BIOGRAPHICAL SKETCH

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NAME: Barnes, Patrick D.

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Professor of Radiology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Oklahoma, Norman OK	BA	06/1969	Letters/Premedicine – Honors PE-ET
Univ of Oklahoma College of Medicine, Oklahoma City, OK	MD	06/1973	Medicine – Honors, AOA
Univ of Oklahoma College of Medicine, Oklahoma City, OK	Residency	06/1976	Diagnostic Radiology
Children's Hospital and Harvard Med School, Boston, MA	Fellowship	06/1977	Pediatric Neuroradiology, Cardiovascular Radiology

A. Personal Statement

Our work seeks to advance neonatal care and outcomes by performing observational studies and interventional trials within a multicenter network of academic institutions. I am a professor of Radiology (Pediatric Neuroradiology) at Stanford University School of Medicine, Chief of the Section of Pediatric Radiology, and Co-Director, Pediatric MRI and CT Center at Lucile Packard Children's Hospital at Stanford. For the past two decades I have continued to dedicate my clinical, teaching, and research endeavors in pediatric neuroradiology emphasizing the design and implementation of advanced MRI technology and techniques for evaluating injury to the developing central nervous system. These endeavors focus upon children from the fetus through adolescence, including the assessment of imaging indicators or predictors of neurodevelopmental outcome. I have served as lead neuroradiologic consultant and central reader for MRI for several NICHD Neonatal Research Network studies including the Whole Body Therapeutic Hypothermia trial and the SUPPORT Neuroimaging study. These studies have yielded highly useful data regarding the ability of neuroimaging to predict outcome in term hypoxic ischemic encephalopathy as well as in extremely low birth weight infants when performed at near term. I am well suited to participate as a neuroradiology faculty collaborator and I look forward to future collaborations with the NICHD Neonatal Research Network.

B. Positions and Honors

Positions and Employment

1977-86	Associate Professor of Radiology, University of Oklahoma College of Medicine, Oklahoma City, OK
1977-86	Chief, Section of Pediatric Neuroradiology and Cardiovascular Radiology, Oklahoma Children's Memorial Hospital, Oklahoma City, OK
1986-99	Director of MRI, Department of Radiology, Children's Hospital, Boston, MA
1986-99	Director, Division of Neuroradiology, Department of Radiology, Children's Hospital, Boston, MA
1986-00	Associate Professor of Radiology, Harvard Medical School, Boston, MA
2000-07	Associate Professor of Radiology, Stanford University Medical Center, Stanford, CA
2000-	Chief, Section of Pediatric Neuroradiology and Co-Director, Pediatric MRI and CT Center,

Lucile Salter Packard Children's Hospital, Palo Alto, CA
2007- Professor of Radiology, Stanford University Medical Center, Stanford, CA
2018- Emeritus Professor of Radiology (Pediatric Radiology – Neuroradiology), Stanford University Medical Center, Stanford CA.

Other Experience and Professional Memberships

1988- Reviewer, Radiology (journal of the Radiological Society of North America)
1988- Reviewer, American Journal of Neuroradiology (journal of the American Society of Neuroradiology)
1991- Editorial Board, Reviewer, Journal of Child Neurology
1991- Reviewer, American Journal of Roentgenology (American Roentgen Ray Society)
1993- Reviewer, Neuroradiology
1993- Reviewer, Pediatrics
1993- Reviewer, Journal of Pediatrics
1994- Editorial Board, Reviewer, Pediatric Radiology (Journal of The Society for Pediatric Radiology and the European Society for Pediatric Radiology)
1995-97 Associate Editor for Pediatric Neuroradiology, International Medical Image Registry
1995- Reviewer, Journal of Computed Assisted Tomography
1997- Reviewer, Neurology
1998-99 Co-Founder, President and Chair, Program/Education Committee, American Society of Pediatric Neuroradiology
1998-99 Member, Executive Committee, Program/Education Committee, Clinical Practice Committee, Clinical Outcomes Research Committee, American Society of Neuroradiology
1999-00 Chair, Board of Directors, American Society of Pediatric Neuroradiology
2000- Chair, Standards and Guidelines Committee, American Society of Pediatric Neuroradiology
2000- Member, Child Abuse Committee, Society for Pediatric Radiology
2007 Chair, Child Abuse Task Force, Society for Pediatric Radiology
2008- Member, Child Abuse Task Force, Society for Pediatric Radiology
2008- Member, Neuroradiology Committee, Society for Pediatric Radiology

