# Rheumatology

## Division Details

| RESEARCH AND TRAINING DETAILS | |
|---|---|
| Faculty | **11** |
| Joint Appointment Faculty | **3** |
| Total Annual Grant Award Dollars | **$922,212** |
| Total Annual Industry Award Dollars | **$3,057,686** |

| CLINICAL ACTIVITIES AND TRAINING | |
|---|---|
| Clinical Fellows | **6** |
| Inpatient Encounters | **437** |
| Outpatient Encounters | **6,306** |

Row 1: J Huggins, H Brunner, S Angeles-Han, S Thornton, E Morgan

Row 2: G Schulert, A Grom, M Henrickson, D Lovell

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## Division Highlights

### Urine Biomarkers to Predict Response in Lupus Nephritis in Children and Young Adults

Systemic lupus erythematosus (SLE) is a multisystem inflammatory autoimmune disease, and lupus nephritis (LN) is one of the main determinants of poor prognosis. At the current time, to make the diagnosis of LN requires a kidney biopsy, and determines the level of renal inflammation. A major factor leading to such unsatisfactory LN outcomes is a lack of noninvasive clinical and laboratory measures to accurately gauge LN status in terms of activity and response to therapy. Therapy of LN encompasses six months of intensive immunosuppression to induce resolution of inflammation, followed by less intense therapy to maintain remission. Dr. Hermine Brunner, MD, MSc, MBA, in collaboration with the Division of Nephrology at Cincinnati Children's, performed a multi-center international study to discover, and subsequently validate, novel biomarkers measured in the urine. The team showed that the combination of six urine biomarkers reflects the degree of active inflammation as seen on kidney biopsy with LN extremely well (accuracy > 92%). More recently, using sample and data from 87 children with LN, Dr. Brunner and the team at Cincinnati Children's showed that low urine levels of TGF-β and ceruloplasmin at the time of biopsy and marked reduction of α-1-acid glycoprotein, transferrin and Vitamin D binding protein within three months of commencing LN therapy are outstanding predictors (accuracy > 90%) for achieving remission of LN. If confirmed, the use of these results can help personalize LN therapy.

This research resulted in three peer-reviewed publications:

Brunner HI, Bennett MR, Abulaban K, Klein-Gitelman MS, O'Neil KM, Tucker L, Ardoin SP, Rouster-Stevens KA, Onel KB, Singer NG, Anne Eberhard B, Jung LK, Imundo L, Wright TB, Witte D, Rovin BH, Ying J, Devarajan P. **Development of a Novel Renal Activity Index of Lupus Nephritis in Children and Young Adults**. *Arthritis Care Res (Hoboken)*. 2016 Jul;68(7):1003-11.

Brunner HI, Bennett MR, Gulati G, Abulaban K, Klein-Gitelman MS, Ardoin SP, Tucker LB, Rouster-Stevens KA, Witte D, Ying J, Devarajan P. **Urine Biomarkers to Predict Response to Lupus Nephritis Therapy in Children and Young Adults.** *J Rheumatol.* 2017 Aug;44(8):1239-1248. Epub 2017 Jun 15.

Gulati G, Bennett MR, Abulaban K, Song H, Zhang X, Ma Q, Brodsky SV, Nadasdy T, Haffner C, Wiley K, Ardoin SP, Devarajan P, Ying J, Rovin BH, Brunner HI. **Prospective validation of a novel renal activity index of lupus nephritis.** *Lupus.* 2017 Aug;26(9):927-936. Epub 2016 Dec 19.

## Biomarkers of Response to Therapy in Children with Systemic Juvenile Idiopathic Arthritis

Systemic juvenile idiopathic arthritis (SJIA) is the most severe form of juvenile arthritis complicated by high fevers, serositis, lymphadenopathy, rashes and organomegaly. Introduction of IL-1 and IL-6 inhibiting biologics has dramatically improved the long-term outcome for patients with SJIA. Increasing clinical experience with these drugs, however, suggests significant SJIA heterogeneity in terms of responsiveness to these treatments. While about 20-30% of the patients appear equally responsive to both therapeutic strategies, about 1/3 of SJIA patients respond to IL-1 inhibiting agents only. In contrast, another third respond only to IL-6 neutralization. Furthermore, 10-15% of the patients fail both treatments. To ensure the timely initiation of the most appropriate treatment, there is a strong need for biomarkers that would predict the response. The main goal of the study, co-led by Dr. Alexei Grom, MD, was to characterize the molecular response to canakinumab, anti-interleukin-1ß (IL-1ß) monoclonal antibody neutralizing IL-1ß-mediated pathways and evaluate potential markers of response using samples from two SJIA pivotal trials. Researchers measured gene expression in patients with febrile SJIA and in matched healthy controls by Affymetrix DNA microarrays. At baseline, microarray analysis identified 984 probe sets differentially over expressed in patients versus controls. The strongest observed clinical response was in patients with higher baseline expression of several genes including IL-1ß, IL-1 receptors (IL1-R1 and IL1-R2), IL-1 receptor accessory protein (IL1-RAP), and IL-6. There is a need for additional research to investigate potential differences in the disease mechanisms in patients with heterogeneous gene transcription profiles.

