Society for Maternal-Fetal Medicine
High-risk pregnancy experts

SMFM Special Statement

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Research to knowledge: promoting the training of physician-scientists in the biology of pregnancy

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Common disorders of pregnancy, such as preeclampsia, preterm birth, and fetal growth abnormalities, continue to challenge perinatal biologists seeking insights into disease pathogenesis that will result in better diagnosis, therapy, and disease prevention. These challenges have recently been intensified with discoveries that associate gestational diseases with long-term maternal and neonatal outcomes. Whereas modern high-throughput investigative tools enable scientists and clinicians to noninvasively probe the maternal-fetal genome, epigenome, and other analytes, their implications for clinical medicine remain uncertain. Bridging these knowledge gaps depends on strengthening the existing pool of scientists with expertise in basic, translational, and clinical tools to address pertinent questions in the biology of pregnancy. Although PhD researchers are critical in this quest, physician-scientists would facilitate the inquiry by bringing together clinical challenges and investigative tools, promoting a culture of intellectual curiosity among clinical providers, and helping transform discoveries into relevant knowledge and clinical solutions. Uncertainties related to future administration of health care, federal support for research, attrition of physician-scientists, and an inadequate supply of new scholars may jeopardize our ability to address these challenges. New initiatives are necessary to attract current scholars and future generations of researchers seeking expertise in the scientific method and to support them, through mentorship and guidance, in pursuing a career that combines scientific investigation with clinical medicine. These efforts will promote breadth and depth of inquiry into the biology of pregnancy and enhance the pace of translation of scientific discoveries into better medicine and disease prevention.

The field of maternal-fetal medicine, like other clinical specialties, is supported by a strong foundation in various scientific disciplines. Disciplines within this field include physiology, developmental biology, genomics and epigenomics, cellular and molecular biology, pharmacology, endocrinology, engineering, informatics, epidemiology, and health services research. Physician-scientists, who are trained to translate basic and applied sciences into clinical medicine, thus linking the bench to the bedside, should lead the way in harnessing these disciplines to forward our understanding of disease pathogenesis, diagnostics, therapy, and prevention.

Because a single, broadly accepted definition of a physician-scientist is lacking, precise information about the number of obstetrics and gynecology academics who are seriously engaged in clinical, translational, or basic research is imprecise. However, objective indicators and opinions suggest that compared with other clinical disciplines, the field of obstetrics and gynecology, including perinatal medicine, is not a highly sought-after training field among students who seek professional careers as physician-scientists.[1-3] Deans and other thought-leaders in schools of medicine commonly view the obstetrics and gynecology specialty as an essential service to the community and, in some instances, a potential source of revenue. Moreover, women's health issues remain relatively underfunded by the National Institutes of Health (NIH) and other funding agencies. For example, recent data from Blue Ridge Institute for Medical Research point to obstetrics and gynecology as one of the lowest among medical school clinical departments in medical school funding, receiving only 1.1% of the total funding in 2016, behind medicine, psychiatry, pediatrics, pathology, neurology, surgery, and ophthalmology.[4] The NIH grant success rate in 2016 suggests a similar trend, with obstetrics and gynecology, orthopedics, surgery, and family medicine scoring among the worst of all major clinical departments.[5] Consequently, graduates of MD-PhD programs frequently prefer to pursue investigation in other fields, including neurobiology, cancer, cardiovascular biology, and diabetes, using knowledge applied to clinical fields such as medicine, pathology, pediatrics, neurology, psychiatry, and radiology. An evaluation of data from NIH-funded Medical Scientist Training Programs from 2004

through 2008 indicates that among residency programs with at least 1000 positions nationally, the most commonly selected residencies for program graduates were internal medicine (25%), pathology (10%), and pediatrics (10%), and the least frequently selected were family medicine (0.3%), obstetrics and gynecology (1%), and emergency medicine (1.1%).[6] In similar observations using data collected in 2007 from directors and administrators of 25 selected MD-PhD programs, the smallest fraction of program graduates selected obstetrics and gynecology (1.2%), emergency medicine (0.4%), or physical medicine and rehabilitation (0.3%) for their future careers.[7] This can be explained, at least in part, by the "surgical" nature of the field, which has been less attractive to academics seeking to combine protected time for research with patient care. Additionally, the field requires an intense residency training and a challenging postresidency workload and long hours.[8,9] Taken together, all of these factors may dissuade junior scholars from selecting obstetrics and gynecology as a specialty.