Honors

1996 John A. Kirkpatrick Jr. Teaching Award, Pediatric Radiology Fellowship Program, Dept. of Radiology, Children's Hospital and Harvard Medical School, Boston, MA
2001 Award of Appreciation for Service & Leadership, The American Society of Pediatric Neuroradiology, American Society of Neuroradiology 39th Annual Meeting, Boston, MA, April 23, 2001.
2003 Stanford B. Rossiter Senior Faculty of the Year, Dept of Radiology, Stanford Univ Medical Center, Stanford, CA
2005 Senior Faculty of the Year, Dept of Radiology, Stanford Univ Medical Center, Stanford, CA
2006 Senior Faculty of the Year, Dept of Radiology, Stanford Univ Medical Center, Stanford, CA

Contribution to Science

1. **Pioneering and ongoing collaborative MRI development for pediatrics (45 publications 1986-2015).** When I completed my pediatric neuroradiology fellowship in 1977, the existing imaging modalities were limited to ultrasound, radiography, computed tomography, myelography, angiography, and nuclear medicine. I was a co-leader in pioneering work to develop magnetic resonance imaging (MRI) for investigating the pediatric central nervous system. With researchers from Oral Roberts University and the University of Oklahoma, we showed MRI to be a reliable, non-invasive methodology to screen patients for spinal dysraphism (a). Eventually MRI effectively replaced myelography for pediatric spine imaging (b,c). I was co-leader in the establishment of other MRI research programs and centers, e.g. in Oklahoma (Oklahoma Diagnostic Imaging, Oklahoma Children's Memorial Hospital), at Boston's Children's Hospital and Harvard Medical Center, as well as, the Lucile Packard Children's Hospital at Stanford. At Boston Children's Hospital we published the very first paper using MRI to image vascular anomalies (d). MRI has replaced CT and angiography as the standard and has advanced the multidisciplinary approach to care, especially in the evaluation of children with

complex head and neck conditions, including early work led by Caroline Robson, one of today's eminent pediatric head & neck radiologists (e). Working with Robert Mulkern and others we pioneered faster imaging techniques (f) which shortened imaging times, facilitated sedation and anesthesia (pioneering work by Keira Mason, MD, Director of Radiology Anesthesia) and helped increase access for pediatric patients. That early Boston experience led to the first "comprehensive" textbook on utilization, Wolpert and Barnes "MRI in Pediatric Neuroradiology" (Mosby Yearbook 1992) plus later textbooks for trainees (Blickman J, Parker B, Barnes P: Pediatric Radiology: The Requisites, 3rd ed. Philadelphia PA, Elsevier, July 2009). More recently, headed by Kristen Yeom and the Roland Bammer team at Stanford, we have implemented a number of newer techniques (g,h) including motion-correction software to further help reduce the need for sedation and anesthesia in pediatric patients receiving MR imaging [Caffey Award Best Scientific Papers (x4), SPR Annual Meeting Boston 2010].

