Impact of PhD training on scholarship in a neurosurgical career

Clinical article

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Object. The purpose of this study was to report the prevalence of neurosurgeons with both medical degrees (MDs) and doctorates (PhDs) at top-ranked US academic institutions and to assess whether the additional doctorate education is associated with substantive career involvement in academia as well as greater success in procuring National Institutes of Health (NIH) research funding compared with an MD-only degree.

Methods. The authors reviewed the training of neurosurgeons across the top 10 neurosurgery departments chosen according to academic impact (h index) to examine whether MD-PhD training correlated significantly with career outcomes in academia.

Results. Six hundred thirteen neurosurgery graduates and residents between the years 1990 and 2012 were identified for inclusion in this analysis. Both MD and PhD degrees were held by 121 neurosurgeons (19.7%), and an MD alone was held by 492. Over the past 2 decades, MD-PhD trainees represented a gradually increasing percentage of neurosurgeons, from 10.2% to 25.7% (p < 0.01). Of the neurosurgeons with MD-PhD training, a greater proportion had appointments in academic medicine compared with their MD-only peers (73.7% vs 52.3%, p < 0.001). Academic neurosurgeons with both degrees were also more likely to have received NIH funding (51.9% vs 31.8%, p < 0.05) than their single-degree counterparts in academia. In a national analysis of all active NIH R01 grants awarded in neurosurgery, MD-PhD investigators held a disproportionate number, more than 4-fold greater than their representation in the field.

Conclusions. Dual MD-PhD training is a significant factor that may predict active participation in and funding for research careers among neurological surgeons at top-ranked academic institutions. These findings and their implications are of increasing relevance as the population of neurosurgeons with dual-degree training continues to rise.

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Key Words • neurosurgery • medical education • training support

Each year, the National Institutes of Health (NIH) spends over $40 million to provide funding to medical students in combined MD-PhD training programs.12 The magnitude and utility of this investment have been the subjects of recent controversy.1,13 In general, compared with their MD-only counterparts, MD-PhD–trained individuals report greater intentions of pursuing research-oriented careers2 and are often recruited to top-ranked academic residency programs as a result. However, fewer data are available regarding the predictive capacity of dual-degree training on actual career choice and contributions to the academic community.5

Neurological surgery remains among the most competitive subspecialties. Given its protracted time course—which already requires 1–2 years of dedicated research time—as well as the growing complexities in clinical care,8 the decision to pursue additional graduate-level education for neurosurgeons must be strategic and well-informed.9 Specifically, it is currently unclear whether MD-PhD–trained neurosurgeons ultimately compete successfully as researchers and whether they do so with any greater facility than their MD-only peers.

Previous studies cite a few variables that may play a role in predicting long-term academic participation among neurosurgery trainees; those listed include publication record, favorable evaluations, and pursuit of subspecialty fellowships.7,10 The present study was performed to assess the prevalence of doctorate training among neurosurgeons in top-ranked academic neurosurgery departments as well as to gauge the potential impact of the concomitant holding of both degrees on long-term career choice and performance in academia.
Does the MD-PhD matter?

Methods

Data in this study were obtained from the top 10 US neurosurgical departments accredited by the Accreditation Council for Graduate Medical Education (ACGME). Ranking was determined, as previously described, using the objective h(10) index,10 a surrogate for academic productivity over the past 10 years. The coordinating offices of these training programs were individually contacted by electronic mail and telephone. Data were acquired from these offices and verified on program websites and online searches. All available data for residents and alumni graduating from these 10 programs between 1990 and 2012 were included in our analysis. Degree status was termed “MD-only” for individuals without PhDs but did not exclude nondoctoral level degrees (for example, M.B.A., M.H.Sc., M.P.H., and so forth). Degree status was termed “MD-PhD” for any neurosurgeon who had received both MD and PhD training. When categorizing career choice, “academic practice” (AP) was defined as holding an appointment at an institution with an ACGME-accredited residency training program as previously described.7 Neurosurgeons in fellowship training were excluded from our analysis, as were those affiliated with academic institutions without ACGME accreditation at the time of our analysis, as were those affiliated with academic institutions without ACGME accreditation at the time of the study. A designation of “private practice” (PP) was assigned to any neurosurgeon who was not affiliated with a university or academic center. To account for potential attrition, we chose to define career choice by current employment information rather than employment immediately following residency, while still recognizing that a certain number of individuals may have alternated between AP and PP throughout their careers. To normalize these data, neurosurgeons who had practiced in academic settings and then switched to PP were considered to be in PP. Likewise, those who had started in PP and then switched to academia were considered academic neurosurgeons. This approach has been used previously to distinguish between neurosurgeons in APs and PPs.7 Data regarding NIH funding was obtained through the NIH Research Portfolio On-line Reporting Tools (RePORT) interface (available publicly at http://projectreporter.nih.gov/reporter.cfm). Comparisons between MD-only and MD-PhD as well as analyses relevant to trends over time were performed using Pearson’s chi-square analysis with statistical significance defined by p < 0.05.

