**Fixing The Leaky Pipeline: Identifying Solutions For Improving Pediatrician-Scientist Training During Pediatric Residency**

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**Statement of Financial Support:**

No financial support was received.

**Disclosure Statement:**

The authors have indicated that they have no conflict of interest to disclose.

**Category of Study:**

Commentary

**Abbreviations:**

Physician-Scientist Training Program: PSTP

American Board of Pediatrics: ABP

Integrated Research Pathway: IRP

Accelerated Research Pathway: ARP

Individualized Curriculum: IC

National Pediatrician-Scientist Collaborative Workgroup: NPSCW

**Key Words:**

Pediatrician-Scientist

Education

Career Development

Workforce

Graduate Medical Education

Structured Curriculum

Curriculum

**What is the key message of your article?**

* The PAS 2019 Scholarly Session (#313009) provided a critical platform for discourse around the current state of pediatrician-scientist training during residency through identification of current barriers and tailored solutions to those barriers.

**What does it add to the existing literature?**

* Dialogue on barriers and solutions to successful training of pediatrician-scientists during residency from diverse stakeholders using Bolman & Deals’ 4-frame organizational framework provides an innovative perspective that has previously not been described within the field of academic pediatrics.

**What is the impact?**

* Dissemination of tailored solutions to complex barriers in pediatrician-scientist training during residency provides alternative and unique approaches for institutions with individual needs and sheds light on evolving complexities of fixing the leaky pipeline of pediatrician-scientists.

The pipeline for the pediatrician-scientist workforce is endangered by inadequate recruitment, limited funding, and attrition (1, 2, 3, 4). The National Institutes of Health (NIH), the American Board of Pediatrics (ABP), and others in the pediatric academic community have expressed great concern about the vulnerability of the pipeline, recognizing pediatrician-scientists as a critical link in the advancement of child health through their work in scientific discovery, development of innovative therapeutics, and bench-to-bedside translation.

Current training models and funding constraints contribute to pediatrician-scientist attrition. The highly structured, combined-degree programs at the undergraduate medical education level provide robust opportunities to obtain advanced degrees in research. However, most graduate medical education training programs do not have similarly structured educational training opportunities (5).

The ABP has attempted to address the barriers to pursuing research during residency by creating two additional training pathways for pediatric residents: the Integrated Research Pathway (IRP) and the Accelerated Research Pathway (ARP). Both pathways allow truncation of clinical experience and incorporation of protected research time while complying with the requirements established by the Accreditation of Graduate Medical Education (ACGME). Additionally, some pediatric residency programs have developed distinct pediatrician-scientist tracks that provide structured curricula within the ARP and/or IRP pathways (6). Others have used an individualized curriculum (IC) approach with research tracks for categorical residents (unpublished). In 2017, the NIH developed the R38 funding mechanism to enable multi-departmental collaboration in training pediatrician-scientist residents through supporting 1-2 years of research time with follow-up funding to support subsequent fellowship training (7). All these approaches represent promising attempts to mitigate the problem of the decreasing pediatrician-scientist pipeline; however, the use, limitations, and challenges of implementing these pathways at various sizes of residency programs are currently unknown.

Pediatric faculty who have successfully obtained a career development award (NIH K-award), which represents the culmination of research productivity during residency and/or fellowship, have an increased likelihood of obtaining subsequent NIH funding (NIH R-award) and promotion opportunities, although the transition from K- to R-funding remains strained, particularly in pediatrics where decreases have outpaced those in many other disciplines (8). Thus, research training opportunities across the continuum and specific fostering are critical to long-term career success as a pediatrician-scientist (8).

To address these challenges, The National Pediatrician-Scientist Collaborative Workgroup (NPSCW) led a discussion forum at the 2019 Pediatric Academic Societies (PAS) Meeting to complement ongoing efforts to reduce pediatrician-scientist attrition (session #313009). Founded in July 2018, the NPSCW is comprised of faculty and trainees in pediatrics with diverse roles (researchers, educators, chairs, and others) who serve as leaders in creating educational experiences and mentorship in clinical and research training for residents, fellows, and junior faculty. Its goal is to create educational models to support pediatrician-scientist trainees and junior faculty in their efforts to develop productive research careers.

