



## Positive trends in neurosurgery enrollment and attrition: analysis of the 2000–2009 female neurosurgery resident cohort

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**OBJECTIVE** Women compose a minority of neurosurgery residents, averaging just over 10% of matched applicants per year during this decade. A recent review by Lynch et al. raises the concern that women may be at a higher risk than men for attrition, based on analysis of a cohort matched between 1990 and 1999. This manuscript aims to characterize the trends in enrollment, attrition, and postattrition careers for women who matched in neurosurgery between 2000 and 2009.

**METHODS** Databases from the American Association of Neurological Surgeons (AANS) and the American Board of Neurological Surgery (ABNS) were analyzed for all residents who matched into neurosurgery during the years 2000–2009. Residents were sorted by female gender, matched against graduation records, and if graduation was not reported from neurosurgery residency programs, an Internet search was used to determine the residents' alternative path. The primary outcome was to determine the number of women residents who did not complete neurosurgery training programs during 2000–2009. Secondary outcomes included the total number of women who matched into neurosurgery per year, year in training in which attrition occurred, and alternative career paths that these women chose to pursue.

**RESULTS** Women comprised 240 of 1992 (12%) matched neurosurgery residents during 2000–2009. Among female residents there was a 17% attrition rate, compared with a 5.3% male attrition rate, with an overall attrition rate of 6.7%. The majority who left the field did so within the first 3 years of neurosurgical training and stayed in medicine—pursuing anesthesia, neurology, and radiology.

**CONCLUSIONS** Although the percentage of women entering neurosurgical residency has continued to increase, this number is still disproportionate to the overall number of women in medicine. The female attrition rate in neurosurgery in the 2000–2009 cohort is comparable to that of the other surgical specialties, but for neurosurgery, there is disparity between the male and female attrition rates. Women who left the field tended to stay within medicine and usually pursued a neuroscience-related career. Given the need for talented women to pursue neurosurgery and the increasing numbers of women matching annually, the recruitment and retention of women in neurosurgery should be benchmarked and assessed.

<http://thejns.org/doi/abs/10.3171/2015.3.JNS142313>

**KEY WORDS** women in neurosurgery; residency; neurosurgery; resident attrition; resident retention

**T**ODAY, women comprise nearly 50% of the incoming medical student class (see <https://www.aamc.org/data/facts/>). Their achievement in terms of success, ranging from undergraduate science grade point average (GPA), Medical College Admission Test (MCAT) scores,

and US Medical Licensing Examination (USMLE) Step 1–3 results, does not differ significantly from that of men.<sup>9</sup> Furthermore, women excel on clinical examinations in medical school. Women successfully secure residency positions in competitive fields of their choosing, filling 62%

**ABBREVIATIONS** AANS = American Association of Neurological Surgeons; PGY = postgraduate year; WINS = Women in Neurosurgery.

**ACCOMPANYING EDITORIAL** See pp 831–833. DOI: 10.3171/2015.4.JNS15500.

**SUBMITTED** October 7, 2014. **ACCEPTED** March 3, 2015.

**INCLUDE WHEN CITING** Published online October 9, 2015; DOI: 10.3171/2015.3.JNS142313.

of dermatology spots, 34% of radiation-oncology spots, 31% of ENT spots, 24% of urology spots, and 23% of plastic surgery spots in the 2009 match (see <https://www.aamc.org/members/gwims/statistics/stats10/>). Historically, the surgical subspecialties such as neurosurgery, orthopedic surgery, and thoracic surgery have the lowest number of female residents, at approximately 10.9%.<sup>6,24</sup>