a. Barnes PD, Lester PD, Yamanashi WS, Prince JR. MRI in infants and children with spinal dysraphism. AJR Am J Roentgenol. 1986 Aug;147(2):339-46. PMID: 3524163 (SPR Annual Meeting Las Vegas 1984).
b. Barnes PD, Brody JD, Jaramillo D, Akbar JU, Emans JB. Atypical idiopathic scoliosis: MRI evaluation. Radiology 1993;186:247-253.
c. Medina LS, Al-Orfali M, Zurakowski D, Poussaint TY, DiCanzio J, Barnes PD. Occult lumbosacral dysraphism in children and young adults: diagnostic performance of fast screening and conventional MR imaging. Radiology 1999;211:767-772.
d. Meyer JS, Hoffer FA, Barnes PD, Mulliken JB. Biological classification of soft-tissue vascular anomalies: MR correlation. AJR Am J Roentgenol. 1991 Sep;157(3):559-64. PMID: 1872245.
e. Robson CD, Mulliken JB, Robertson RL, Proctor MR, Steinberger D, Barnes PD, McFarren A, Muller U, Zurakowski D. Prominent basal emissary foramina in syndromic craniosynostosis: correlation with phenotypic and molecular diagnosis. AJNR 2000;21: 1707-1717 (Outstanding Head & Neck Radiology Paper ASNR/ASPNR/ASHNR Annual Meeting, Atlanta 2000).
f. Ahn SS, Mantello MT, Jones KM, Mulkern RV, Melki PS, Higuchi N, Barnes PD. Rapid MR imaging of the pediatric brain using the fast spin-echo technique. AJNR Am J Neuroradiol. 1992 Jul-Aug;13(4):1169-77. PMID: 1636531.
g. Skare S, Holdsworth S, Yeom K, Barnes P, Bammer R. High-resolution motion corrected diffusion-tensor imaging (DTI) in infants. Caffey Award Best Scientific Paper Society for Pediatric Radiology Annual Meeting, Boston MA April 2010.
h. Yeom KW, Straka M, Iv M, Moseley ME, Barnes PD, Skare S, Holdsworth SJ. Intensity-Corrected Dual-Echo Echo-Planar Imaging (DE- EPI) for Improved Pediatric Brain Diffusion Imaging. PLoS One. 2015 Jun 12;10(6):e0129325. doi: 10.1371/journal.pone.0129325. eCollection 2015.

2. **Pioneering and ongoing collaborative advances in imaging for pediatric neuroncology (37 publications 1986-2015).** Also with researchers from Oral Roberts University and the University of Oklahoma, we showed MRI to be a reliable, non-invasive methodology to evaluate children with intracranial masses (a). At the Boston Children's Hospital, I collaborated with Dr. Nancy Tarbell and other leaders in the subspecialties of Pediatric Neuroncology (Dana Farber Cancer Institute), Radiation Oncology, and Neurosurgery to establish one of the first Pediatric Brain Tumor Working Groups which eventually lead to the formation nationally of the Pediatric Brain Tumor Consortium (Kieran M, Tarbell N. Co-Principle Investigators, PBTC, NIH/NCI 1 U01 CA 81452-01,1999-2000, Barnes PD, Senior Site Consultant, Neuroradiology Committee). This early collaboration with neuroradiology, more recently led by Tina Young Poussaint, has successfully developed image-guided techniques that allow more effective and safer therapeutic interventions with improved outcomes (b,c,d). In studying central nervous system (CNS) tumors using MRI, we found the termination of the caudal spinal dural sac to be highly variable among pediatric patients, indicating imaging should guide craniospinal irradiation (b). In another study of pediatric and adult patients with intracranial neoplasms we showed the overall benefits of image-guided stereotactic radiation therapy which delivers localized treatment to a target area thus providing more effective use of the radiation while sparing normal brain (c). This led to improved treatment responses and reduced adverse outcomes such as central endocrinopathies and cognitive impairments. MRI, along with MRS and perfusion MRI (early work led by Aria A. Tzika), proved beneficial in terms of distinguishing hemorrhage, and other treatment effects, from tumor progression following the treatment of CNS neoplasia in pediatric patients

(d,e). Progress in pediatric neuroncology has continued at the Lucile Packard Children's Hospital-Stanford where, headed by Kristen Yeom, we have determined that distinctive MRI features, including ADC patterns, can be used to predict medulloblastoma, and other, histologic subtypes (f).