This research led to the following peer-reviewed publication:

Brachat AH, Grom AA, Wulffraat N, Brunner HI, Quartier P, Brik R, McCann L, Ozdogan H, Rutkowska-Sak L, Schneider R, Gerloni V, Harel L, Terreri M, Houghton K, Joos R, Kingsbury D, Lopez-Benitez JM, Bek S, Schumacher M, Valentin MA, Gram H, Abrams K, Martini A, Lovell DJ, Nirmala NR, Ruperto N; Pediatric Rheumatology International Trials Organization (PRINTO) and the Pediatric Rheumatology Collaborative Study Group (PRCSG). **Early changes in gene expression and inflammatory proteins in systemic juvenile idiopathic arthritis patients on canakinumab therapy.** *Arthritis Res Ther.* 2017 Jan 23;19(1):13.

## The Pediatric Rheumatology Collaborative Study Group (PRCSG)

The mission of the Pediatric Rheumatology Collaborative Study Group (PRCSG) is to foster, facilitate, and conduct high quality clinical research in the field of pediatric rheumatology. The PRCSG is a network of pediatric rheumatology professionals working mostly at academic and clinical centers. PRCSG members are actively engaged in the diagnosis and management of children with rheumatic and related musculoskeletal diseases. Embedded in the Division of Rheumatology at Cincinnati Children's are the leadership and the PRCSG Coordinating Center. Dr. Daniel Lovell, MD, MPH, serves as the chairman of the organization, while Dr. Hermine Brunner, MD, MSc, MBA, is the scientific director. Additional information is available on the PRCSG website. Involved currently in the following Phase I - III trials are the PRCSG, in collaboration with Paediatric Rheumatology International Trials Organisation (PRINTO), where they study the following medications for use in JIA: Oral JAK (Janus Kinase) inhibitor tofacitinib trials- one in Polyarticular forms of JIA and one in SJIA; subcutaneous abatacept; subcutaneous tocilizumab; subcutaneous canakinumab; Subcutaneous adalimumab; subcutaneous certolizumab; intravenous golimumab; and subcutaneous secukinumab. The PRCSG involvement in Phase III trials in other pediatric rheumatic diseases includes intravenous rituximab for ANCA-associated vasculitis and intravenous belimumab in childhood-onset lupus.

Published peer-reviewed manuscripts resulting from the research conducted by the PRCSG during the preceding year are below:

Brunner HI, Ruperto N, Tzaribachev N, Horneff G, Chasnyk VG, Panaviene V, Abud-Mendoza C, Reiff A, Alexeeva E, Rubio-Pérez N, Keltsev V, Kingsbury DJ, Del Rocio Maldonado Velázquez M, Nikishina I, Silverman ED, Joos R, Smolewska E, Bandeira M, Minden K, van Royen-Kerkhof A, Emminger W, Foeldvari I, Lauwerys BR, Sztajnbok F, Gilmer KE, Xu Z, Leu JH, Kim L, Lamberth SL, Loza MJ, Lovell DJ, Martini A, PRINTO, PRCSG. **Subcutaneous golimumab for children with active polyarticular-course juvenile idiopathic arthritis: results of a multicentre, double-blind, randomised-withdrawal trial**. *Ann Rheum Dis*. 2017 May 15.

Brachat AH, Grom AA, Wulffraat N, Brunner HI, Quartier P, Brik R, McCann L, Ozdogan H, Rutkowska-Sak L, Schneider R, Gerloni V, Harel L, Terreri M, Houghton K, Joos R, Kingsbury D, Lopez-Benitez JM, Bek S, Schumacher M, Valentin MA, Gram H, Abrams K, Martini A,

Lovell DJ, Nirmala NR, Ruperto N, PRINTO, PRCSG. **Early changes in gene expression and inflammatory proteins in systemic juvenile idiopathic arthritis patients on canakinumab therapy**. *Arthritis Res Ther*. 2017 Jan 23:19(1):13.

