

**Russell (“Chip”) A. Norris, PhD**

Curriculum Vitae

**Office Address:**

Department of Regenerative Medicine  
Medical University of South Carolina  
173 Ashley Avenue  
608 Children’s Research Institute  
Charleston, SC 29425

**Laboratory Address:**

Medical University of South Carolina  
Cardiovascular Developmental Biology  
Center  
173 Ashley Avenue  
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Charleston, SC 29425

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**Professional History:**

- Assistant Professor of Medicine (tenure track), Medical University of South Carolina
  - 2011-Present
- Assistant Professor of Medicine (research track), Medical University of South Carolina
  - 2007-2011
- Postdoctoral Fellow, Medical University of South Carolina
  - 2004-2007 (Roger Markwald Lab)
- Postdoctoral Fellow, Medical University of South Carolina
  - 2000-2004 (Corey Mjaatvedt Lab)

**Faculty Appointment:**

*Primary:* Department of Regenerative Medicine and Cell Biology

*Secondary:* Department of Medicine

**Educational Background:**

*Undergraduate:* University of Cincinnati (1991-1995), B.S. Biology

*Graduate School:* Medical University of South Carolina (1995-2000), PhD—Molecular and

Cellular Biology and Pathobiology

*Fellowship:* Cell Biology and Anatomy (2000-2007)

**Affiliations/Study Sections:**

- 2009- Member of the American Association of Anatomists
- 2009- Member of the American Heart Association
- 2010- Member of the American Society for Matrix Biology
- 2013- AHA Study Section Member for Cardiovascular Development
- 2014- NIH-NHLBI Study Section Member for R15/AREA Awards
- 2014- DOD/VA Study Section Member for CDMRP-PRMRP Congenital Heart Disease Panel
- 2015- Member of the International Heart Valve Society

**Editorial Boards/Manuscript Review:**

Journal of Cardiovascular Development and Disease: Associate Editor

Circulation: Ad hoc reviewer

Circulation Research: Ad hoc reviewer

Developmental Biology: Ad hoc reviewer

Developmental Dynamics: Ad hoc reviewer

Journal of Tissue Engineering: Ad hoc reviewer

Anatomical Record: Ad hoc reviewer

Journal of Biological Chemistry: Ad hoc reviewer

Journal of Dermatology: Ad hoc reviewer

Journal of Molecular and Cellular Cardiology: Ad hoc reviewer

Annals of Plastic Surgery: Ad hoc reviewer

Journal of Visual Experiments: Ad hoc reviewer

Cardiovascular Research: Ad hoc reviewer

***Research Interests:***

My lab focuses on developmental mechanisms that contribute to the pathogenesis of cardiac valve diseases. Our collaborative studies using deep sequencing, GWAS, and various tractable genetic models (e.g. zebrafish and mice) have yielded new genes causal to mitral valve prolapse (MVP) and bicuspid aortic valve (BAV) disease, two of the most common cardiac diseases with no known etiology. The genes that we have identified indicate a potential common thread for the etiology of these diseases. Our studies utilizing these genetic discoveries have informed new paradigms driving

valve development and will likely parlay potential modes of intervention that could be used to treat the diseases.

**Biology of interest:** Fibroblast-fibroblast interactions, fibroblast-ECM interactions, fibroblast-myocyte interactions, cell polarity, collective migration, cilia, ciliopathies, bicuspid aortic valve disease, myxomatous valve disease.

#### **University Activities:**

- 2009- IACUC review board member
- 2013- Admission Committee Member for MUSC college of Graduate Studies
- 2013- Interviewer for Masters, PhD, and MSTP admissions committee
- 2013- Graduate Coordinator for the Department of Regenerative Medicine and Cell Biology
- 2013- MUSC Masters in Biomedical Science Steering Committee
- 2014- MUSC Faculty Senate
- 2014- MUSC Graduate Council
- 2014- MUSC Institutional Advancement Committee
- 2014- Masters admissions committee
- 2014- Masters in Biomedical Sciences Committee

#### **Teaching Activities:**

- 2013- Cell Signaling in Development; Course co-Director
- 2015- Masters Proposal Writing Course, Course Director

#### **Publications:**

##### *Original Research Articles:*

1. **Norris RA** and Kern MJ. *Functional characterization of domains important for transcriptional regulation by Prx1 and Prx2 homeoproteins.* **Molecular Biology of the Cell** 10S:p96:556 1999
2. **Norris RA**, Scott KK, Moore CS, Stetten G, Brown CR, Jabs EW, Wulfsberg EA, Yu J, and Kern MJ. *Human PRRX1 and PRRX2 genes: cloning, expression, genomic localization, and exclusion as disease genes for Nager syndrome.* **Mammalian Genome** 11:1000-1005, 2000
3. **Norris RA** and Kern MJ. *Identification of domains mediating transcription activation, repression, and inhibition in the paired-related homeobox protein, Prx2 (S8).* **DNA Cell Biol.** 2001 Feb;20(2):89-99.
4. **Norris, RA** and Kern MJ. *The identification of Prx1 transcription regulatory domains provides a mechanism for unequal compensation by the Prx1 and Prx2 loci.* **J Biol Chem.** 2001 Jul

20;276(29):26829-37. Epub 2001 May 23.