a. Barnes P, Lester P, Yamanashi W, Woosley R, Wheatley K. Magnetic resonance imaging in childhood intracranial masses. Magn Reson Imaging 1986;4:41-49.
b. Dunbar SF, Barnes PD, Tarbell NJ. Radiologic determination of the caudal border of the spinal field in cranial spinal irradiation. Int J Radiat Oncol Biol Phys. 1993 Jul 15;26(4):669-73. PMID: 8330999.
c. Dunbar SF, Tarbell NJ, Kooy HM, Alexander E 3rd, Black PM, Barnes PD, Goumnerova L, Scott RM, Pomeroy SL, La Vally B, et al. Stereotactic radiotherapy for pediatric and adult brain tumors: preliminary report. Int J Radiat Oncol Biol Phys. 1994 Oct 15;30(3):531-9. PMID: 7928483.
d. Poussaint TY, Siffert J, Barnes PD, Pomeroy SL, Goumnerova LC, Anthony DC, Sallan SE, Tarbell NJ. Hemorrhagic vasculopathy after treatment of central nervous system neoplasia in childhood: diagnosis and follow-up. AJNR Am J Neuroradiol. 1995 Apr;16(4):693-9. PMID: 7611024.
e. Tzika AA, Vajapeyam S, Barnes PD. Multivoxel proton MR spectroscopy and hemodynamic MR imaging of childhood brain tumors. AJNR 1997;18:203-218 (Derek Harwood-Nash Award Paper 33rd ASNR Annual Meeting Chicago 1995).
f. Yeom KW, Mobley BC, Lober RM, Andre JB, Partap S, Vogel H, Barnes PD. Distinctive MRI features of pediatric medulloblastoma subtypes. AJR Am J Roentgenol. 2013 Apr;200(4):895-903. PMID: 23521467.

2. **Pioneering and ongoing collaborative advances in fetal MRI (10 publications 1997-2018).** While at the Boston Children's Hospital, I collaborated with Dr. Deborah Levine of the Beth Israel Deaconess Medical Center in her original work to develop ultrafast fetal MRI (NIH R29 NS37945-01), including for the early diagnosis of central nervous system (CNS) anomalies and other abnormalities (a-e). When an ultrasound (US) shows that a fetal CNS anomaly is suspected, we found that an ultrafast MRI can add information to imaging findings and/or alter diagnoses. Importantly, MRI findings may decrease the ambiguity in counseling expectant parents (a-d). We observed that changes in diagnosis and maternal counseling were significantly associated with gestational age, with MRI findings more likely to impact the course of care for fetuses evaluated at later gestational ages. Additionally, fetal MRI also allows for the evaluation of brain anatomy and can identify secondarily acquired brain injuries. It provides faster imaging and improved resolution. I helped establish a leading role for pediatric neuroradiology in these studies, which contributed to the impetus for advancing multidisciplinary fetal medicine programs (e.g. Boston Children's Hospital - Brigham & Women's Hospital, Packard Children's Hospital – Stanford) and for decreasing ambiguity in counseling expectant parents.
    a. Levine D, Barnes PD, Madsen JR, Li W, Edelman RR. Fetal central nervous system anomalies: MR imaging augments sonographic diagnosis. Radiology. 1997 Sep;204(3):635-42. PMID: 9280237.
    b. Levine D, Barnes PD, Madsen JR, Abbott J, Wong GP, Hulka C, Mehta T, Li W, Edelman RR. Fetal CNS anomalies revealed on ultrafast MR imaging. AJR Am J Roentgenol. 1999 Mar;172(3):813-8. PMID: 10063888.
    c. Levine D, Barnes PD, Madsen JR, Abbott J, Mehta T, Edelman RR. Central nervous system abnormalities assessed with prenatal magnetic resonance imaging. Obstet Gynecol. 1999 Dec;94(6):1011-9. PMID: 10576192.
    d. Levine D, Barnes PD, Robertson RR, Wong G, Mehta TS. Fast MR imaging of fetal central nervous system abnormalities. Radiology. 2003 Oct;229(1):51-61. PMID: 12920177.
    e. Katz J, Chock V, Davis A, Blumenfeld Y, Hahn J, Barnes P, Barth R, Rubesova E, Hintz, S. Utility of prenatal MRI in the evaluation and management of fetal ventriculomegaly, J. Perinatology 2018;38:1444-1452.