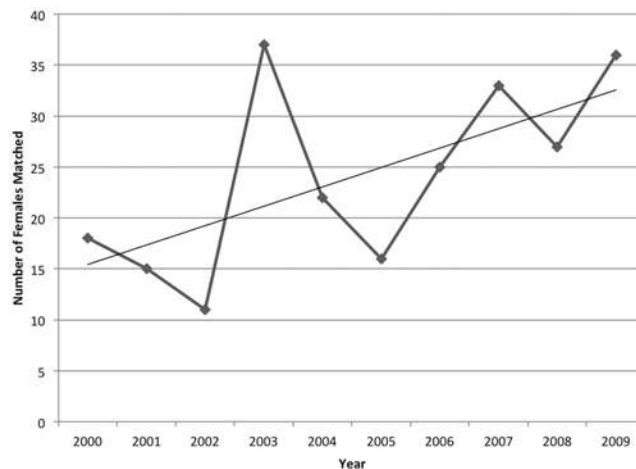
Whereas the percentage of women has increased dramatically in medicine, that percentage has not been commensurate in neurosurgery. Achieving the critical workforce mass of women in neurosurgery requires both recruitment and retention. There has been a perception that neurosurgery may be an unattractive career choice due to the length of training, work hours, and high patient acuity. However, with the increasing number of qualified women graduating from medical school who hold equal achievement potential, perhaps these prior perceptions no longer are valid. Quantification of attrition rates in neurosurgery sorted by gender have only recently become available for those who trained more than 15 years ago (1990s cohort).<sup>19</sup> Trends in recent enrollment and retention of women in neurosurgery are useful benchmarks to build upon established data and to continue to monitor established priorities of organized neurosurgery.<sup>4</sup> The purpose of this paper was to perform an analysis of the subsequent decade to ascertain if these attrition rates have changed as more women have entered into neurosurgery, to identify the at-risk period for attrition, and to analyze alternative career paths to improve our recruitment and retention strategies.

## Methods

Public databases from the American Association of Neurological Surgeons (AANS) and the American Board of Neurological Surgery (ABNS) with information for all residents who matched into neurosurgery during the years 2000–2009 were obtained. Only US and Puerto Rico residents were included. Residents were sorted by female gender and then matched against graduation records. If graduation was not reported from neurosurgery residency programs, an Internet search was used to determine residents' alternative career choice. Postgraduate year (PGY) of attrition was determined by the end dates reported by resident programs. Junior residents were defined as PGY-1 to PGY-3; senior residents were defined as PGY-4 and above. Relative risk was calculated to determine the relative probability of attrition for female residents, with  $p < 0.05$  considered statistically significant.

## Results

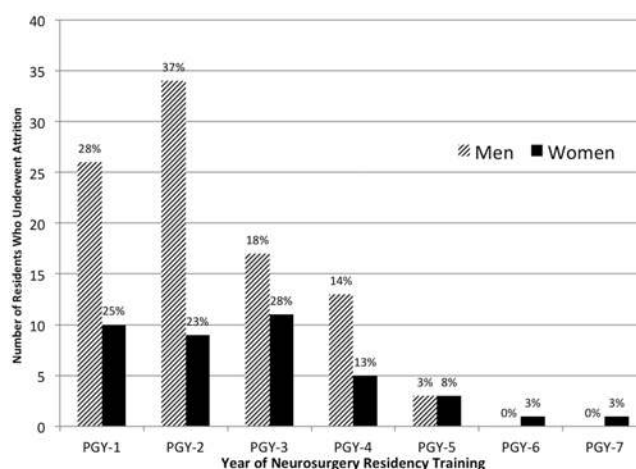
Of the 1992 residents who matched into neurosurgery between 2000 and 2009, 240 (12%) were women. The annual number of women who matched ranged from 11 to 37, with a trend toward increasing numbers of women matching in the later years of the decade (Fig. 1). The overall attrition rate, regardless of sex, was 6.7% (133/1992 matched residents). In regard to retention of women in training, 40/240 (17%) of women underwent attrition, 2 of whom died prior to residency completion. This is significantly greater than the 93/1750 (5.3%) of men who did not com-