Results

Of the 613 neurosurgeons included in our study, 184 were current neurosurgery residents and 429 were practicing neurosurgeons who had completed residency between the years 1990 and 2012. The total number of trainees and their representation at respective institutions are listed in Table 1.

We first sought to determine the prevalence of MD-PhD training among neurosurgeons as a proportion of both current and recently graduated neurosurgery residents (Table 2). There was a slightly increased percentage of dual-degree trainees among current residents as compared with those who had completed residency in the previous 2 decades (22.3% vs 18.6%). When separated by sex, male and female neurosurgeons appeared to trend in opposite directions; that is, the percent of graduated male neurosurgeons holding MD-PhDs as compared with current male residents increased from 17.6% to 22.4%, whereas the percent of graduated female neurosurgeons as compared with residents decreased from 32.1% to 21.7%. But these trends were not statistically significant. Interestingly, the proportion of females in neurosurgery nearly doubled over the study period (from 7.5% to 12.5%).

When practicing neurosurgeons were considered alone, we observed a gradual increase in both the total number (Fig. 1 left) and the proportion of MD-PhDs over time (10.2% in 1990–1994 to 25.7% in 2005–2009, p < 0.01; Fig. 1 right). Importantly, this increase in dual-degree trainees appeared to be specific to neurosurgery as compared with other residency programs. In the 2011 National Resident Matching Program report “Charting Outcomes in the Match,” 10.3% of medical students matching into neurosurgery held both MD and PhD degrees, more than other surgical residencies (plastic surgery was the second highest at 6.8%; Fig. 2).

We next examined neurosurgeons currently in practice to determine whether degree status influenced the decision to enter AP versus PP. Virtually no preference was observed between those who pursued AP (52.3%) and those who pursued PP (47.7%) among neurosurgeons with MD training only (Table 3). In contrast, neurosurgeons with dual MD-PhD training displayed a significant tendency to favor careers in academic medicine as compared with their MD-only counterparts (73.7% vs 52.3%, respectively, p < 0.001). This difference was heavily reflected in male neurosurgeons (73.1% MD-PhD vs 52.3% MD-only group, p < 0.01). Although female neurosurgeons displayed a similar trend, interpretations of these data were limited by sample size.

To assess whether MD-PhD training might be predictive of the ability to procure research funding in neurosurgery, NIH grants were enumerated as a surrogate for success in grantsmanship and academic productivity. Our data demonstrated that, compared with their MD-only counterparts in academia, neurosurgeons with MD-PhDs were more likely to have acquired NIH grants early in their career as measured by the number of Career Development Awards (K-Awards) obtained (p < 0.05; Table 4). When considering all grant mechanisms throughout their career, dual-degree investigators were also more likely to have received at least one NIH grant (51.9% MD-PhD vs 31.8% MD only, p < 0.05). The average number of NIH grants awarded per neurosurgeon (that is, the total number of NIH grants awarded divided by the total number of individuals) was also greater in the MD-PhD group compared with the MD-only group (1.20 vs 0.71, p < 0.01). Interestingly, analyses limited to investigators receiving at least one NIH grant did not reveal statistically significant differences between MD-PhD and MD-only groups (2.3 vs 2.2).

Lastly, we sought to capture whether these trends in funding were consistent with broader analyses applied to programs outside the selected top-ranked academic institutions. To this end, using search criteria available
through the NIH RePORT interface, we compiled data on grants awarded to Departments of Neurosurgery without exclusion. When sorted by degree status of the principal investigator, excluding all PhD-only investigators, we found that a slightly higher percentage of all active NIH R01 grants were held by MD-only versus MD-PhD project leaders (56.5% vs 43.5%, respectively; Table 5). Note, however, that these data also imply that NIH R01 grants are disproportionately held by MD-PhD investigators, considering their overall representation in neurosurgery (Fig. 2).

Discussion

Previous studies have revealed that most combined MD-PhD program graduates pursue careers in academic medicine.4 Importantly, the current study establishes that neurosurgeons with both MD and PhD training are similarly more likely to choose academic careers and compete successfully for research funding, as compared with their MD-only counterparts, even when trained at the same top-ranked academic institutions. As an additional observation, physicians with MD-PhD training represent an increasing proportion of practicing neurosurgeons over time since 1990.