5. Mjaatvedt CH, Nakaoka T, Moreno-Rodriguez R, **Norris RA**, Kern MJ, Eisenberg CA, Turner D, Markwald RR. *The outflow tract of the heart is recruited from a novel heart-forming field.* **Dev Biol.** 2001 Oct 1;238(1):97-109.
6. Scott KK, **Norris RA**, Potter SS, Norrington DW, Baybo MA, Hicklin DM, Kern MJ. *GeneChip microarrays facilitate identification of Protease Nexin-1 as a target gene of the Prx2 (S8) homeoprotein.* **DNA Cell Biol.** 2003 Feb;22(2):95-105
7. **Norris RA**, Kern CB, Wessels A, Moralez EI, Markwald RR, Mjaatvedt CH. *Identification and detection of the periostin gene in cardiac development.* **Anat Rec A Discov Mol Cell Evol Biol.** 2004 Dec;281(2):1227-33.
8. Kern CB, Hoffman S, Moreno R, Damon BJ, **Norris RA**, Krug EL, Markwald RR, Mjaatvedt CH. *Immunolocalization of chick periostin protein in the developing heart.* **Anat Rec A Discov Mol Cell Evol Biol.** 2005 May;284(1):415-23.
9. Mjaatvedt CH, Kern CB, **Norris RA**, Fairey S, Cave CL. *Normal distribution of melanocytes in the mouse heart.* **Anat Rec A Discov Mol Cell Evol Biol.** 2005 Aug;285(2):748-57.
10. **Norris RA**, Kern CB, Wessels A, Wirrig EE, Markwald RR, Mjaatvedt CH. *Detection of betaig-H3, a TGFbeta induced gene, during cardiac development and its complementary pattern with periostin.* **Anat Embryol (Berl).** 2005 Aug;210(1):13-23. Epub 2005 Jul 21.
11. Butcher JT, **Norris RA**, Hoffman S, Moreno R, Markwald R. *Periostin enhances atrioventricular cushion mesenchyme invasion and matrix condensation mediated by integrin signaling and Rho kinase.* **Dev Biol.** 2006 Oct 4.
12. Kasyanov V, **Norris RA**, Wen X, Damon B, Ramamurthi A, Trusk T, Forgacs G, Ozolanta I, Vetra J, Markwald RR, Mironov V. *Biomechanical Properties of Skin from Wild and Periostin-Null Mice.* **5<sup>th</sup> World Congress on Biomechanics.** 2006 Aug; G729C1745: 509-516.
13. Kern CB, **Norris RA**, Thompson R, Hoffman S, W. Argraves WS, Markwald RR and Mjaatvedt CH. *Versican proteolysis facilitates myocardial regression during outflow tract development.* **Dev Dyn.** 2007 Mar;236(3):671-83.
14. **Norris RA**, Damon B, Mironov V, Kasyanov V, Ramamurthi A, Moreno-Rodriguez R, Trusk T, Potts JD, Goodwin RL, Davis J, Hoffman S, Wen X, Sugi Y, Kern CB, Mjaatvedt CH, Turner DK, Oka T, Conway SJ, Molkentin J, Forgacs G, Markwald RR. *Periostin regulates collagen I fibrillogenesis and the biomechanical properties of connective tissues.* **J Cell Biochem** 2007; Jun 1; 101(3): 695-711.
15. Inai K, **Norris RA**, Hoffman S, Markwald RR, and Sugi Y. *BMP-2 induces cell migration and periostin expression during atrioventricular valvulogenesis.* **Dev Biol.** 2008 Mar 15;315(2):383-96.