Ravelli A, Minoia F, Davì S, Horne A, Bovis F, Pistorio A, Aricò M, Avcin T, Behrens EM, De Benedetti F, Filipovic L, Grom AA, Henter JI, Ilowite NT, Jordan MB, Khubchandani R, Kitoh T, Lehmberg K, Lovell DJ, Miettunen P, Nichols KE, Ozen S, Pachlopnik Schmid J, Ramanan AV, Russo R, Schneider R, Sterba G, Uziel Y, Wallace C, Wouters C, Wulffraat N, Demirkaya E, Brunner HI, Martini A, Ruperto N, Cron RQ, PRINTO, PRCSG; Histiocyte Society. **2016 Classification Criteria for Macrophage Activation Syndrome Complicating Systemic Juvenile Idiopathic Arthritis: A European League Against Rheumatism/American College of Rheumatology/Paediatric Rheumatology International Trials Organisation Collaborative Initiative**. *Arthritis Rheumatol*. 2016 Mar;68(3):566-76.

Grom AA, Ilowite NT, Pascual V, Brunner HI, Martini A, Lovell D, Ruperto N; PRINTO, PRCSG, Leon K, Lheritier K, Abrams K. **Rate and Clinical Presentation of Macrophage Activation Syndrome in Patients With Systemic Juvenile Idiopathic Arthritis Treated With Canakinumab**. *Arthritis Rheumatol*. 2016 Jan;68(1):218-28.

Ravelli A, Minoia F, Davì S, Horne A, Bovis F, Pistorio A, Aricò M, Avcin T, Behrens EM, De Benedetti F, Filipovic L, Grom AA, Henter JI, Ilowite NT, Jordan MB, Khubchandani R, Kitoh T, Lehmberg K, Lovell DJ, Miettunen P, Nichols KE, Ozen S, Pachlopnik Schmid J, Ramanan AV, Russo R, Schneider R, Sterba G, Uziel Y, Wallace C, Wouters C, Wulffraat N, Demirkaya E, Brunner HI, Martini A, Ruperto N, Cron RQ, PRINTO, PRCSG; Childhood Arthritis and Rheumatology Research Alliance; Histiocyte Society. **2016 Classification Criteria for Macrophage Activation Syndrome Complicating Systemic Juvenile Idiopathic Arthritis: A European League Against Rheumatism/American College of Rheumatology/Paediatric Rheumatology International Trials Organisation Collaborative Initiative**. *Ann Rheum Dis*. 2016 Mar:75(3)481-9.

## Interferon-Gamma Activation Characterizes Macrophage Activation Syndrome Complicating Systemic JIA

Macrophage activation syndrome (MAS) is a potentially life-threatening complication of systemic juvenile idiopathic arthritis (JIA), and has striking similarity to the rare histiocytic disorder hemophagocytic lymphohistiocytosis (HLH). Interferon-gamma (IFNγ) has a central role in the pathogenesis of HLH, but its role in MAS remains unclear. In this study, together with two centers in Italy, researchers determined levels of inflammatory cytokines and IFN-induced chemokines in patients with HLH or with systemic JIA with, and without MAS. Levels of IFNγ and IFN-induced chemokines were strikingly high in patients with both HLH and active MAS. In contrast, levels in patients with active systemic JIA, but without MAS, were comparable to those in patients with clinically inactive systemic JIA. Serum IFNγ and IFN-induced chemokine levels also strongly correlated with laboratory features of MAS. These findings strongly suggest that IFNγ, and IFN-induced chemokines, have a pivotal role in MAS, and supports the use of targeted anti- IFNγ therapy for this often fatal disorder.

This research led to the following peer-reviewed publication:

Bracaglia C, de Graaf K, Pires Marafon D, Guilhot F, Ferlin W, Prencipe G, Caiello I, Davì S, Schulert G, Ravelli A, Grom AA, de Min C, De Benedetti F. **Elevated circulating levels of interferon-γ and interferon-γ-induced chemokines characterise patients with macrophage activation syndrome complicating systemic juvenile idiopathic arthritis**. *Ann Rheum Dis.* 2017 Jan;76(1):166-172. Epub 2016 Jun 13.

## Research Flow Cytometry Core Provides Novel Technologies for CCHMC Investigators

Housed in the Division of Rheumatology, the Research Flow Cytometry Core (RFCC) is under the direction of Dr. Sherry Thornton, PhD. RFCC provides state-of-the-art equipment to over 140 research investigators to perform single cell analysis. In the last year, funding from the Cincinnati Children's Research Foundation enabled the RFCC to upgrade instruments for increased capability, and more detailed highly multi-parametric flow cytometry for both analysis and sorting of cell populations. Dr. Thornton submitted, and received, a National Institutes of Health (NIH) Shared Instrumentation Grant for a fourth cell sorter, increasing the capacity of cell sorting and allowing users access to cell sorting 24/7. The RFCC receives support from two NIH Center grants, the Cincinnati Rheumatic Disease Core Center, and the Digestive Health Center. To enhance the research of Cincinnati Children's investigators, the RFCC works closely with investigators and other core facilities to improve workflow. The RFCC presented these innovative activities at a workshop on Cross Core Collaborations at the 2017 Annual Meeting of the Association for Biomolecular Research Facilities in San Diego, CA.