4. **Pioneering and ongoing collaborative advances in neonatal neuroimaging (27 publications 1993-2021).** At Boston Children's Hospital and Brigham and Women's Hospital (BCH-BWH), I collaborated with Petra Huppi and Dr. Joseph Volpe's neonatal neurology team in the early development of MRI techniques for perinatal / neonatal evaluations (a-c). Prior to the use of diffusion-weighted imaging (DWI), T1- and T2-

weighted MR imaging was often normal in the first few hours after an ischemic insult. This early period overlaps with the narrow and finite “therapeutic window” during which neuroprotective therapies can be effective. As led by Richard Robertson, we showed that differences in line-scan diffusion imaging (LSDI) reflect differences in the pathophysiology or timing of the injury (a). Neonates with brain ischemia were observed to develop either symmetric/diffuse injury or focal/multifocal injury. In transition from Boston Children’s to Packard Children’s-Stanford, I have further focused on collaborative neonatal neuroimaging, including the early work of Ashok Panigrahy, as correlated with outcomes (d-n). One project was to compare the utility of serial cranial ultrasound (CUS) with a single near-term MRI to predict cerebral palsy (g). Early cranial US is the usual practice. We found that MRI was superior, however, demonstrating both higher sensitivity and specificity. I have continued this important work with Dr. Susan Hintz and the Neonatal Research Network (NRN) of the NICHD (h,m). We prospectively evaluated MRI white matter abnormalities and cerebellar lesions with serial CUS findings in extreme preterm infants as predictors of outcomes at 18-22 months corrected age in 480 infants. We found that both late CUS and MRI were associated with outcomes independent of early CUS, and other factors, underscoring the prognostic value of near-term neuroimaging. This study is the largest of its kind and the findings are likely to significantly impact the practices and recommendations for neuroimaging in preterm infants. In a second collaboration with the NRN, we investigated the relationship between brain injury on MRI and outcome within a randomized controlled trial of whole body cooling for term neonatal hypoxic-ischemic encephalopathy (i-k,n). Fewer areas of infarction and a trend towards more normal scans were noted following whole body hypothermia. We were able to use MRI scans to categorize all areas of brain injury and show that the NRN pattern of brain injury is strongly associated with death or disability at both 18-22 months and 6-7 years of age, no matter the treatment modality. This has proven beneficial when counseling parents. I served as the primary pediatric neuroradiology consultant and lead central reader for these NICHD/NRN investigations.