16. **Norris RA**, Moreno-Rodriguez RA, Sugi Y, Hoffman S, Amos J, Hart MH, Potts J, Goodwin RL, Markwald RR. *Periostin Regulates Atrioventricular Valve Maturation*. **Dev Biol**. 2008 Apr 15;316(2):200-13.
17. Li G, Jin R, **Norris RA**, Zhang L, Wu F, Markwald RR, Nanda A, Conway SJ, Smyth SS, Granger DN. *Adenovirus-mediated overexpression of periostin promotes vascular smooth muscle cell migration through the integrin  $\alpha$ V $\beta$ 3/ FAK signaling pathway*. **Atherosclerosis**. 2010 Feb; 208(2): 358-365.
18. **Norris RA**, Potts JD, Yost MJ, Junor L, Brooks T, Tan H, Hoffman S, Hart MM, Kern MJ, Damon B, Markwald RR, Goodwin RL. *Periostin promotes a fibroblastic lineage pathway in atrioventricular valve progenitor cells*. **Dev Dyn**. 2009 May;238(5):1052-63. doi: 10.1002/dvdy.21933.20.
19. Gruber HE1, **Norris RA**, Kern MJ, Hoelscher GL, Ingram JA, Zinchenko N, Hanley EN Jr. *The Extracellular Matrix Protein, Periostin, is Expressed by Cells of the Human and Sand Rat Intervertebral Discs*. **Biotech Histochemistry**. 2011 Jun; 86(3); 199-206
20. Kokko, KP, Norris, RA, Wen, X, Glen, K, Hartsock, L, Kern, MJ. *A novel Murine Fibula Fracture Model Facilitates Micro-CT Analyses*. **Journal of Orthopaedic Research**, 2009.
21. Levine RA, Slaugenhaupt S, Hagege A, Jeunemaitre X, Markwald RR, **Norris RA**, on behalf of the Leducq Mitral Consortium. *Mitral Valve Prolapse: From Genes To New Therapies. The Exciting Potential of an International Network of Scientists and Clinicians*. **Society for MVP Syndrome and on-line at [www.mitralvalveprolapse.com](http://www.mitralvalveprolapse.com)** (Nov 2009).
22. Hajdu Z, Mironov V, Mehesz AN, **Norris RA**, Markwald RR, Visconti RP. *Tissue spheroid fusion-based in vitro screening assays for analysis of tissue maturation*. **J Tissue Eng Regen Med**. 2010 Dec; 4(8): 659-64.
23. Chiu, Y-N, **Norris RA**, Mahler G, Recknagel A, Butcher JT. *Complementary and Redundant Roles for TGF $\beta$ , BMP, and VEGF in Embryonic Atrioventricular Remodeling: Natural Template for Heart Valve Tissue Engineering*. **Tissue Eng Part A**. 2010 Nov;16(11):3375-83. Epub 2010 Jul 14.
24. **Norris RA**, Moreno-Rodriguez, R, Wessels, A, Merot, J, Hagege, A, Slaugenhaupt, S, Schott, JJ, Harris, BS, Williams, LK, Richards, A, Levine, RA, Markwald, RR. *Expression Of The Familial Cardiac Valvular Dystrophy Gene, Filamin-A, During Heart Morphogenesis*. **Dev Dyn**. 2010 Jul;239(7):2118-27
25. Teekakirikul P, Eminaga S, Toka O, Alcalai R, Wang L, Wakimoto H, Naylor M, Konno T, Gorham JM, Wolf CM, Kim JB, Schmitt JP, Molkentin JD, **Norris RA**, Tager AM, Hoffman SR, Markwald RR, Seidman CE, Seidman JG. *Cardiac fibrosis, in hypertrophic cardiomyopathy, is mediated by non-myocyte proliferation and requires Tgf $\beta$* . **J. Clin Invest**. 2010 Oct; 120(10):3520-9