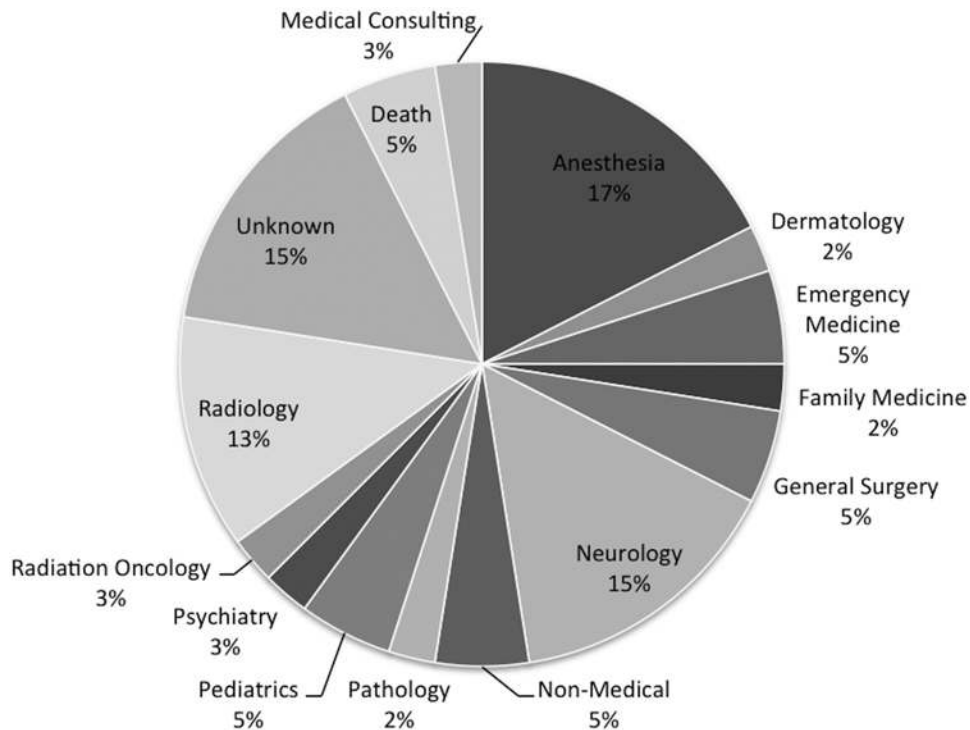
**FIG. 1.** Graph showing number of female neurosurgery residents matched by year for the cohort of residents from 2000 to 2009. The overall trend for the years 2000–2009 was an increasing number of female neurosurgery residents matched, nearing an average of 30 female residents per year toward the later part of the decade.

plete residency (RR 3.14, 95% CI 2.22–4.43,  $p < 0.0001$ ). Although the raw data indicate that more men undergo attrition, women are 3 times as likely to undergo attrition compared with male residents. Regardless of sex, attrition occurs primarily during the junior training years (PGY-1 to PGY-3) as compared with senior residents (76% vs 24%, respectively, in women and 83% vs 17% in men) (Fig. 2). Breakdown by year for women showed loss of 19 residents in PGY-1 and -2 combined; 11 in PGY-3; 5 in PGY-4; 3 in PGY-5; and 1 each in PGY-6 and -7. The 2 programs with the highest rate of attrition were also programs that were in the top 10 for greatest number of women matched in the decade.

After leaving residency, the majority of women stayed



**FIG. 2.** Bar graph showing attrition numbers organized by sex and year of training for neurosurgery residents during 2000–2009. Most attrition occurs early in residency, during the junior years of PGY-1 to PGY-3 for both sexes. When comparing junior to senior residents, 3 times as many women left neurosurgery during their junior training years (PGY-1 to PGY-3) compared with senior residents. Almost no residents left training during their chief year.



**FIG. 3.** Chart showing alternative careers pursued by women who left neurosurgery residency programs. The majority of women stayed in the field of medicine and went on to complete residencies in other disciplines. The most common fields pursued were anesthesia, neurology, and radiology. Almost one-third of women stayed within the field of neuroscience, becoming neuroradiologists, interventional neuroradiologists, or neurologists.

in medicine (73%) and went on to pursue other disciplines (Fig. 3). Although a variety of specialties were pursued, the most common residencies completed were anesthesia (N = 7, 17%), neurology (N = 6, 15%), and radiology (N = 5, 13%). Nearly one-third of women pursued careers in the neurosciences as neuroradiologists, interventional neuro-radiologists, or neurologists. A minority of women, 2 (5%), chose nonmedical careers. Of the two women known to have left medicine, one became a stay-at-home mother and the other went into photography. The career choice for 6 (15%) women who left neurosurgery could not be determined.

## Discussion

In 2008, Benzil et al. published a landmark white paper that outlined goals adopted by the AANS and WINS (Women in Neurosurgery) for the recruitment and retention of women in neurosurgery. These goals included women comprising 20% of each class entering neurosurgical residency by the year 2012 and women comprising 20% of all neurosurgery faculty by the year 2020. The authors recommended regular assessment of the progress toward these goals and adjustment of efforts as required to achieve these goals.<sup>4</sup> The current manuscript details the embarkation and journey of women neurosurgery residents who matched between 2000 and 2009. We compare these data to the prior decade to establish trends, monitor attainment of stated goals, and project the future timing and feasibility of accomplishing these goals. In conjunc-

tion with the recently published cohort of women in neurosurgery from 1990 to 1999, this study details a 20-year period describing the trends for enrollment and retention of women in neurosurgery.<sup>19</sup>