**Call to Action: Identifying Barriers in Training Pediatrician-Scientists During Residency**

The NPSCW’s vision is to identify and advocate for best practices in training pediatrician-scientists during residency, with programs that can be tailored to unique institutional environments and needs. Currently, large variations exist in the structures and components of the pediatrician-scientist programs due to insufficient literature on best practices for program development. The aim of the scholarly session held at PAS was to identify the current and future state of pediatrician-scientist training. The session provided a venue to share and appraise successful models in training and to identify existing challenges and potential strategies.

The recording and transcribing of the session were approved by the PAS and the Institution Review Board at the Baylor College of Medicine. Following is a synthesis of identified barriers and descriptions of successful practices derived from short talks, group discussions, panel engagements, and interactive dialogue from participants.

**Current State of Pediatrician-Scientist Training**

The sequence of the 2-hour session was as follows: Part I) a platform presentation titled “Identification of The Current State of Training” to showcase four models of research residency training programs, Part II) facilitated group discussions titled “Future State of Pediatrician-Scientist Training” using the Bolman & Deal’s organizational framework to discuss challenges and potential solutions, and Part III) an expert panel session titled “Challenges and Solutions to Current State of Pediatrician-Scientist Training” to address challenges and provide recommendations on issues identified in the preceding discussions (9). The strong attendance of key stakeholders, such as Chairs and Vice Chairs, physician-scientist residency program leadership, residency program directors, and executive leadership from the American Board of Pediatrics (ABP), facilitated rich discussions.

Introductory remarks addressing the challenges of pediatrician-scientist training were offered by the session moderator, Jordan Orange, MD, PhD (New York-Presbyterian Morgan Stanley Children’s Hospital). He highlighted the unique impact on children’s health that pediatrician-scientists create. Following were four presentations of successful models of training pediatrician-scientists. Case studies of experiences were highlighted through two pioneer programs, Boston Children’s Hospital (Samuel Lux, MD), using the ABP-ARP, and Cincinnati Children’s Hospital (Margaret Hostetter, MD), using the IC. Descriptions of two new programs followed: Texas Children’s Hospital (Audrea Burns, PhD), using the IRP, and Golisano Children’s Hospital (Kate Ackerman, MD), using the IC. All four programs highlighted the importance of aligning the structure of the pediatrician-scientist training with the institution’s mission and strengths and providing several pathways to support trainees with various degrees of research experience, using unique combinations of the available pathways including the ARP, IRP, and IC.

**Future State of Pediatrician-Scientist Training**

In Part II, to identify challenges and potential strategies for training pediatrician-scientists during residency, four NPSCW faculty facilitated group discussions in one of these four domains: 1) recruitment, 2) structure/curricula, 3) mentorship, and 4) resources.

To facilitate the discussions from a strategic organizational vantage point, the Bolman and Deal’s (B&D) theory of the four frames of organizational function was used to address each domain. The four frames are *structural* (i.e., rules, policies), *human resource* (i.e., employee needs), *political* (i.e., power distribution, competing interests), and *symbolic* (i.e., values, culture) (10). For more than two decades, extensive use of the four-frame model has provided a theoretical lens in academic health sciences organizations to comprehensively identify gaps in leadership and programmatic assessment. Satid Thammasitboon, MD, MHPE (Texas Children’s Hospital) introduced the session and explained the B&D model using a companion discussion guide with examples for all four frames.

Four groups (approximately 20-40 participants in each group) were formed based on individual participants’ domain of interest (recruitment, structure/curricula, mentorship, and resources)**.** The group facilitator asked participants to envision an “ideal” pediatrician-scientist training program and then to discuss barriers and potential strategies within each B&D frame. The facilitators from each group collated notes, which are synthesized in Table 1. We identified overlaps in barriers across domains that reflected the complexity and interconnectedness of challenges that occur in training pediatrician-scientists. In particular, the discussions highlighted residency programs’ current constraints on providing protected time for research due to clinical demands and the lack of supports for a faculty to mentor/support/engage in pediatrician-scientist training. Participants provided insightful solutions based on their personal experiences or institutional successes. Many of these solutions have overreaching implications across domains, including expanding funding opportunities and cross mentorship/training of pediatrician-scientists in career and research development. As the discussions prompted myriad sub-domains for future discussion, facilitators recounted various barriers that would be addressed in the final session, a panel discussion.