The identification of early human development as the origin of chronic diseases has highlighted the critical role of pregnancy in shaping short- and long-term health and wellness, including cardiovascular disease, diabetes, and obesity.[10-12] Additionally, some processes are influenced at the level of female and male germ cells even prior to pregnancy.[13,14] Stem-cell biologists infer consequences of tissue engineering and regeneration from knowledge gained in embryology. Communicable disease experts have gained insight into the importance of sexual transmission of pathogens. Researchers in the field of aging have a better grasp of the significance of pelvic floor health as a component of healthy aging. Clinicians, advocacy groups, and policymakers now appreciate that the path to precision and personalized medicine starts with deciphering gender differences in pathophysiology, diagnostic approaches, and response to drugs. These advances shine a different light on obstetrics and gynecology as a discipline and position it, along with reproductive sciences, as central to human health and wellness. In perinatal sciences and medicine, where we strive to understand how adverse events during the most plastic period of human development imprint dramatic, long-term changes in fetal and maternal disease risk, and where exposures such as unrecognized viral infections during pregnancy pose epidemic, lifelong risks to large human populations, the potential for meaningful research is immense. These new investigative directions have been advanced by the introduction of high-throughput tools and the development of technology to noninvasively probe and diagnose many genetic disorders and link genomic data to population data. Finally, funders such as the NIH, March of Dimes, and the Bill and Melinda Gates Foundation offer new resources to tackle vexing challenges in placental health and preterm birth and support pioneering approaches to a healthier start in low- and middle-income communities and countries.

The field of perinatal biology and medicine will greatly benefit by an expansion of its scientific workforce, primarily by physician-scientists who are trained to bridge clinical challenges with investigative tools and who will promote scientific curiosity among clinical colleagues. Attempts to attract MD-PhDs to any field will require a culture change in medical schools, which is a lengthy process with unclear prospects of success. Furthermore, in the absence of a strong emphasis on research during the obstetrics and gynecology residency and a reduction in the requirement for research in the maternal-fetal medicine fellowship from 18 to 12 months, the opportune time to enlist maternal-fetal medicine scholars who seek training in scientific investigation is likely to be the early faculty stage. Although postdoctoral T32 training may be available to maternal-fetal medicine fellows, limited programmatic resources from the NIH and host departments diminish participation in this program. The National Association of MD-PhD Programs Executive Committee recommendation[15] to shorten the total training time for physician-scientists seems relevant to disciplines in which the physician-scientist workforce includes many MD-PhDs, but less relevant to our field, which relies heavily on the late training of MD scholars who have completed their fellowship training and seek to embark on an academic career that emphasizes research. Our field, therefore, continues to depend on K-level career development grants and similar non-NIH training mechanisms.

To better define the opinions of obstetrics and gynecology department leadership about the physician-scientist career path in our field, we conducted an electronic survey of department chairs in 2016. The survey was sent to 141 US and Canadian chairs of obstetrics and gynecology departments, and 59 responses were received (a 42% response rate). The majority (88%) reported having <10 faculty members with at least 50% of their time devoted to research. In addition, most chairs (52%) reported no access to mentor training, no mechanism for tracking mentoring activity (67%), and no specific credit for mentoring activities (78%). The majority of chairs (70%) also believed that research training grants add extra cost to the department that is not otherwise supported. However, the majority of chairs (93%) viewed research training grants as an investment in the future, with the expected time frame for return on this investment anticipated to be at least 3 years (86%).

The *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD), the major provider of training grants in the field of reproductive biology, invests in institutional and individual career awards, targeting scholars who have completed their fellowship training and seek further development as physician-scientists, usually at the assistant professor level. Institutional K12 programs include the Building Interdisciplinary Research Careers in Women's Health (BIRCWH) program, which is sponsored primarily by the Office of Research on Women's Health, NICHD, and other NIH institutes, provide mentored research training to clinicians and nonclinicians

who engage in basic, translational, behavioral, clinical, and/or health services research relevant to women's health or sex/gender issues. Another program is Women's Reproductive Health Research (WRHR), which provides mentored research training to obstetrics and gynecology junior faculty who are committed to an independent research career in women's reproductive health. These programs fund selected institutions across the country that recruit their trainees from a local and national candidate pool. Major advantages of these institutional K12 programs include the formation of a research community within each funded institution that has both individual and direct programmatic supervision and the more flexible funding support. An additional program in this K12 category is the Reproductive Scientist Career Development Program (RSDP), which is run by a single institution (currently Washington University in St Louis), and supports scholar training across the country. In contrast, individual K grants (eg, K08) require that each trainee is directly accountable to the NIH. Scholars are also directly subject to study section peer review. These factors are believed by many to encourage rigor in the application process, teach applicants how to navigate NIH review and resubmission processes, and provide direct experience with reviewer critiques.

