

Diversification in the Medical Sciences Fuel Growth of Physician-Scientists:

Association of American Physicians 2019 Presidential Address

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Introduction

It has been a privilege and pleasure to serve as the 2018-2019 President of the Association of American Physicians (AAP). This venerable organization was founded October 10, 1885 by William Osler (President 1885), William Pepper (President 1891), William Draper (President 1888), Francis Delafield (President 1886), James Tyson (President 1908), Robert Edes and George Peabody, who was joined by William Welch (President 1886) at the first meeting of this organization in Washington, D.C. in 1886 for the “advancement of scientific and practical medicine” (1). Under Linda Fried (President 2016), the goals of the AAP were further articulated as to “inspire the full breadth of physician-led research across all fields of science related to medicine and health, and to build a community of physician scientists in support of the principle that objective science and evidence are essential foundations for improving patient care and the health of Americans” (1). Additional key goals of the AAP include election honoring physicians who have made outstanding and enduring contributions to medical science across all spectrums of specialties, and to hold an annual meeting in which to meet, interact, and exchange information. The AAP now has more than 2300 elected members of which 1700 are active and 600 are emeritus (triggered by ≥ 75 years of age beginning in 2019), with 60 new members elected annually (moving to up to 70 new members in 2020). The AAP spawned the American Society for Clinical Investigation (ASCI) in 1907 and helped spawn the American Federation for Clinical Research (AFCR) in 1940. Beginning in 1940, tri-society meetings were held. In more recent years, the Joint Meeting programming is contributed by AAP, ASCI and the American Physician Scientist Association (APSA). All three societies have an entrenched vested interest in furthering the physician-scientist and the knowledge generated to continue to improve patient care (2).

AAP and Diversification

The AAP has grown more diverse over time. As of 2019, there are now over 200 women members of the organization. At the leadership level, there have been 6 women AAP Presidents: Helen Ranney (1985), Judith Swain (2007), Cricket Seidman (2015), Linda Fried (2016), Serpil Erzurum (2017) and Mary Klotman (2019). There has now been 1 President from a historically underrepresented group (John Carethers, 2018). Further, the AAP has over 90 foreign members from 19 countries. Elected member specialties have also diversified. In the early days, members were largely internists with interest in pathology who operated large practices. Early in the 20th century, elected membership shifted towards full-time university physicians. By the 1930's, elected membership was being drawn from physicians conducting basic and clinical research. Over the past several decades, elected membership has moved to a wide variety of specialties that include internal medicine, pathology, pediatrics, general surgery and its subspecialties, neurosurgery, orthopedic surgery, dermatology, otolaryngology, urology, emergency medicine, obstetrics/gynecology, ophthalmology, radiation oncology, neurology, psychiatry, anesthesiology, and others. AAP diversification has accelerated in recent times due to conscious evaluation of qualified individuals by an energetic AAP Council. It has been my outstanding pleasure to work with such a talented group of individuals before, leading up to, and during my Presidential year. Lori Ennis, AAP's Executive Director, is the most facile person (ever) to keep AAP running strong. The 2018-2019 AAP Council consisted of: Mary Klotman (infectious diseases), Mitch Lazar (endocrinology), Peter Igarashi (nephrology), Robert Brown (neurology), Paul Noble (pulmonology), Maurizio Fava (psychiatry), David Ginsburg (genetics), Todd Golub (pediatric oncology), Nancy Davidson (medical oncology), John Ioannidis (metascience), Dan Kelly (metabolic cardiology), Warren Leonard (molecular immunology), Elizabeth McNally (cardiology and genetics), David Thomas

(infectious diseases), and Anna Huttenlocher (pediatric rheumatology). With myself and Robert Brown coming off of the Council for 2019, this esteemed Council group will be joined by Juanita Merchant (gastroenterology) and Jeff Rothstein (neurology).

Diversity of the Biomedical Workforce

Data from the U.S. Census Bureau show diversification of the scientific workforce. Changes from 1990 to 2014 show that there is a marked increase in the private sector biomedical workforce, with slight increases in the public sector and with relative shrinkage of the biomedical workforce in academia (3). The private sector, which includes biotechnology firms, hospitals, and pharmaceutical companies, pay higher average salaries than academic positions (and is a likely driver for that growth). The majority of the biomedical workforce is under 45 years of age, ranging from 64% in 2002 to 55% in 2013 (3). This young biomedical workforce often has children at home, with 82% of married researchers age 40-49 years having children in their household (3). Women in the workforce often have an employed spouse as compared to men, and men from ages 30-39 years are 7 times more likely to have a non-working spouse (3). From 1990 to 2014, biomedical scientists have grown from 27,500 in number to over 69,000. Increasing proportions of biomedical scientists are from diverse backgrounds, with growth of Asians from 12% to 34%, Blacks from 1% to 2%, and other backgrounds from 2% to 6% (3). Comparing 1990 to 2014, the percentage of naturalized citizens in the biomedical workforce has grown from 8% to 18%, and the percentage of non-citizens conducting biomedical research has grown from 14% to 34% (3).