a. Robertson RL, Ben-Sira L, Barnes PD, Mulkern RV, Robson CD, Maier SE, Rivkin MJ, DuPlessis AJ. MR line scan diffusion imaging of term neonates with perinatal brain ischemia. AJNR 1999; 20: 1658-1670. (Derek Harwood-Nash Award Outstanding Pediatric Neuroradiology Paper ASNR/ASPNR 1999).
a. Huppi PS, Murphy B, Maier SE, Zientara GP, Inder TE, Barnes PD, Kikinis R, Jolesz FA, Volpe JJ. Microstructural brain development after perinatal cerebral white matter injury assessed by diffusion tensor MR imaging. Pediatrics 2001; 107 (3): 455-460.
b. Inder TE, Huppi PS, Warfield S, Kikinis R, Zientara GP, Barnes PD, Jolesz F, Volpe JJ. Periventricular white matter injury in the premature infant is followed by reduced cerebral cortical gray matter volume at term. Annals of Neurology 1999; 46: 755-760.
c. Panigrahy A, Barnes PD, Robertson RL, Back SA, Sleeper LA, Sayre JW, Kinney HC, Volpe JJ. Volumetric Brain Differences in Children with Periventricular T2-Signal Hyperintensities: A Grouping by Gestational Age at Birth. Am J Roentgenol. 2001;177:695-702.
d. Panigrahy A, Barnes PD, Robertson RL, Sleeper LA, Sayre JW. Quantitative analysis of the corpus callosum in children with cerebral palsy and developmental delay: correlation with cerebral white matter volume. Pediatr Radiol. 2005;35:1199-207.
e. Ment L, Bada H, Barnes P, Grant P, Hirtz D, Papile L, Pinto-Martin J, Rivkin M, Slovis T. Practice parameter: neuroimaging of the neonate. Neurology 2002; 58: 1726-1738.
f. Mirmiran M, Barnes PD, Keller K, Constantinou JC, Fleisher BE, Hintz SR, Ariagno RL. Neonatal brain magnetic resonance imaging before discharge is better than serial cranial ultrasound in predicting cerebral palsy in very low birth weight preterm infants. Pediatrics. 2004 Oct;114(4):992-8. PMID: 15466096.
g. Hintz SR, Barnes PD, Bulas D, Slovis TL, Finer NN, Wrage LA, Das A, Tyson JE, Stevenson DK, Carlo WA, Walsh MC, Laptook AR, Yoder BA, Van Meurs KP, Faix RG, Rich W, Newman NS, Cheng H, Heyne RJ, Vohr BR, Acarregui MJ, Vaucher YE, Pappas A, Peralta-Carcelen M, Wilson-Costello DE, Evans PW, Goldstein RF, Myers GJ, Poindexter BB, McGowan EC, Adams-Chapman I, Fuller J, Higgins RD; SUPPORT Study Group of the Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Neuroimaging and neurodevelopmental outcome in extremely preterm infants. Pediatrics. 2015 Jan;135(1):e32-42. PMID: 25554820; PMCID: PMC4279063.
h. Shankaran S, Barnes PD, Hintz SR, Laptook AR, Zaterka-Baxter KM, McDonald SA, Ehrenkranz RA, Walsh MC, Tyson JE, Donovan EF, Goldberg RN, Bara R, Das A, Finer NN, Sanchez PJ, Poindexter BB, Van Meurs KP, Carlo WA, Stoll BJ, Duara S, Guillet R, Higgins

RD; Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Brain injury following trial of hypothermia for neonatal hypoxic-ischaemic encephalopathy. Arch Dis Child Fetal Neonatal Ed. 2012 Nov;97(6):F398-404. Erratum in: Arch Dis Child Fetal Neonatal Ed. 2014 Mar;99(3):301. PMID: 23080477; PMCID: PMC3722585.

i. Shankaran S, McDonald SA, Laptook AR, Hintz SR, Barnes PD, Das A, Pappas A, Higgins RD; Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Neonatal Magnetic Resonance Imaging Pattern of Brain Injury as a Biomarker of Childhood Outcomes following a Trial of Hypothermia for Neonatal Hypoxic-Ischemic Encephalopathy. J Pediatr. 2015 Nov;167(5):98793.e3. doi:10.1016/ j.jpeds. 2015.08.013. Epub 2015 Sep 16. PMID:26387012

j. Shankaran S, Laptook A, McDonald S, Hintz S, Barnes P, Das A, Higgins R. Eunice Kennedy Shriver National Institute of Child Health, and Human Development Neonatal Research Network. Acute perinatal sentinel events, neonatal brain injury pattern, and outcome of infants undergoing a trial of hypothermia for neonatal hypoxic-ischemic encephalopathy. J Pediatr. 2017 Jan;180:275-278.e2. doi:10.1016/j.jpeds.2016.09.026.

k. Barnes P. Neuroimaging in the evaluation of pattern and timing of fetal and neonatal brain abnormalities. Stevenson DK, Benitz WE, Sunshine P, Hintz SR, Druzin ML, eds. *Fetal and Neonatal Brain Injury*. 5th ed. Cambridge: Cambridge University Press; 2018:283-311; doi:10.1017/9781316275498.