26. Tan H, Junor L, Price RL, **Norris RA**, Potts JD, Goodwin RL. *Expression and deposition of fibrous extracellular matrix proteins in cardiac valves during chick development.* **Microsc Microanal.** 2011 Feb;17(1):91-100.
27. Sauls K, de Vlaming A, Harris BS, Williams K, Wessels A, Levine RA, Slaughaupt SA, Goodwin RL, Pavone LM, Merot J, Schott JJ, Le Tourneau T, Dix T, Jesinkey S, Feng Y, Walsh C, Zhou B, Baldwin S, Markwald RR, **Norris RA**. *Developmental basis for filamin-A-associated myxomatous mitral valve disease.* **Cardiovasc Res.** 2012 Oct 1;96(1):109-19
28. Wessels A, van den Hoff MJ, Adamo RF, Phelps AL, Lockhart MM, Sauls K, Briggs LE, **Norris RA**, van Wijk B, Perez-Pomares JM, Dettman RW, Burch JB. *Epicardially-derived fibroblasts preferentially contribute to the parietal leaflets of the atrioventricular valves in the murine heart.* **Dev Biol.** 2012 Jun 15;366(2):111-24
29. Doyle AJ, Doyle JJ, Bessling SL, Maragh S, Lindsay ME, Schepers D, Gillis E, Mortier G, Homfray T, Sauls K, **Norris RA**, Huso ND, Leahy D, Mohr DW, Caulfield MJ, Scott AF, Destrée A, Hennekam RC, Arn PH, Curry CC, Laer LV, McCallion AS, Loeys BL, Dietz HC. *Mutations in the Prototypical TGF- $\beta$  Repressor SKI Cause Shprintzen-Goldberg Syndrome with Aortic Aneurysm.* **Nature Genetics.** 2012 Nov;44(11):1249-54
30. Lockhart MM, Wirrig EE, Phelps AL, Ghatnekar AV, Barth JL, **Norris RA**, Wessels A. *Mef2c regulates transcription of the extracellular matrix protein cartilage link protein 1 in the developing murine heart.* **PLoS One.** 2013;8(2):e57073. doi: 10.1371/journal.pone.0057073. Epub 2013 Feb 26.
31. Shanmugan I, Sinha A, **Norris RA**, Markwald R, Vyavahare N. *Periostin as an early marker for elastin mediated vascular smooth muscle cell calcification.* **Cardiovascular System**, ISSN 2052-4358. 2013
32. Kolpa HJ, Peal DS, Lynch SN, Giokas AC, Ghatak S, Misra S, **Norris RA**, Macrae CA, Markwald RR, Ellinor P, Bischoff J, Milan DJ. *miR-21 represses Pcd4 during cardiac valvulogenesis.* **Development.** 2013 May;140(10):2172-80.
33. Duval D, Lardeux A, Le Tourneau T, **Norris RA**, Markwald RR, Sauzeau V, Probst V, Le Marec H, Levine R, Schott JJ, Merot J. *Valvular dystrophy associated filamin A mutations reveal a new role of its first repeats in small-GTPase regulation.* **Biochim Biophys Acta.** 2013 Nov 4;1843(2):234-244.
34. Zhou J, Bowen C, Lu G, Knapp Iii C, Recknagel A, **Norris RA**, Butcher JT. *Cadherin-11 Expression Patterns in Heart Valves Associate with Key Functions during Embryonic Cushion Formation, Valve Maturation and Calcification.* **Cells Tissues Organs.** 2013; 198(4):300-10.
35. Trombetta-eSilva J, Eadie EP, Zhang Y, **Norris RA**, Borg TK, Bradshaw AD. *The effects of age and the expression of SPARC on extracellular matrix production by cardiac fibroblasts in 3-D cultures.* **PLoS One.** 2013 Nov 6;8(11):e79715.