Although there have been gains overtime for minority men and women in the biomedical workforce, the distribution gets smaller among minority persons with advancing higher education degrees. Minority men and women make up 20% of the 726,000 first time freshmen in science and engineering, but only 17% of the 452,000 with Bachelor's Degrees in science and engineering, and only 10% of 145,000 advanced degrees in science and engineering (4). The NIH-funded biomedical workforce portfolio shows a similar picture between minorities and NIH funding. White females with advanced degrees are underrepresented whereas White female post docs and White males with research project grants (RPG) or R01s are overrepresented relative to the labor market (5). Black males and females with Bachelor's and advanced degrees are underrepresented, and those with RPGs or R01s are woefully underrepresented relative to the labor market (5). Asian males and females are overrepresented with Bachelor's and advanced degrees, but underrepresented relative to the labor market for holders of RPGs and R01s (5). Hispanic males are about on par regarding K awards, RPGs and R01s, but Hispanic women are underrepresented for RPGs and R01s (5).

The pipeline for developing physician scientists is good, with challenges for racial and ethnic diversity. Medical Scientist Training Programs (MSTPs) have graduated nearly 10,000 MD-PhD students since 1975, with a total of 356 (3.7%) Black and 386 (4%) Hispanic students (6). The percentage of women in MSTPs have grown from 15.7% (1975-1984) to 36.7% (2005-2014) (6) but has not yet reached the level of 50% women observed for regular MD programs. The percentage of Hispanics in MSTPs have grown from 0.8% (1975-1984) to 6.2% (2005-2014), and there is no data released for Blacks in MSTPs since the numbers are low (6). This is highly relevant for minority men and women because overall, MSTP students in the long run do well in terms of competing for grants and MSTP could be a pipeline for future diverse faculty. Between 1980-1989, MSTPs who applied for R01 or equivalent grants had an 80% success rate, and between 1990-1999 a 63% success rate, much higher than non-MD-PhDs (6). While the underrepresented minority population in the U.S. continues to rise as a

percentage of the population, the underrepresented minority matriculants to medical schools is flat (7).

These medical school diversity pipeline issues extend into specialty training. For instance, while Blacks and Hispanics make up 13% and 18% of the U.S. population respectively, they make up only 6% and 8% of all residents and fellows, 4% and 5% of practicing physicians, 4% and 5% of oncology fellows, and 2% and 3% of practicing oncologists (8). Within the subspecialty of gastroenterology from 2010-2017, the percentage of underrepresented in medicine applicants to fellowship fell from 14.3% to 12.1%, and there has been no change in the percentage of matriculated Hispanic, Black or Native American gastroenterology fellows (9).

There has also been no change in the percentage of underrepresented in medicine gastroenterology faculty; collectively as a group they are <10% of faculty from 2010-2017, with no increase over time (9). This observation extends to multiple other specialties. In evaluation of 16 medical specialties (internal medicine, pediatrics, surgery, psychiatry, radiology, obstetrics/gynecology, anesthesia, neurology, family medicine, pathology, emergency medicine, orthopedics, ophthalmology, otolaryngology, physical medicine & rehabilitation, dermatology) from 1990 (52,939 faculty) compared to 2016 (129,545 faculty), assistant professor Hispanic males and females are underrepresented in all 16 specialties at that faculty level relative to the U.S. Census, with trends over time towards greater representation (10). Assistant professor Black males and females are underrepresented in 15 specialties relative to the U.S. Census (the exception being obstetrics/gynecology), with representation trends worsening for internal medicine, pediatrics, surgery psychiatry, radiology, anesthesia, neurology, emergency medicine, orthopedics and ophthalmology (10). Assistant professor White females are underrepresented in internal medicine, surgery, radiology, emergency medicine, and orthopedics relative to the U.S. Census, and assistant professor White males and Asians are overrepresented in several specialties (10). More troubling is that at the associate and full professor levels, Blacks and Hispanics are more underrepresented as faculty in 2016 than 1990 relative to the U.S. Census (10). While there are challenges with the pipeline of diverse faculty, there are observed disparities with promotion and retention of diverse faculty. Based on the AAMC Faculty Roster from 2003 to 2006 for four specialties (surgery, internal medicine, pediatrics, and obstetrics/gynecology), the 10-year promotion rates for Black assistant professors to associate professor was statistically markedly lower compared to Whites, Asians, and Hispanics for all four specialties (11). Promotion from associate to full professor was equivalent across all racial/ethnic groups in the four specialties (11), suggesting that once a faculty member was more senior and invested in, their promotion to full professor is on equal footing. Retention rates over 10 years, the ability to keep a faculty member at one's institution, was also disparate across racial/ethnic groups. White assistant professors in surgery and internal medicine and White associate professors in internal medicine had statistically higher retention rates over other racial/ethnic groups, and Black assistant professors in pediatrics had the lowest statistical retention rates compared to other racial/ethnic groups (11).

