that best characterized their future practice, the overwhelming majority (90%) indicated an academic setting. For students without an expressed interest in orthopaedics (the nonorthopaedic group), the rate was nearly identical (90.3%). When asked about a preference for primary professional activity, orthopaedic students selected patient care approximately twice as often as did their nonorthopaedic counterparts (63% compared with 31%; $p < 0.001$); conversely, they chose research less often (27% compared with 58%; $p < 0.001$). In total, 87% of the orthopaedic respondents listed research as a primary or secondary professional activity.

Student Demographics and Qualities

As seen in Table III, no significant difference between orthopaedic and nonorthopaedic students was detected with regard to mean age (26.4 and 26.6 years, respectively; Student t test, $p > 0.05$), stage in program (23.3% and 22.1% had completed their thesis; $p > 0.05$), mean satisfaction with training (2.4 and 2.7 on a scale of 1 to 8; Mann-Whitney U test, $p > 0.05$), educational debt (57% and 50% with debt of <\$50,000; $p > 0.05$), and intent to become a physician-scientist (2.73 and 3.3 on a scale of 1 to 8; $p > 0.05$). The orthopaedic group (compared with the nonorthopaedic group) was significantly less diverse with regard to the proportion of female (16.7% and 33.3%, respectively; $p < 0.05$) and minority (0% and 12.1%; $p < 0.05$) students (Table IV). In somewhat of a contrast, other surgical respondents had intermediate proportions (25.5% were female and 11% were a member of a minority group; Table IV).

Importance of Factors in Deciding Clinical Interests

Students were asked to rate the importance of twenty different factors in choosing their clinical interests on a scale of 1 (greatest importance) to 8 (no importance). The average scores given by orthopaedic students are shown in Figure 1.

Discussion

It is important for clinical medicine to be well founded in the sciences. Despite the importance placed by society (and by leaders in medicine) on the physician who is well versed in the research and clinical aspects of surgical practice, orthopaedic surgery has historically had a disproportionately small number of these clinician-scientists[3,14]. In fact, it has fared poorly even compared with other surgical fields.

Certainly, increasing funding opportunities and decreasing barriers to clinical and academic success will make a better environment for the orthopaedic clinician-scientist[25-27]. However, without proper recruitment, there will be no new investigators to support. The two most obvious long-term sources for such orthopaedic surgeons are residents currently in training (who are committed to orthopaedics but not necessarily to research) and academically oriented medical students (with a high interest in research but not necessarily in orthopaedics). Among the medical students, those engaged in MD-PhD programs represent the single most easily identifiable group of students committed to academic careers and research.

In our examination of a recent nationwide survey of MD-PhD students, we found a small cohort with an interest in orthopaedic surgery. However, as small a group as this may be, it has real potential to increase the number of orthopaedic clinician-scientists.

The future practice characteristics of these students suggest that they desire to be clinicians and researchers in an academic setting. Although they prefer clinical work more than their nonsurgical counterparts do (and perhaps rightly so), their desire to work in academics was equivalent. Overall, almost 90% of the students with an interest in orthopaedic surgery in our cohort would perform research as a primary or secondary professional activity and would do so in an academic practice.

According to criteria posed by Brand et al.[2], there were approximately 560 active orthopaedic clinician-scientists in 2002 to 2003 in the United States. Of those, approximately 25% (140 surgeons) spend one day a week or more, on the average, on research activities. Extrapolation from our data suggests that there are approximately 240 MD-PhD students interested in orthopaedics in the United States. Even at a conservative (<50% recruitment) rate, we could attract >100 MD-PhD students to orthopaedics over an eight-year period (the average time to attain an MD-PhD degree). This would double the number of active orthopaedic clinician-scientists in less than fifty years; indeed, considering their strong research interest, we would likely have a doubling effect on the more research-intensive surgeon population (one day or more of research per week) in just ten to fifteen years. In addition, considering the relatively high success rate of National Institutes of Health RO1 (research project grant) applications by scientists with MD-PhDs (higher than the rate for those with MDs or PhDs)[28,29], an increase in the number of MD-PhDs within orthopaedics could also reverse the decreasing trend among orthopaedic surgeons for successful RO1 applications as noted in the report by Brand et al.[2].

So how should we recruit? First and foremost, we need to increase our exposure. Not surprisingly, students noted "interest in subject matter" as the most important factor in deciding their residency interests. Few medical schools have well-organized musculoskeletal curricula in the preclinical years[30], and very few students know much about what orthopaedic surgeons do, let alone the burden of musculoskeletal disease in the United States or worldwide. Outside the classroom, individual departments need to identify potential local role models and to provide interaction opportunities with MD-PhD students, be it informal lunchtime seminars or intramural research symposia. At the national level, organizations such as the American Academy of Orthopaedic Surgeons or the Orthopaedic Research and Education Foundation should develop web-based and in-person interaction programs similar to those offered by the Clinician Scientist Development Program. We must also not lose sight of those underrepresented in our field. Women and minorities continue to be underrepresented in orthopaedics in general, but they are also underrepresented among MD-PhD students interested in orthopaedic surgery. Our data also suggest the need for wide recruitment. Although students with a secondary interest in orthopaedics—the very group we would want to convert to the primary interest group—were twice as likely to have a primary interest in another surgical field, 70% of them did not have a primary surgical interest. Therefore, we need to provide exposure to those interested (at least at the outermost layer) in surgical and nonsurgical fields.

Our study is not without limitations. First, although a similar questionnaire was used for another study[16,21,22] and our data concerning the surveyed population are consistent with those in previous studies[14-20], the survey instrument has not been formally validated. We asked students in our survey to express their desires as it appeared futile to ask them to predict their future careers. Those opinions, in and of themselves, are meaningful. Nonetheless, the predictive value of those desires would be useful to know. We are in the process of designing a longitudinal study to address this issue in the future. Second, the response rate—similar to other studies surveying medical professionals[24]—can only be considered moderate and, therefore, is open to substantial responder bias. As noted in the Materials and Methods section, we performed an adequately powered analysis that showed a low likelihood of nonresponder bias compared with our cohort.

Collectively, our data show that successful recruitment of MD-PhD students who already have some interest in orthopaedic surgery can meaningfully contribute to the current pool of orthopaedic clinician-scientists. With these data in hand, it is up to the leaders and practitioners in our field to effect that change.

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