36. Gallo EM, Loch DC, Habashi JP, Calderon JF, Chen Y, Bedja D, van Erp C, Gerber EE, Parker SJ, Sauls K, Judge DP, Cooke SK, Lindsay ME, Rouf R, Myers L, Ap Rhys CM, Kent KC, **Norris RA**, Huso DL, Dietz HC. *Angiotensin II-dependent TGF- $\beta$  signaling contributes to Loeys-Dietz syndrome vascular pathogenesis.* **J Clin Invest.** 2014 Jan;124(1): 448-60.
37. Ghatak S, Misra S, **Norris RA**, Moreno-Rodriguez RA, Hoffman S, Levine RA, Hascall VC, Markwald RR. *Periostin induces intracellular cross-talk between kinases and hyaluronan in atrioventricular valvulogenesis.* **J Biol Chem.** 2014 Mar 21;289(12):8545-61.
38. Lockhart MM, Boukens BJ, Phelps AL, Brown CL, Toomer KA, Burns TA, Mukherjee RD, **Norris RA**, Trusk TC, van den Hoff MJ, Wessels A. *Alk3 mediated Bmp signaling controls the contribution of epicardially derived cells to the tissues of the atrioventricular junction.* **Dev Biol.** 2014 Dec 1;396(1):8-18.
39. Beachley V, Kasyanov V, Nagy-Mehesz A, **Norris RA**, Ozolanta I, Kalejs M, Stradins P, Baptista L, da Silva K, Grainjero J, Wen X, Mironov V. *The fusion of tissue spheroids attached to pre-stretched electrospun polyurethane scaffolds.* **J. Tissue Engineering,** 2014 Nov 6; 5: 2041731414556561
40. **Norris RA**, on behalf of the Leducq Consortium for Valve Disease. *Non-syndromic mitral valve prolapse from gene mutations to modifiable mechanisms.* **Circulation.** 2015; 130:A18977
41. Lindner HB, Felmly LM, Demcheva M, Seth A, **Norris RA**, Bradshaw AD, Vournakis J, Muise-Helmericks RC *pGlcNAc Nanofiber Treatment of Cutaneous Wounds Stimulate Increased Tensile Strength and Reduced Scarring via Activation of Akt1.* **PLoS One.** 2015; May 8; 10(5):e0127876.
42. Judge DP, Nematalla H, **Norris RA**, Levine RA, Butcher JT, Vignier N, Kang KH, Nguyen Q, Bruneval P, Perier MC, Messas E, Jeunemaitre X, deVlaming A, Markwald R, Carrier L, Hagege A. *Targeted Mybpc3 knockout mice with cardiac hypertrophy exhibit structural mitral valve abnormalities.* **J. Cardiovasc. Dev. Dis.** 2015, 2, 48-65.
43. Duval D, Labbem P, Bureau L, Tourneau T, **Norris RA**, Markwald R, Levine R, Schott JJ, Merot J. *MVP associated Filamin-A Mutations Affect FLNA-PTPN12 (PTP-PEST) Interactions.* **J. Cardiovasc. Dev. Dis.** 2015, 2(3), 233-247; doi:10.3390/jcdd2030233
44. Durst R\*, Sauls K\*, Peal DS\*, deVlaming A, Toomer K, Leyne M, Salani M, Talkowski ME, Harrison B, Perrocheau M, Simpson C, Jett C, Stone MR, Charles F, Chiang C, Lynch SN, Bouatia-Naji N, Delling FN, Freed LA, Tribouilloy C, LeTourneau T, LeMarec H, Fernandez-Friera L, Solis J, Trujillano D, Ossowski S, Estivill X, Dina C, Bruneval P, Chester A, Schott J-J, Irvine KD, Mao Y, Wessels A, Motiwala T, Puceat M, Tsukasaki Y, Menick DR, Kasiganesan H, Nie X, Broome A-M, Williams K, Johnson A, Markwald RR, Jeunemaitre X<sup>§</sup>, Hagege A<sup>§</sup>, Levine RA<sup>§</sup>, Milan DJ<sup>§</sup>, **Norris RA<sup>§,#</sup>**, Slaugenhaupt SA<sup>§,#</sup>. *Mutations in DCHS1 Cause Mitral Valve Prolapse.* **Nature.** 2015 Sep 3;525(7567):109-13. doi: 10.1038/nature14670. \*-Co-first authors with equal contribution, <sup>§</sup>-Co Senior Authors, <sup>#</sup>-Co-

#### Corresponding authors

45. Dina C, Bouatia-Naji N, Tucker N, Delling FN, Toomer K, Durst R, Perrocheau M, Fernandez-Friera L, Solis J; PROMESA investigators, Le Tourneau T, Chen MH, Probst V, Bosse Y, Pibarot P, Zelenika D, Lathrop M, Hercberg S, Roussel R, Benjamin EJ, Bonnet F, Lo SH, Dolmatova E, Simonet F, Lecointe S, Kyndt F, Redon R, Le Marec H, Froguel P, Ellinor PT, Vasan RS, Bruneval P, Markwald RR, **Norris RA\***, Milan DJ\*, Slaughter SA\*, Levine RA\*, Schott JJ\*, Hagege AA\*, Mvp-France, Jeunemaitre X\*; Leducq Transatlantic MITRAL Network. \*Co-Senior and co-corresponding authors with equal contribution. *Genetic association analyses highlight biological pathways underlying mitral valve prolapse*. **Nat Genet.** 2015 Aug 24. doi: 10.1038/ng.3383
46. Sauls K, Toomer K, Williams K, Johnson AJ, Markwald RR, Hajdu Z, **Norris RA**. *Increased infiltration of extra-cardiac cells in Myxomatous valve disease*. **J. Cardiovasc. Dev. Dis.** **2015**, 2(3), 200-213
47. Horne TE, VandeKopple M, Sauls K, Koenig SN, Anstine LJ, Garg V, **Norris RA**, Lincoln J. *Dynamic Heterogeneity of the Heart Valve Interstitial Cell Population in Mitral Valve Health and Disease*. **J. Cardiovasc. Dev. Dis.** **2015**, 2(3), 214-232