Research Funding and Challenges to Overcome for the Diverse Medical Workforce

Once a faculty member gets through the pipeline, promotion, and retention challenges, what is the success of NIH funding, a key milestone for physician-scientists as faculty members? Data from the NIH indicate growth from 2016 to 2018 in the number and total amount of awards, with success rates for RPGs at 20.2% for 2018 (12). In particular, those who held K awards have a 24% increased likelihood of obtaining an RPG over those who were

not ever awarded a K award (12). In analysis of dermatology faculty, trends from 2009-2014 show a slight uptick in R01s awarded to PhD faculty, a slight downtick for MD-PhD faculty, and a more marked downtick for MD only faculty (13). The number of R01 awards to male and female dermatology faculty were steady from 2009-2014; however, men held 73% of all grants compared to 27% for women (13). In evaluation of trends from 2009-2016 for NIH funding, the number of funded scientists increased 2-5% per year, with a higher proportion of awards going to experienced investigators (increasing from 52% in 2009 to 60% in 2016) and a smaller proportion to early-stage investigators (ESIs, those within the timeframe from training, dropping from 18.8% to 16.2%) and new investigators (NIs, those receiving first RPG but not ESIs, dropping from 28.4% to 23.1%) (14). The overall success rate for 24,545 grant applicants in 2016 was 5,577 awards, or 23% of applicants (14). The funding rate for ESIs did mirror the funding rate for experienced investigators from 2009-2016, with NIs training tracking about 7% below both (14). The average age of the investigator to receive the first R01 is increased from 39 years in 1990 to 44.2 years in 2016, and to receive a second R01 is increased from 43 years to 46.9 years (14). The age trend was not different between men and women; however, underrepresented minorities tended to be slightly older than majority awardees (14). Overall, there was no major difference in the RPG funding rate between men and women from 2002-2016; however, women only make up 29% of the applicants and only one-quarter of the awardees (14). In contrast, there is a persistent 7.5% lower funding gap rate for underrepresented minorities as compared to majority RPG applicants from 2002-2016, and underrepresented minorities making up only 2.8%, 2.1%, and 1.0% of the ESI, NI and experienced investigators, respectively (14). The probability for R01 funding was lowest for Black NIH applicants who ranged 5-10% lower than any other racial/ethnic group between 2000-2006 (15-17). Compared to White NIH applicants, the percentage change in R01 award probability was 27% lower for Black applicants for those who were previously on F32 or T32 training awards (17). The overall R01 award probability for Black NIH applicants was 16.6%, compared to 26.6%, 25.3%, and 28.7% for Asians, Hispanics, and Whites, respectively, from 2000-2006 (18). The R01 award probability remained lower for Black men and women irrespective of whether the applicant's degree was PhD or MD (18). Comparing 1054 matched pairs of applicants for R01 grants between 2010-2015, White applicants had 46.7% proposals not discussed, 37.5% proposals discussed but not funded, and 15.8% proposals discussed and funded, compared to 55.1% not discussed, 33.2% discussed but not funded, and 11.7% discussed and funded for Black applicants (15). The data highlighted a disparity, demonstrating a deficit of 133 awards that should be awarded to Black applicants to reach parity with White applicants (15).