**Barriers and Solutions to Current State of Pediatrician-Scientist Training**

In Part III, four expert panelists, Rebecca Blankenburg, MD, MPH (Stanford Children’s Hospital), Catherine Forster, MS, MD (Children’s National Hospital), Margaret Hostetter, MD (Cincinnati Children’s Hospital), and Anthony French MD, PhD (St. Louis Children’s Hospital), shared their institutional perspectives on how to provide research training support during residency, the importance of supporting trainees with limited prior research experience and mentorship, and how to provide training in resource-limited climates. As anticipated, the discussions generated more insightful questions than answers. Participants expressed enthusiasm for continued efforts to engage affiliated pediatric societies such as the Association of Medical School Pediatric Department Chairs (AMSPDC) and the Society for Pediatric Research (SPR) and to hold dedicated meetings for residency pediatrician-scientist training program directors including the MD/PhD national student conference and the Association of American Physicians, American Society of Clinical Investigation, and American Physician-Scientists Association (AAP/ASCI/APSA) joint annual meeting.

In summary, the PAS session coalesced the efforts of the NPSCW through facilitating collaboration among researchers, educators, and trainees in the pediatrician-scientist community, thereby identifying challenges and potential best practices for pediatrician-scientist training during residency. The session fueled the desire for continued collaborations to identify how pediatrician-scientists are trained across ACGME-accredited pediatric residency programs and to tailor solutions that address unique institutional milieus. The NPSCW has launched a survey to investigate the practices and needs of residency and research-track program directors. We will integrate this work with the work of others to derive innovative and effective practice recommendations useful for diverse pediatric residency training programs interested in fostering research careers. Future studies should explore the implementation of research training pathways that (1) offer more robust mentoring of individuals at different stages of career development; (2) provide ongoing faculty development and mentorship; (3) protect residents’ research time; and (4) explore novel ways of funding research along the educational continuum.

**Acknowledgments:** We would like to acknowledge and thank the Pediatric Academic Societies (PAS) for supporting the recording, transcription, and dissemination of scholarly session #313009 at the PAS 2019 Meeting (session #313009, http://bit.ly/pasmtg2019). The brainstorming, planning, and execution of the session represent the collective efforts of the National Pediatrician-Scientist Collaborative Workgroup (NPSCW). We also thank Dr. B. Lee Ligon, Department of Pediatrics, Baylor College of Medicine, for editorial assistance.

**Authorship Contribution**: Dr. Burns drafted the initial manuscript; Drs. Ackerman, Thammasitboon, Orange, Rassbach, Ward, Blankenburg, Forster, McPhillips, Wenger, Powell, Heyman, Hostetter, Boyer, Nguyen, Moore, Weiss, Parsons, and French provided important intellectual contributions to the conception of the session, content of the manuscript, and revisions; and all authors approve of the final manuscript as submitted.

**References:**

1. Cornfield DN, Lane R, Rosenblum ND, et al. Patching the pipeline: Creation and retention of the next generation of physician-scientists for child health research. J Pediatr 2014;165(5):882–4.

2. Daye D, Patel CB, Ahn J, Nguyen FT. Challenges and opportunities for reinvigorating the physician-scientist pipeline. J. Clin. Invest. 2015;

3. Heyman MB, Weiss P, Boyer D, et al. Challenges of Funding Pediatric Fellowship Programs—Invited Commentary from the Council of Pediatric Subspecialties. J Pediatr 2019;204:4-6.e1.

4. Weiss P, Myers AL, McGann KA, et al. Funding Sources and Perceived Financial Insecurity in Pediatric Subspecialty Fellowship Programs. Acad Pediatr 2019;19(7):815–21.

5. Zemlo TR, Garrison HH, Partridge NC, Ley TJ. The Physician-Scientist: Career Issues and Challenges at the Year 2000.

6. Burns AM, Thammasitboon S, Ward MA, et al. Implementation of a Novel Curriculum and Fostering Professional Identity Formation of Pediatrician-Scientists. J Pediatr 2019;

7. Hurst JH, Barrett KJ, Kelly MS, et al. Cultivating Research Skills During Clinical Training to Promote Pediatric-Scientist Development. Pediatrics 2019;144(2):e20190745.

8. Garrison HH, Deschamps AM. NIH research funding and early career physician scientists: Continuing challenges in the 21st century. FASEB J 2014;

9. Bolman Terrence E LG ;Dea. Reframing Organizations : Artistry, Choice, and Leadership. Hoboken: John Wiley & Sons, Incorporated; 2003.

10. Sasnett B, Clay M. Leadership styles in interdisciplinary health science education. J Interprof Care 2008;22(6):630–8.