#### Reviews/Book Chapters:

1. Litvin J, Zhu S, **Norris RA**, Markwald R. *Periostin family of proteins: therapeutic targets for heart disease*. **Anat Rec A Discov Mol Cell Evol Biol.** 2005 Dec;287(2):1205-12.
2. **Norris RA**, Borg TK, Butcher JT, Markwald RR. *Neonatal and Adult Cardiovascular Pathophysiological Remodeling and Repair: Developmental Role of Periostin*. **Ann N Y Acad Sci.** 2008 Mar;1123:30-40
3. **Norris RA**, Hoffman S, Markwald RR. *The role of Periostin during Cardiac Morphogenesis and Disease*. **J Cell Commun Signal.** 2009 Dec;3(3-4):275-86.24.
4. Markwald RR, **Norris RA**, Levine R. *Developmental Basis Of Adult Cardiovascular Diseases: Valvular Heart Diseases*. **Ann N Y Acad Sci.** 2010 Feb;1188:177-8325.
5. de Vlaming A, Sauls K, Hajdu Z, Visconti RP, Mehesz AN, Levine RA, Slaughter SA, Hagege A, Chester AH, Markwald RR, **Norris RA**. *Atrioventricular valve development: new perspectives on an old theme*. **Differentiation.** 2012 Jul;84(1):103-16.
6. Pavone LM, **Norris RA**. *Distinct Signaling Pathways Activated by "Extracellular" and "Intracellular" Serotonin in Heart Valve Development and Disease*. **Cell Biochem Biophys.** 2013; 67(3) 819-28.
7. *Unifying Concepts of Mitral Valve Disease: From Morphology to Mechanisms and Beyond*.



Robert Levine, Albert Hagege, Daniel Judge, Muralidhar Padala, Jacob Dal-Bianco, Elena Aikawa, Jonathan Beaudoin, Joyce Bischoff, Nabila Bouatia-Naji, Patrick Bruneval, Jonathan Butcher, Alain Carpentier, Miguel Chaput, Adrian Chester, Catherine Clusel, Francesca Nesta Delling, Harry Dietz, Christian Dina, Ronen Durst, Leticia Fernandez, Mark Handschumacher, Morton Jensen, Xavier Jeunemaitre, Hervé Le Marec, Thierry Le Tourneau, R Markwald, Jean Mérot, Emmanuel Messas, David Milan, Tui Neri, **Russell Norris**, David Peal, Maelle Perrocheau, Vincent Probst, Michael Puceat, Nadia Rosenthal, Jorge Solis-Martin, Jean-Jacques Schott, Ehud Schwammenthal, Susan Slaugenhaupt, Jae-Kwan Song, and Magdi Yacoub. In Press **Nature Reviews Cardiology** (In Press 2015)

8. Markwald RR, Ghatak S, Misra S, Moreno-Rodriguez RA, Sugi Y, Visconti R, **Norris RA**. *Congenital Heart Disease: In Search of Remedial Etiologies*. **Takao 7<sup>th</sup> Symposium on Congenital Heart Defects**. (In Press 2015)

#### **Patents:**

1. Title: "Acceleration of Fracture Bone Healing by Periostin Polypeptides" US patent #61/039,017
2. Title: "Novel Periostin Inhibitory Reagents Promote Myocardial Regeneration and Reduce Cardiac Scarring" Patent Pending (MUSC-FRD File No.: P0905)

#### **Invited Talks:**

- 1998 Invited Lecturer Developmental Biology meeting of Medical College of Georgia
- 2006 Invited Lecturer for NSF FIBRE Tissue Engineering Symposium, Columbia, MO
- 2007 Invited Lecturer for NSF FIBRE Tissue Engineering Symposium, Salt Lake City, Utah
- 2007 Invited Lecturer Cardiovascular Developmental Biology Meeting, Charleston, SC
- 2008 Invited Lecturer INBRE Symposium, College of Charleston, Charleston, SC
- 2008 Invited Lecturer, University of North Carolina, Charlotte, North Carolina.
- 2010 Platform Presentation, Cardiovascular Development, Differentiation, and Disease Symposium, Charleston, SC
- 2010 Platform Presentation, Marfan Syndrome Society, Washington, DC
- 2010 Platform Presentation, International Society of Biofabrication, Philadelphia, PA
- 2011 Platform Presentation, Weinstein Cardiovascular Conference, Cincinnati, Ohio
- 2009 Platform Presentation, Leducq Cardiovascular Meeting, London, UK
- 2009 Platform Presentation, Leducq Cardiovascular Meeting, Boston, Mass
- 2010 Platform Presentation, Cardiovascular Development, Differentiation, and Disease Symposium, Charleston, SC
- 2010 Platform Presentation, Marfan Syndrome Society, Washington, DC
- 2010 Platform Presentation, Leducq Cardiovascular Meeting, Paris, France
- 2010 Platform Presentation, International Society of Biofabrication, Philadelphia, PA
- 2011 Platform Presentation, Leducq Cardiovascular Meeting, Baltimore, MD
- 2011 Platform Presentation, Weinstein Cardiovascular Conference, Cincinnati, Ohio
- 2012 Platform Presentation, Leducq Cardiovascular Meeting, Jerusalem, Israel
- 2012 Platform Presentation, Leducq Cardiovascular Meeting, Paris, France
- 2012 Platform Presentation, Symposium on Development of the Heart, Amsterdam, Netherlands
- 2012 Invited Talk at University of South Carolina