My Own Pathway to Becoming a Physician-Scientist

I was fortunate to have nurturing parents that despite not having the financial means, pushed higher education on all 12 of their children (19). During my undergraduate education where I had a strong desire to apply for medical school, I had no real lab experiences. After my first year in medical school, I was fortunate to have research laboratory exposure that piqued my interest in academia and research (and my first research publications), followed by 4th year electives in a research laboratory (19). During residency, there was minimal time to conduct research, but specific role models steered and solidified my thinking towards an investigative career. After applying to fellowship programs that held T32 grants, and after evaluating one potential mentor who introduced me to my ultimate research mentor, I began a research focus in colorectal cancer, was mentored in grant and manuscript writing, and approaches to answer patient-oriented scientific questions. I spent 5 years in my research mentor's laboratory to gain

a footing in research (19). Along the way, I also learned and was exposed to work-life balance approaches emulating from my mentor (and role model). Dually-applying for a VA Career Development Award as well as a K08 award saw both eventually awarded, with myself choosing the K08 as the pathway. With my “extended post-doc”, I was able to convert from a K08 to an R01 at age 37 years, with eventually subsequent awards over time via R01, T32, R24, U54, U01, and VA Merit mechanisms. With research funding and productivity, I was an assistant professor for 6 years and associate professor for 4 years before moving to full professor. In my experience, my mentors and role models looked at me as a potentially successful academic person and not specifically as an underrepresented minority and afforded me opportunities and lessons with hard work to succeed academically. Based on data presented earlier in this article, in many ways I defied the odds to eventually succeed in academia. This is despite not having very many others in faculty roles with similar racial/ethnic backgrounds.

Diversification Leads to Better Science

Is there data that even suggests that diversification leads to better science? In the business and education worlds, there is strong evidence the diversity improves innovation and outcomes. The author and academic Scott E. Page wrote from his research that “diverse groups of problem solvers outperformed the groups of the best individuals at solving complex problems. The reason: the diverse groups got stuck less often than the smart individuals, who tended to think similarly” (20). “Diversity in” does not automatically lead to “creativity out”; maximizing diversity’s benefits requires careful management, including having a positive climate, engaging managers, having non-hierarchical structures, and critical mass to effectualize diversifying knowledge outcomes, collective intelligence, diversifying research methods, and utilizing team expertise (21). In the biosciences, there is strong evidence that ethnic diversity enhances scientific impact (22). Data from over 6 million scientists and over 10 million published papers (examining their citations within 5 years) in 8 main and 24 subfields of science show that ethnic diversity had the strongest correlation with scientific impact (22). Ethnic diversity consistently outperformed the non-diverse regardless of the year of paper publication, the number of authors per paper, and the number of collaborators per scientists (22). Group ethnic diversity (e.g. diverse teams) trumped individual ethnic diversity, and ethnic diversity resulted in a 11% impact gain for papers and 48% impact gain for scientists when comparing the upper 90th percentile group versus the lower 10th percentile group (22).

There remain challenges to building diverse research groups. As mentioned above, the diversity physician-scientist pipeline is constrained and there are academic barriers to propel one to the level of a funded senior faculty. In many instances, life barriers are also in place due to issues of student debt, timing of starting a family, obligations towards caring for family members, exposure to science, and role models and mentorship (4). However, there are opportunities to AAP members as senior physician-scientists to provide opportunity to build diverse groups to produce high impact science and publications. AAP members should be a mentor and/or advisor to underrepresented minorities at any stage of their career, be it high school, undergraduate, medical school, residency, fellowship or faculty (23). AAP members should be great role models to show the importance of being a physician-scientist and the potential role that a faculty could potentially become over time. AAP members should invite underrepresented students to experience their research program and expose them to clinical medicine. AAP members should participate with students in programs that are geared towards research exposure to underrepresented students, such as NIH CURE and NIH R25-funded programs, and foster NIH research supplements that promote diversity (4,23). AAP members

can specifically pay attention to junior underrepresented faculty at their institutions and help guide them through milestones to become senior faculty (23). I am grateful that my research mentor, an AAP member, provided much-needed guidance particularly at the beginning of my academic career, and I also provide that same guidance to a new generation of diverse students and junior faculty.

I look forward to the next 100 years of outstanding science and the AAP as both will fuel the growth of diverse physician-scientists that will lead the way for discovery to improve care of our patients.