Relatively few attempts have been made to identify characteristics that may predict long-term commitment to academics in neurosurgery.7,10 In contrast to our findings, those of Lawton and colleagues, who performed a single-institution study,7 revealed no significant association between degree status and career choice (AP vs PP) among neurosurgery trainees. Importantly, their study did not distinguish individuals with MD-PhDs from those with other dual degrees. In addition, of the 69 neurological residents included in their analysis, only 7 were categorized as holding additional degrees, making it reasonable to presume that their analysis may not have been sufficiently powered to detect a significant difference.

Unlike previous work, our study includes data gathered across several objectively ranked institutions, which in part normalizes biases that may be inherent to any single institution. Perhaps the greatest limitation of our data is the omission of variables other than degree status that are likely to be involved in a given individual's career trajectory. Certainly, the purpose of an MD-PhD education is to train physician-scientists for successful participation in the academic community. However, it is important to note that our data do not definitively demonstrate a causal relationship between MD-PhD training and the outcomes studied herein. As such, MD-PhD training may simply represent a marker for other characteristics that have greater predictive value in one or all of our analyses. Such variables may include a genuine interest in pursuing research careers, greater access to mentoring interactions,3 or financial incentives that may be specific to a given population.

One important conclusion from our study is that MD-PhD neurosurgeons from top-ranked academic programs are more likely to obtain at least one grant through NIH funding than their MD-only peers from the same institutions. Additionally, in a broad analysis across all institutions (that is, not limited to the top-ranked programs by the h index), we found that active NIH R01 grants in neurosurgery are disproportionally held by MD-PhD investigators at a proportion over 4-fold greater than their representation in the entire field. Consistent with these findings, those of Lawton and colleagues, who performed a single-institution study,7 revealed no significant association between degree status and career choice (AP vs PP) among neurosurgery trainees. Importantly, their study did not distinguish individuals with MD-PhDs from those with other dual degrees. In addition, of the 69 neurological residents included in their analysis, only 7 were categorized as holding additional degrees, making it reasonable to presume that their analysis may not have been sufficiently powered to detect a significant difference.

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Does the MD-PhD matter?

**Fig. 1.** The prevalence of MD-PhDs in neurosurgery has gradually increased over time. **Left:** The total number of individuals completing a neurosurgical (NSU) residency with a PhD increased between 1990 and 2009. **Right:** This increase was also observed when analyzed as a proportion of NSU residents completing their residencies with a PhD over the same intervals. Horizontal bars represent a statistical significance of p < 0.01, Pearson’s chi-square test.

**Fig. 2.** Match results for MD-PhD applicants in surgical residencies as enumerated in the 2011 National Resident Matching Program report “Charting Outcomes in the Match.” The percentage of matching residents with MD-PhD training was highest in neurological surgery (10.3%), followed by plastic surgery (6.8%), otolaryngology (3.7%), and orthopedic surgery (2.4%).
cess than MD-only peers in obtaining R01 grants regardless of field of study. Moreover, MD-PhD investigators in that study also had lower rates of attrition than their MD-only peers, with a greater probability of obtaining subsequent R01 funding after initial success.

However, an additional, somewhat contrary finding in our study was that among neurosurgeons who had received at least one NIH grant over their career, the number of grants obtained per capita was virtually identical between MD-PhD and MD-only groups. Although this analysis is not a formal measure of attrition, it does suggest that among individuals in neurosurgery who repeatedly pursue NIH funding, grant success rates may not actually differ significantly between groups defined by degree. Thus, the conclusion that MD-PhD neurosurgeons are more likely to acquire NIH funding may not necessarily reflect an increased rate of success upon application, insofar as it may simply indicate a greater tendency to seek funding at baseline. Alternatively, these data may also indicate that success in procuring funding is critically dependent on the level of performance immediately preceding an application. That is to say, while MD-PhD neurosurgeons may enjoy greater success initially, this advantage may decline over time such that on renewal, the PhD credential becomes less relevant when compared with other factors such as recent evidence of progress and scientific success.