2013 Invited Talk at CVRC Massachusetts General Hospital/Harvard (April 9<sup>th</sup>, 2013)  
 2013 Platform Presentation, Cardiovascular Development, Differentiation, and Disease Symposium, Charleston, SC  
 2013 Platform Presentation, Leducq Cardiovascular Meeting, Madrid, Spain  
 2013 Platform Presentation, Weinstein Cardiovascular Conference, Tuscon, Arizona  
 2013 Invited Talk at Vanderbilt University  
 2013 Invited Talk at Nationwide Children's Hospital Research Institute, Columbus, Ohio  
 2014 Platform Presentation, Cardiovascular Development, Differentiation, and Disease Symposium, Charleston, SC  
 2014 Invited Talk, Department of Pediatrics, MUSC  
 2014 Platform Presentation, Weinstein Conference, Madrid Spain  
 2014 Invited Talk, Pediatric Grand Rounds, Yale University  
 2014 Invited Talk, Valve Conference, Columbus, Ohio  
 2014 AHA, Chicago, Il.—best in cardiovascular sciences presentation  
 2014 Invited Talk at Nationwide Children's Hospital Research Institute, Columbus, Ohio  
 2014 Invited Talk and Training Session, University of Pittsburgh  
 2015 Invited Talk at UNC Chapel Hill, NC  
 2015 Platform Presentation, Keystone, Copper Mountain, Co  
 2015 Platform Presentation, Monaco  
 2015 Keynote Lecture, Monaco

**Press Releases:**

- *American Society of Human Genetics, Boston:* [www.bioquicknews.com/node/1371](http://www.bioquicknews.com/node/1371)
- *MUSC—Progressnotes, 2015*
- *MUSC:* <http://academicdepartments.musc.edu/pr/newscenter/2015/mitral-valve-prolapse-research.html#.Ve7t-SjJWCa>
- *Healthy Living/Reuters:* <http://www.healthylivingmagazine.us/Articles/12435/>

**Mentored Student Training:**

Cuyler Brown, rotating DMD student, 1998  
 Georgina Gainey, rotating DMD student, 1998  
 Allison Varn, rotating DMD student, 1998  
 David Hicklin, rotating DMD student, 2000  
 David Norington, rotating DMD student, 2000  
 Kirby Smith, rotating MD student, 2003  
 Kyle P. Kokko, MD, PhD student, 2008-2009  
 Annemarieke deVlaming, MS Student, 2007-2010  
 Tahirali Moliwala, MD rotating student, 2011  
 Marie Lockhart, PhD, Advisory Committee, 2009-2014  
 Laura Briggs, MD, PhD, Advisory Committee, 2008-2013  
 Lauren Fanning, Undergraduate Student, 2014 Summer  
 Kimberly Sauls, PhD Student, 2011-

Katelynn Toomer, PhD Student, 2013-  
Alex Drohan, Summer Undergraduate—2015 summer  
Josh Nguyen, Summar Magnet Highschool Student, 2015 summer

**Funding:**

Active:

**R01 HL033756** 07/01/12-06/30/16

**Role: Co-I (Markwald, RR.-P.I.)**

**NIH NHLBI**

**Mucopolysaccharide Metabolism in Cardiac Anomalies**

The major goals of this project are to determine if the heart defect (htd) gene is a prototype candidate for an embryonic segmentation gene; to determine if the fate of the luminal “face” of cushion mesenchyme is to expand into the definitive precursor valve leaflets; and to determine if a primary fate of cushions is to interact with the myocardium to complete septal development.

**P20 GM103444-07** 07/01/14-6/30/18

**Role: Target Faculty (Vyavahare-PI)**

**NIH/NIGMS**

**Sub-Project Title: Developmental And Biomechanical Mechanisms of Valve Tissue Formation**

The goals of this project are to determine developmental mechanisms that contribute to mitral valve prolapse. Additionally, we aim to integrate biomechanical studies with development using novel bioreactors and cells derived from patients with mitral valve prolapse to gain a clear understanding for how valve developmental defects give rise to mechanically inferior adult valve tissues.