References

1. <https://aap-online.org>. Accessed April 1, 2019.
2. Carethers JM, Coughlin S, Diamond B, Erzurum S, Fried L, Jameson JL, Kaushansky K, Klotman M, Lemon S, Mitchell B, Rothman P, Sayers C, Seidman C, Somlo S. AAP Position Statement: The imperative to invest in science has never been greater. *J Clin Invest* 2014;**124**:3680-3681.
3. Heggeness ML, Gunsalus KT, Pacas J, McDowell G. The new face of US science. *Nature* 2017;**541**:21-23.
4. Duncan GA, Lockett A, Villegas LR, Almodovar S, Gomez JL, Flores SC, Wilkes DS, Tigno XT. National Heart, Lung, and Blood Institute Workshop Summary: Enhancing Opportunities for Training and Retention of a Diverse Biomedical Workforce. *Ann Am Thorac Soc* 2016;**13**:562-567.
5. Heggeness ML, Evans L, Pohlhaus JR, Mills SL. Measuring diversity of the National Institutes of Health-Funded Workforce. *Acad Med* 2016;**91**:1164-1172.
6. Harding CV, Akabas MH, Andersen OS. History and Outcomes of 50 Years of Physician-Scientist Training in Medical Scientist Training Programs. *Acad Med* 2017;**92**:1390-1398.
7. Cohen JJ, Gabriel BA, Terrell C. The case for diversity in the health care workforce. *Health Affairs* 2002;**21**:90-102.
8. Winkfield KM, Flowers CR, Patel JD, Rodriguez G, Robinson P, Agarwal A, Pierce L, Brawley OW, Mitchell EP, Head-Smith KT, Wollins DS, Hayes DF. American Society of Clinical Oncology Strategic Plan for Increasing Racial and Ethnic Diversity in the Oncology Workforce. *J Clin Oncol* 2017;**35**:2576-2579.
9. Carethers JM, Quezada SM, Carr RM, Day LW. Diversity within US Gastroenterology Physician Practices: The Pipeline, Cultural Competencies, and US Gastroenterology Societies Approaches. *Gastroenterol* 2019;**156**:829-833.
10. Lett LA, Orji WU, Sebro R. Declining racial and ethnic representation in clinical academic medicine: A longitudinal study of 16 US medical specialties. *PLoS One* 2018;**13**:e0207274.
11. Abelson JS, Wong NZ, Symer M, Eckenrode G, Watkins A, Yeo HL. Racial and ethnic disparities in promotion and retention of academic surgeons. *Am J Surgery* 2018;**216**:678-682.
12. <https://nexus.od.nih.gov/all/2019/04/02/association-between-receiving-an-individual-mentored-career-development-k-award-and-subsequent-research-support/>. Accessed April 2, 2019.
13. Cheng MY, Sukhov A, Sultani H, Kim K, Maverakis E. Trends in National Institutes of Health Funding of Principle Investigators in Dermatology Research by Academic Degree and Sex. *JAMA Dermatol* 2016;**152**:883-887.
14. Nikaj S, Roychowdhury D, Lund PK, Matthews M, Pearson K. Examining trends in the diversity of the U.S. National Institutes of Health participating and funded workforce. *FASEB J* 2018;**32**:6410-6422.
15. Mervis J. Mentoring's moment. *Science* 2016;**353**:980-982.
16. Ginther DK, Schaffer WT, Schnell J, Masimore B, Liu F, Haak LL, Kington R. Race, ethnicity, and NIH research awards. *Science* 2011;**333**:1015-1019.
17. Ginther DK, Haak LL, Schaffer WT, Kington R. Are race, ethnicity, and medical school affiliation associated with NIH R01 type 1 award probability for physician investigators? *Acad Med* 2012;**87**:1516-1524.

18. Ginther DK, Kahn S, Schaffer WT. Gender, Race/Ethnicity, and National Institutes of Health R01 Research Awards: Is There Evidence of a Double Bind for Women of Color? *Acad Med* 2016;**91**:1098-1107.
19. Carethers JM. GRG Profiles: John M. Carethers. *Dig Dis Sci* 2016;**61**:1429-1435.
20. Page SE. *The Diversity Bonus: How Great Teams Pay Off in the Knowledge Economy*. Princeton University Press, 328 pp, 2017.
21. Neilsen MW, Alegria S, Börjeson L, Etzkowitz H, Falk-Krzesinski HJ, Joshi A, Leahey E, Smith-Doerr L, Woolley AW, Schiebinger L. Gender diversity leads to better science. *PNAS* 2017;**114**:1740-1742.
22. AlShebli BK, Rahwan T, Woon WL. The preeminence of ethnic diversity in scientific collaboration. *Nature Communications* 2018;**9**:5163.
23. Carethers JM. Facilitating minority medical education, research, and faculty. *Dig Dis Sci* 2016;**61**:1436-1439.