The number of women who matched in neurosurgery increased from 146 of 1361 residents (10.7%) during the 1990s to 240 of 1992 (12%) during the 2000s. Although a small overall increase by decade, the number of women matching into neurosurgery appears to be increasing with time. By the end of this past decade, women accounted for almost 16% of incoming residents (AANS data). This held steady, with women accounting for 15.5% (32/206) of incoming neurosurgery residents in the 2013 match (AANS data). Surpassing 15% of total residents is a significant accomplishment; population studies have cited this as the critical mass necessary within a group for the minority to function as a group rather than a subset of isolated individuals.<sup>11</sup> Retention of women also improved; 111/146 women graduated from residencies during the 1990 cohort (76%) compared with 200/240 in the 2000s cohort (83%), decreasing attrition rates from 24% to 17% over the last decade. Retention also improved for men: 1059/1215 (87.2%) completed residencies during the 1990 cohort compared with 1657/1750 (94.7%) during the 2000s cohort. It is important to note that the 2008–2009 cohorts have not yet finished their last years of residency.

The attrition rate for women in neurosurgery (17%) is comparable to that reported for general surgery, although higher than that of most surgical subspecialties. A recent study reported an 11% attrition rate from surgical subspe-

cialties including urology, otolaryngology, plastic surgery, neurosurgery, and orthopedics over a 6-year period.<sup>1</sup> The rate of attrition for general surgery has been reported to range from 17% to 26% during the past 2 decades.<sup>10,17</sup>

Women who leave neurosurgery tended to stay in medicine and to complete residencies in related disciplines (Fig. 3). The most frequently chosen residency was anesthesia (17%), which in conjunction with radiology is a trend also seen following attrition from general surgery training.<sup>30</sup> Our study demonstrated that a significant number of women remained within the neurosciences, pursuing neurology (15%) or neuroradiology (12%). We are aware of only 2 women who left medicine for other pursuits.

Women neurosurgery residents appear to be most at risk for attrition early in their residency training, again noting that those in the 2008–2009 cohort are still completing the last years of their residency. The majority of female residents (76%) withdrew as junior residents, as compared with senior residents (24%), which is a trend mirrored in men as well (Fig. 2). These data are concordant with a national prospective study of general surgery residents which reported that attrition occurred predominantly in the first and second years of training (76%). In that study, residents in the attrition group expressed dissatisfaction with their program, had concerns about length of training and work-life balance, and perceived deficits in their operative skills. Gender was not predictive of attrition in this study.<sup>27</sup> Our study was based on database information and did not attempt to ascertain reasons for attrition. Previous single-institution attrition studies in general surgery demonstrate that women are up to twice as likely to leave surgical training as men. However, these studies were descriptive, and institutional characteristics were likely to influence attrition. Regardless, lifestyle considerations were regarded as the main reason for attrition among women.<sup>2,10</sup> Despite the implementation of the 80-hour work week, more residents, both male and female, are leaving surgery than before, and lifestyle considerations are the main reason;<sup>12</sup> studies cite a declining interest in entering specialties with uncontrolled lifestyles.<sup>18</sup> These studies implicate work-life balance as very important to the current generation of surgical trainees, regardless of sex. Neurosurgical training will probably have to continue to evolve to accommodate these stated needs of the current generation,<sup>26</sup> and some degree of flexibility in career structure may have to be considered.<sup>7</sup>

The reason for attrition reported in this study is probably multifactorial, and future studies are needed to determine the cause of attrition and strategies for retention. This is necessary to maintain a stable neurosurgical workforce. A strong consideration for intervention is suggested by multiple studies that cite the importance of mentors for female residents even more than for their male counterparts.<sup>5,15,21,28,29</sup> Data on the recruitment of women into underrepresented specialties, such as orthopedics and general surgery, also stress the importance of female mentorship and ameliorating a perceived gender bias in these fields.<sup>13,14,23</sup> Female medical students are more likely than males to enter programs with a higher proportion of female residents. This is an association notable in neurosur-

gery as well as diagnostic radiology, general surgery, internal medicine, pediatrics, urology, and otolaryngology.<sup>15</sup>

To address this critical factor in the recruitment and retention of female neurosurgical residents, WINS codified their mentorship program in the early 2000s as a way to connect with other women in the field and to foster mentorship between female faculty mentors and medical students. This program has grown to include both sexes, with 260 mentorship pairings since 2010. This effort is being further expanded into an encompassing AANS-sponsored mentorship program to pair mentors with premedical students, medical students, residents, fellows, and young faculty. In addition, mentorship efforts seem to improve recruitment. Our data show that 8 of the top 10 programs for recruitment of women had low numbers of female attrition, supporting mentorship as an important factor in retention.