l. Hintz S, Vohr B, Bsnn C, Taylor H, Das A, Gustafson K, Yolton K, Watson V, Lowe J, DeAnda M, Ball M, Finer N, Van Meurs, K, Shankara, S, Pappas, A, Barnes P, Bulas D, Newman J, Wilson-Costello D, Heyne R, Harmon H, Peralta-Carcelen, M, Adams-Chapman I, Duncan A, Fuller J, Vaucher Y, Colaizy T, Winter S, McGowan e, Goldstein R, Higgins, R. Eunice Kennedy Shriver National Institute of Child Health and Human Development, Pregnancy and Perinatology Branch. Preterm neuroimaging and school-age cognitive outcomes. Pediatrics 2018;142:e20174058.

m. Laptook A, Shankaran S, Barnes P, Rollins N, et al. Limitations of conventional MRI as predictor of death or disability following neonatal hypoxic-ischemic encephalopathy in the late hypothermia trial. J Pediatr 2021; 230:106-111.

5. **Imaging of infant and child trauma, including child abuse and the mimics (26 publications 1987-2019).** Having served as a pediatric radiologist and pediatric neuroradiologist consultant for child protection teams at Oklahoma Children's Memorial Hospital and Boston Children's Hospital, I then co-founded the Child Abuse SCAN team at Lucile Packard Children's Hospital Stanford in 2008. During these years I have co-led the development of advanced imaging techniques, especially MRI, to assist in the evaluation of childhood trauma (a-c). I have also collaborated with leaders in medicine and law in addressing controversies in the determination of non-accidental injury (NAI), including recognizing the "mimics" of child abuse, to promote more comprehensive and compassionate management strategies (d-k). I reviewed case histories and the literature and find that there is no established scientific evidence base, especially for using imaging (e.g. CT, MRI), to reliably distinguish NAI from accidental injury or from the medical mimics (d-k). In addition to giving a detailed report of the imaging findings, radiologists should also provide a differential diagnosis and communicate any concern for NAI. Considering case series of rickets versus abuse, we often found severe maternal-fetal vitamin D deficiencies. This led us to claim that the diagnosis and treatment of vitamin D deficiency is most important in improving the health of pregnant women and their infants (g,h). Laboratory studies showed that rickets in the fetus and neonate does occur, is linked to maternal health, and when observed in infancy can mimic the symptoms of abuse (g,h). Our findings, along with other supporting reports in the literature, influenced the American Congress of Obstetricians and Gynecologists (ACOG) and the American Academy of Pediatrics (AAP) to raise the levels of vitamin D supplementation recommended for pregnant mothers and neonatal breastfed babies. We have also found that findings of subdural hemorrhage, retinal hemorrhage and encephalopathy (i.e. triad) cannot reliably identify abuse or the timing of such (d-f,i-k)). I was one of the lead neuroradiologists on many of these reports.

a. Barnes PD, Mulkern RV. Physical, biological, and clinical principles of MRI. In Kleinman, PK, ed. Imaging of Child Abuse, 2nd ed. St. Louis-Mosby-Year Book Publishers, Ch. 22, 1998.