The Foundation for the Society for Maternal-Fetal Medicine (SMFM) has sponsored a scholarship award since 1992. Its main goals have been to identify and attract promising scholars among maternal-fetal medicine trainees and junior faculty, stimulate their research interest, ensure excellent mentorship, protect and foster their career development, and nurture their intention to become productive and funded physician-scientists in the biology of pregnancy. Scholars were initially supported for only 1 year of training but this period was later extended to 2 years. In 2003, the Foundation for SMFM (at that time known as the Pregnancy Foundation) and the American Association of Obstetricians and Gynecologists Foundation (AAOGF), with support from the American Board of Obstetrics and Gynecology (ABOG), partnered to support a 3-year program designed to support the training of MD physician-scientists. Using the individual K-grant model, a national committee of maternal-fetal medicine physician-scientists oversees the program and the training of individual scholars. Unlike the NIH individual K award, the oversight committee provides close supervision of each trainee's progress, mentoring, and environmental support, which is more aligned with the supervision provided in institutional K12 programs or the RSDP.

In our attempt to assess programmatic success, we recently surveyed the 20 scholars who graduated from the Foundation for SMFM-AAOGF program from 1992 through 2015. The Table summarizes key information from 19 graduates who completed the survey. Recognizing that the number of trainees is small, reflecting the young age of the program, and that there is no single measure of success for such programs, we used several success metrics reported by others assessing NIH and other programs. As shown in the Table, most program graduates (68%) defined their professional position as academic. The majority (74%) indicated that they are still engaged in research. Although the level of engagement is difficult to define, more than one fourth of the graduates indicated that they are engaged in

TABLE
Academic and research advancement of Society for Maternal-Fetal Medicine/American Association of Obstetricians and Gynecologists Foundation scholars

Benchmark	No. of scholars n = 19	
Program completion		
Completed program	18	
Did not complete program	1	
Professional status		
Academic medicine	14	
Private practice	5	
Academic status		
Professor	5	
Professor, clinician track	1	
Associate professor	4	
Associate professor, clinician track	2	
Assistant professor	3	
Assistant professor, clinician track	1	
Leadership		
Division director	3	
Fellowship director	5	
NIH training program director (WRHR, BIRCWH)	2	
Productivity		
No. of grants awarded	96	
No. of NIH grants awarded	26	
Funded by NIH RPG (R01, R03, R21) as PI/co-PI	10	53%
Funded by NIH R01 awards, as PI/co-PI	7	37%
No. of publications[a]	613	

Data updated to 2015.

BIRCWH, Building Interdisciplinary Research Careers in Women's Health; *NIH*, National Institutes of Health; *PI*, principal investigator; *RPG*, research project grant; *WRHR*, Women's Reproductive Health Research.

[a] Key publications (as first author, senior author, or coauthor) include Aging Cell, British Medical Journal, Development, Federation of American Societies for Experimental Biology Journal, Journal of the American Medical Association, Journal of Clinical Investigation, Nature, Nature Communications, Nature Medicine, New England Journal Medicine, and Proceedings of the National Academy of Sciences.

SMFM. Promoting physician-scientist training in biology of pregnancy. Am J Obstet Gynecol 2018.

research >60% of their time. In all, 74% published ≥10 manuscripts (as authors or coauthors) since the initiation of their training. Among grant recipients, as principal investigator (PI) or co-PI (excluding coinvestigators), 53% have received any research project grant and 37% received an R01. The well-defined metric of funded R01 as PI/co-PI compares well with the numbers for former K trainees, reported by the Review of NICHD Training and Career Development Programs,[16] which indicated that 36.8% of K12 trainees and 29.8% of individual K trainees received an R01 grant at some point after their K-level training. Even lower success rates were recently reported by Okeigwe et al,[17] who found that among K-award recipients from 1988 through 2009, only 22% were successful at obtaining an R01. Interestingly, they also found that sex, subspecialty, and educational degree did not affect the likelihood of an obstetrics and gynecology K-grant recipient to obtain independent funding, with a slight, statistically significant advantage for BIRCWH scholars to receive independent funding of any type compared with RSDP and WRHR scholars, and an insignificant trend for K08 awardees to receive an R01 compared with K12 awardees.[17]