Importantly, because a large part of our analysis focused on top-ranked academic programs, our findings are not necessarily intended for generalization across the more than 100 ACGME-accredited neurosurgery residency programs currently in existence. For example, the proportion of current residents with MD-PhD training in our study was 22.3%, which is almost twice the overall presence of MD-PhDs in the field, thus implying the presence of bias in our study population. However, our conclusion that MD-PhD and MD-only neurosurgeons differ from each other significantly by various metrics, even when trained at the same top-ranked institutions, is uninfluenced by this potential bias. Certainly, one can speculate that other programs—perhaps those with lower h index rankings—do not follow these trends and instead have an increased representation of MD-PhD neurosurgeons who are less inclined to pursue academic activity. If this is the case, then further study is needed to identify other variables (for example, grades, board scores, relevance of dissertation research, and so forth) that may differentiate these residents from those at top-ranked academic programs, for which we have clearly demonstrated MD-PhD training as a significant and independent predictor of eventual academic activity.

Nonetheless, sweeping interpretations of our results should be tempered, especially given that approximately one-quarter of the MD-PhD neurosurgeons, despite matriculation at top-ranked academic programs, ultimately entered private practice (Table 3). Since many believe that the sole purpose of MD-PhD programs should be the training of physicians and surgeons committed to academia, one could conclude that even a small proportion (26.3%) dedicated to private practice would actually indicate MD-PhD trainee misallocation or underperformance. Moreover, the fact that over half of the MD-only neurosurgeons (52.3%) were committed to academic careers is notable and should not be discounted, especially since as an absolute number the representation of MD-only trainees in academic neurosurgery clearly predominates. Thus, our findings, while controversial, should not be taken in isolation but rather incorporated into the evolving discussion on joint MD-PhD graduates and the metrics by which they should be evaluated against their MD-only peers.

### TABLE 3: Career choice among 407 MD-PhD and MD-only neurosurgeons*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MD-PhD</th>
<th>MD</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>331</td>
<td>173</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>female</td>
<td>23</td>
<td>7</td>
<td>NS</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD-PhD</td>
<td>76</td>
<td>56 (73.7)</td>
<td>20 (26.3)</td>
</tr>
<tr>
<td>female</td>
<td>9</td>
<td>7 (77.8)</td>
<td>2 (2.22)</td>
</tr>
<tr>
<td>male</td>
<td>67</td>
<td>49 (73.1)</td>
<td>18 (26.9)</td>
</tr>
</tbody>
</table>

* Academic Practice was used to describe neurosurgeons with appointments at ACGME-accredited programs. Individuals in non-ACGME-accredited residency training programs and in fellowships were excluded from analysis. NS = not significant.

### TABLE 4: Grantsmanship statistics among 229 MD-PhD and MD-only neurosurgeons in academia

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MD-PhD</th>
<th>MD</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-Award</td>
<td>20 (11.8)</td>
<td>13 (24.1)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>any NIH grant</td>
<td>54 (31.8)</td>
<td>28 (51.9)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>per capita*</td>
<td>0.71</td>
<td>1.20</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

* Per capita reflects the total number of NIH grants awarded divided by the total number of individuals in each respective group.

### TABLE 5: Active NIH R01 grants awarded to Departments of Neurosurgery by degree status of principal investigator (2013)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MD-PhD</th>
<th>MD</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-Award</td>
<td>35 (56.5)</td>
<td>27 (43.5)</td>
<td></td>
</tr>
</tbody>
</table>

* Excluding NIH R01 grants awarded to PhD-only investigators.
Does the MD-PhD matter?

Overall, the fact that neurosurgical trainees with both MDs and PhDs appear to be increasing in prevalence at top-ranked academic programs may in part reflect the parallel expansion of combined MD-PhD medical school programs across the country. However, the increased representation of residents with MD-PhD training, specifically in neurological surgery compared with other specialties, suggests that trends toward dual-degree training may be isolated or at least more pronounced in the field of neurosurgery. Importantly, given increasing emphasis on research accomplishments in career development, such trends toward more MD-PhD training may ultimately influence the type of individuals considered for the next generation of leaders (for example, chairpersons and directors) in academic neurosurgery. Additional longitudinal studies will be needed to adequately investigate this speculation.

Lastly, consistent with what has been observed elsewhere, female representation in neurosurgery has increased gradually over time according to our results. Despite this, the relatively low number of female neurosurgeons limited our ability to detect significant sex-specific findings. Further study is needed to explore these and other factors that may predictively influence the careers of neurosurgeons in academia.

Conclusions

Individuals with MD-PhD training compose a consistently increasing proportion of neurosurgeons over time. Our data demonstrate for the first time that dual MD-PhD training correlates significantly with the pursuit of research careers and successful grantsmanship among neurological surgeons.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Concept and design: Sampson, Choi, MR DeLong. Acquisition of data: Choi, MR DeLong. Drafting the article: Choi, MR DeLong. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Sampson. Statistical analysis: DM DeLong. Administrative/technical/material support: Sampson. Study supervision: Sampson.

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