b. Alberico RA, Barnes PD, Robertson RL, Burrows PE. Helical CT angiography: dynamic cerebrovascular imaging in children. AJNR 1999; 20: 328-334. Alberico RA, Barnes PD, Robertson RL, Burrows PE. Helical CT angiography: dynamic cerebrovascular imaging in children. AJNR 1999; 20: 328-334 (Kirkpatrick Young Investigator Award SPR St. Louis 1997).
c. Schutzman SA, Barnes PD, Duhaime A-C, Greenes D, Homer C, Jaffe D, Lewis RJ, Luerssen TG, Schunk J. Evaluation and management of children younger than two years old with apparently minor head trauma: proposed guidelines. Pediatrics 2001; 107: 983-993.
d. Barnes PD. Ethical issues in imaging nonaccidental injury: child abuse. Top Magn Reson Imaging 2002; 13: 85-93.
e. Barnes PD, Krasnokutsky M. Imaging of the Central Nervous System in Suspected or Alleged Nonaccidental Injury, including the Mimics. Top Magn Reson Imaging 2007; 18:53-74
f. Barnes PD. Imaging of nonaccidental injury and the mimics: issues and controversies in the era of evidence-based medicine. Radiol Clin North Am. 2011 Jan;49(1):205-29. PMID: 21111136.
g. Keller KA, Barnes PD. Rickets vs. abuse: a national and international epidemic. Pediatr Radiol. 2008 Nov;38(11):1210-6. PMID: 18810424.
h. Keller K, Barnes P. Rickets vs. Abuse–the evidence: Reply. Pediatr Radiol. 2009; 39:1130.
i. Findley KA, Barnes PD, Moran DA, Squier W. Shaken baby syndrome, abusive head trauma, and actual innocence: getting it right. *Legal Studies Research Paper Series,* Paper No. 1195. Houston J Health Policy. Social Science Research Network Electronic Paper Collection, 2012 http://ssrn.com/abstract=2048374 .
j. Miller D, Barnes P**,** Miller M.The significance of macrocephaly or enlarging head circumference in infants with the triad: further evidence of mimics of shaken baby syndrome. Am J Forensic Med Pathol. 2015 Jun;36(2):111-20. doi: 10.1097/PAF.0000000000000152.
k. Findley K, Risinger D, Barnes P, Mack J, Moran D, Scheck B, Bohan T. Feigned Consensus: Usurping the Law in shaken baby syndrome / abusive head trauma prosecutions. University of Wisconsin Law School. Legal Studies Research Paper Series Paper No. 1461, 2019. https://ssrn.com/abstract=3328996

Complete List of Published Work in MyBibliography:
http://www.ncbi.nlm.nih.gov/sites/myncbi/1HAaHrFq9I59/bibliography/47853117/public/?sort=date&direction=ascending

D. Research Support

Ongoing Research Support
None

Completed Research Support

2U HD 27880-16 Van Meurs (PI). Project period: 04/01/06–03/31/11 NIH/NICHD
Multicenter Network of Neonatal Intensive Care Unit Intervention Trial of Hypothermia for Term Hypoxic Ischemic Encephalopathy.
Role: Central MRI reader/Neuroimaging consultant

2U HD 27880-16 Van Meurs (PI). Project period: 04/01/06–03/31/18 NIH/NICHD
Multicenter Network of Neonatal Intensive Care Units Neuroimaging and Neurodevelopmental Outcome, SUPPORT Multi-Center Project This project investigates the value of brain magnetic imaging (MRI) in predicting neurodevelopmental outcome in extremely low birthweight (ELBW) infants.
Role: Central MRI reader / Neuroimaging consultant

NIH 1R01 EB008706 Bammer (PI) 09/01/2008–08/31/2013
Short Axis Epi For Diffusion Tensor Mri At High Field
The main objective of the project is to create significant improvements in Diffusion Tensor Imaging (DTI) at high field (i.e. 3T and 7T) via novel acquisition/reconstruction techniques so that improved pediatric and adult high-field DTI is enabled. This will assist in building the basic methodological framework at high field for further

clinically focused studies and basic neuroscience research
Role: Collaborator

NIH 1R01 MH083972 Hardan (PI) 03/01/2009–12/31/2013
A Neuroimaging Study of Twin Pairs with Autism
The goal of this study is to develop a better understanding of linkages among clinical features and neurobiological measures in individuals affected by autism. High resolution anatomical, diffusion tensor and proton spectroscopy scans will be obtained from 80 same-sex autism twin pairs, with at least one twin with autism, as well as 40 typically developing same-sex twin pair controls, in order to better identify clinical or biological endophenotypes associated with autism.
Role: Collaborator