Although the perinatology-focused grants offered by the Foundation for SMFM-AAOGF, the broader training by the AAOGF-ABOG and the NIH BIRCWH, WRHR, RSDP, and individual K grants have been instrumental in promoting research by obstetrician-gynecologist physician-scientists, there is a pressing need to further boost research in our field to meet expanding scientific challenges. The recent NICHD task force recommendations[18] to rebalance training and career development programs and place more emphasis on individual K awards (eg, K08) rather than institutional K programs (K12) suggest that unless new resources are allocated to NICHD, the number of positions in K12 programs may decline.

It remains unclear how many physician-scientists are needed within the field of maternal-fetal medicine. The 2014 report by the Physician-scientist Workforce Working Group[18] cited American Medical Association annual surveys indicating a gradual decline in the number of physician-scientists from 2003 through 2012, with only 1.5% of the total physician workforce defining themselves as physician-scientists and <60% of them receiving funding.[18] These figures, which are based on data from research-intensive fields, may not be applicable to our discipline. In September 2014, we published recommendations by our 2013 Pregnancy Task Force,[19] which was convened to promote research in our field. Some of these recommendations had already been incorporated by SMFM and the Foundation for SMFM. Examples include increased fundraising activities by the Foundation for SMFM, with the goal of offering new mechanisms for research training, and new bridge funding by ABOG, designed to assist promising researchers on their way to an independent, funded research career, and administered by the Foundation for SMFM. These mechanisms address support to rising scholars during their K to R transition, which is one of the most vulnerable periods in their career. Other recent initiatives include the establishment of a new research committee within SMFM, intended to stimulate new science, sponsor an interactive research symposium during the national meeting, promote research mentoring to fellows, share research data sets online, and stimulate research pursuits during SMFM fellow retreats.

More can be done to broaden the scientific foundation of our growing field and ensure a well-supported pathway for perinatal biology physician-scientists. It is clear that the 3-year Foundation for SMFM-AAOGF grant cannot replace the NIH K grant, and some graduates of the Foundation for SMFM-AAOGF grant may require additional training or early-investigator funding, possibly through a K08 or K99 grant, to achieve R-level funding. Further fundraising activities may allow us to provide additional resources to new and existing trainees and expand their investigative training by an additional year. Meaningful interactions between SMFM and other societies that emphasize scientific research, such as the Society for Reproductive Investigation and the Society for the Study of Reproduction, may create better thematic ties among physician- scientists and PhD researchers and promote the participation of basic researchers in the translation of perinatal biology knowledge into practice. The availability of the NIH Loan Repayment Program should be highlighted in this context, as it provides financial relief to promising academics who struggle to balance the burden of their training-related loans with their career aspirations in academics.

At a time of limited resources and training capacity, enhanced training pathways for perinatal biology physician-scientists should perhaps be established only in selected academic programs that have the scientific foundation, experienced mentors, and intellectual and technical environment that are essential for a robust training program. University-based resources, such as those supported by the NIH Clinical and Translational Science Award, may be identified in these selected institutions. These institutions will hopefully recognize the significance of pregnancy-related research and make it a priority by allocating additional academic and monetary resources to promising scholars. Such resources may help alleviate concerns about balancing research career development and personal life challenges and assist with student loan debt. Technological innovation may provide avenues to expand the national mentor pool to trainees across a variety of regional settings and track and incentivize mentoring activities. Such selective programs may also be allowed by the subspecialty board to allocate additional protected research time during fellowship training. The unique characteristics of selected, research-intensive programs and the availability of quality mentors may also stimulate greater emphasis on research during the senior years of residency training at these institutions.

Finally, enhanced coordination among relevant funding agencies, including WRHR, BIRCWH, RSDP, AAOGF, and the Foundation for SMFM, may enable better identification of candidates and resource allocation, improve national-level mentoring and oversight of career development, and reduce attrition. Such activities, as suggested by others,[15] may also allow research mentors and funders to compare success on the basis of common metrics, deepen entrepreneurship and fundraising, and advocate for better recognition of our field among general governing bodies such as the Association of American Physicians and the Association of American Medical Colleges.

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