**1R01 HL122906** 09/01/14-08/31/15

**Role: Co-I (Wessels, A. – P.I.)**

**NIH/NHLBI**

**Mechanisms of DMP Development and Atrioventricular Septation**

The major goal of this project is to test the hypothesis that primary cilia are functioning as a signaling center in the pSHF/DMP and are critically important in the development of the DMP and in atrioventricular septation.

**1R01 HL127692-01** 04/01/15-03/31/20

**Role: Institutional PI (Milan, D-PI; MGH/Harvard).**

**NIH/NHLBI**

**Genetics and Mechanisms of Mitral Valve Prolapse**

Mitral Valve Prolapse affects about 7 million Americans and increases the risk of endocarditis and congestive heart failure, but relatively little is known about the underlying mechanisms leading to this disease. The goal of our application is to study the genetics and mechanisms of this disease. Characterizing new pathways for mitral valve prolapse will provide new targets for drug discovery to prevent and treat this heart disease

**15GRNT25080052**

**07/01/15-06/30/17**

**Role: PI**

**AHA Grant in Aid**

**Etiology and Treatment for Mitral Valve Prolapse**

Mitral valve prolapse is one of the most common disease in the human population and affects 1 in 40 people. Roughly 50% of people who have MVP require some aspect of clinical intervention ranging from medical management to valve replacement. To date, little is known regarding the etiology of the disease. Although MVP can be inherited through generations, disease genes have been elusive. We have recently identified DCHS1 as an MVP disease gene and have developed applicable models to study MVP in mice. This affords us the ability to ask questions that heretofore have not been possible and are critical if we are to improve medical options for patients with MVP.

***Pending:***

**1RO1HL123974-01A1**

**07/01/15-06/30/20**

**Role: PI**

**NIH/NHLBI**

**Primary Cilia and Valvular Heart Disease**

Little is known regarding the etiology of valve disease. Uncovering the genetic causes for valve disease will provide key insight into mechanisms that contribute to valve development and allow us to study why valve disease happens. Based on our genetic discoveries, our goal for this proposal is to examine a new mechanism for how valve leaflets develop, and whether this pathway can be pharmacologically targeted to treat disease.

***CAV-BAV: Calcific Aortic Valve Disease of the Bicuspid Aortic Valve***

***Leducq Foundation***

**Role: Site PI**

Bicuspid aortic valve (BAV) is observed in ~1% of the population and accounts for ~40% of aortic valve replacements performed in Western countries, principally for aortic stenosis due to calcific aortic valve disease (CAVD). Currently, there is no medical therapy that can prevent or treat CAVD. This Trans-Atlantic Network of Excellence (TNE) will identify the mechanisms responsible for the accelerated CAVD seen in individuals with BAV. These discoveries will lead to the development of therapeutic targets and strategies for CAVD prevention, which are currently unavailable.

***Completed:***

- **HL07260** **01/01/01-01/01/04**  
**Role: Postdoctoral Fellow**  
**NIH**  
*Institutional Postdoctoral Training Grant in Cardiovascular Biology*
- **2 P20 RR16461-05A1** **09/30/05 - 04/30/10**  
**Role-Target Faculty**  
**NIH INBRE RFA Grant**  
*Stem Cell and Regenerative Medicine Core*

- **EF052684** **09/01/06-08/31/10**  
**Role: Co-Investigator**  
**National Science Foundation (NSF)**  
*Understanding and Employing Matricellular Self-Assembly*
  
- **0765280U** **07/01/07-06/30/09**  
**Role: PI**  
**AHA Beginning Grant in Aid**  
*Cardiac Valve Differentiation, Maturation, and Function is Dependent on the Periostin Gene*
  
- **1R01HL086856-01A1** **08/01/07-07/31/12**  
**Role: Co-Investigator**  
**NIH-NHLBI**  
*The Role of Fluid Flow in Valvulogenesis*
  
- **07CVD04** **10/1/08-09/30/14**  
**Role: Co-Investigator**  
**Leducq Foundation**  
*Mitral Valve Disease: From Genetic Mechanisms to Improved Repair*
  
- **3 P20 RR016434-09S2** **09/01/09-08/31/11**  
**Role: Co-Investigator**  
**NIH NHLBI**  
*SC COBRE For Developmentally Based Cardiovascular Diseases*
  
- **11SDG5270006** **01/01/11-12/31/14**  
**Role: PI**  
**AHA Scientist Development Grant**  
*Pathogenetic Mechanisms of Myxomatous Mitral Valve Dystrophy*