The next step to continue fostering success among women neurosurgery residents entails identifying risk factors for attrition. Predicting individual risk for attrition is difficult, but several studies have attempted to identify key elements to a resident's success. A study by Bell et al. surveyed personality traits of residents, compared them with attrition data, and found that characteristics such as an independent desire for knowledge, a commitment to the service of others, and a view of the world with a sense of direction and purpose were predictive of success in surgical residency.<sup>3</sup> Passion and perseverance for long-term goals appears to be a marker for success and protective against attrition.<sup>8</sup>

Awareness of individual resident learning styles is another tool to improve resident retention and maximize effective training. We should no longer think of resident education as a "one size fits all" model, but recognize that different subgroups, including women, may learn and interact in different ways.<sup>16,20,22,25</sup> For instance, learners who overgeneralize criticism may conflate educational failure (i.e., an incorrectly answered question) with personal failure.<sup>16</sup> Positive reinforcement may be beneficial for such learners, to prevent the potential for risk avoidance and failure to gain needed experience. Faculty educators can enhance the resident educational experience by recognition that generational, cultural, and gender gaps may influence individual learning styles.

Limitations of our study include its retrospective nature in the face of changes in neurosurgical ownership of the intern year, and the length of training in comparison with the recent nature of these data. Actual outcomes may vary slightly from our reported data, because prior to 2009 many neurosurgery residents did not match as categorical neurosurgery residents and underwent an intern year in general surgery. Attrition of those who intended to become neurosurgery residents during their general surgery intern year may not be accurately captured within our data. Additionally, those who matched in 2008 and 2009 are currently finishing their final year of training, and it is still possible that these residents may not complete training. However, based on our cohort, the rate of attrition this late in training is extremely low and would not significantly alter our reported results.

The initial phase of the goals outlined by the WINS

white paper includes gathering data to understand the extent of the disparity between men and women in neurosurgery.<sup>4</sup> Our data suggest that the recruitment of women has improved in the past decade, albeit marginally when compared with the percentage of eligible women, and attrition of female residents reached 17%. Organized neurosurgery should make it a priority to understand the attrition of any resident who makes it through the competitive process of medical school and the neurosurgery match, particularly any group whose attrition is disproportionate. Such a study would probably lead to global improvement in many aspects of residency training, early career satisfaction, and resident success. Such data will be useful for improving the retention of all trainees.

## Conclusions

The number of women matching into neurosurgery is slowly increasing over time, reaching 15.5% in 2013, along with an improved retention rate of neurosurgical residents when compared with prior decades. Gender disparity still exists in retention of neurosurgical residents, and the percentage of women entering neurosurgical residency is disproportionate to the number who are eligible. Women who left the field most often pursued alternative careers in the clinical neurosciences such as neurology and neuroradiology. Understanding trends regarding women in neurosurgery over time helps to set a benchmark for progress in recruiting and retaining talented applicants into neurosurgery for the future betterment and diversity of the field.

## Acknowledgment

We thank Chris A. Phillips from the AANS for her expertise in accessing and filtering the databases of matched resident information.

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### Disclosure

Dr. Pilitsis is a consultant for Medtronic, St. Jude, and Boston Scientific, and received grant support from these companies, as well as NIH Grant No. 1R01CA166379.

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Conception and design: Wolfe, Rodriguez. Acquisition of data: Wolfe, Renfrow, Rodriguez, Liu. Analysis and interpretation of data: Wolfe, Renfrow, Rodriguez, Liu. Drafting the article: Wolfe, Rodriguez, Liu. Critically revising the article: Wolfe, Pilitsis, Samadani, Ganju, Germano, Benzil. Reviewed submitted version of manuscript: Wolfe, Renfrow, Pilitsis, Ganju, Germano, Benzil. Approved the final version of the manuscript on behalf of all authors: Wolfe. Statistical analysis: Wolfe, Renfrow.

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