## Increasing The Impact Of Patient Reported Outcomes in Pediatric Rheumatology Care

The National Institutes of Health (NIH) created the Patient Reported Outcomes Measurement Information System (PROMIS®) cooperative network (2005-2015) to develop a publicly available system to measure health from the patient perspective with more efficient and precise patient reported outcome (PRO) tools than previously available. During the second phase of this project, Dr. Esi Morgan, MD, MSCE, was principal investigator leading a multidisciplinary research project "Enhancing PROMIS in Pediatric Pain, Rheumatology and Rehabilitation Research" (U01AR057940). The project included longitudinal validation of PROMIS measures of self-reported health in children with juvenile idiopathic arthritis (JIA), and chronic pain, as well as development of new PROMIS item banks to assess pain behavior, pain quality and pain intensity in children with chronic painful conditions. The team published an article using application of an innovative method to determine meaning of patient reported outcome measure scores from the patient perspective, as well as the viewpoint of parents and clinical providers. Researchers documented differences in perspectives, which has implications for medical decision making.

Morgan EM, Mara CA, Huang B, Barnett K, Carle AC, Farrell JE, Cook KF. **Establishing clinical meaning and defining important differences for Patient-Reported Outcomes Measurement Information System (PROMIS®) measures in juvenile idiopathic arthritis using standard setting with patients, parents, and providers**. *Qual Life Res.* 2017 Mar;26(3):565-586. Epub 2016 Dec 2.

The research team also published an article on the newly developed PROMIS Pediatric Pain Behavior Items:

Cunningham NR, Kashikar-Zuck S, Mara C, Goldschneider KR, Revicki DA, Dampier C, Sherry DD, Crosby L, Carle A, Cook KF, Morgan EM. **Development and validation of the self-reported PROMIS pediatric pain behavior item bank and short form scale.** *Pain.* 2017 Jul;158(7):1323-1331.

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## Division Publications


1. Ombrello MJ; Arthur VL; Remmers EF; Hinks A; Tachmazidou I; Grom AA; Foell D; Martini A; Gattorno M; Özen S. **Genetic architecture distinguishes systemic juvenile idiopathic arthritis from other forms of juvenile idiopathic arthritis: clinical and therapeutic implications.** *Annals of the rheumatic diseases*. 2017; 76:906-913.
2. Rider LG; Aggarwal R; Pistorio A; Bayat N; Erman B; Feldman BM; Huber AM; Cimaz R; Cuttica RJ; de Oliveira SK. **2016 American College of Rheumatology/European League Against Rheumatism Criteria for Minimal, Moderate, and Major Clinical Response in Juvenile Dermatomyositis: An International Myositis Assessment and Clinical Studies Group/Paediatric Rheumatology International Trials Organisation Collaborative Initiative..** *Annals of the rheumatic diseases*. 2017; 76:782-791.
3. Hinks A; Bowes J; Cobb J; Ainsworth HC; Marion MC; Comeau ME; Sudman M; Han B; Juvenile Arthritis Consortium for Immunochip; Becker ML. **Fine-mapping the MHC locus in juvenile idiopathic arthritis (JIA) reveals genetic heterogeneity corresponding to distinct adult inflammatory arthritic diseases.** *Annals of the rheumatic diseases*. 2017; 76:765-772.
4. Rossetti M; Spreafico R; Consolaro A; Leong JY; Chua C; Massaf M; Saidin S; Magni-Manzoni S; Arkachaisri T; Wallace CA. **TCR repertoire sequencing identifies synovial Treg cell clonotypes in the bloodstream during active inflammation in human arthritis.** *Annals of the rheumatic diseases*. 2017; 76:435-441.
5. Bracaglia C; de Graaf K; Pires Marafon D; Guilhot F; Ferlin W; Prencipe G; Caiello I; Davì S; Schulert G; Ravelli A. **Elevated circulating levels of interferon-gamma and interferon-gamma-induced chemokines characterise patients with macrophage activation syndrome complicating systemic juvenile idiopathic arthritis.** *Annals of the rheumatic diseases*. 2017; 76:166-172.
6. Spreafico R; Rossetti M; Whitaker JW; Wang W; Lovell DJ; Albani S. **Epipolymorphisms associated with the clinical outcome of autoimmune arthritis affect CD4(+) T cell activation pathways.** *Proceedings of the National Academy of Sciences of the United States of America*. 2016; 113:13845-13850.

7. Rider LG; Aggarwal R; Pistorio A; Bayat N; Erman B; Feldman BM; Huber AM; Cimaz R; Cuttica RJ; de Oliveira SK. **2016 American College of Rheumatology/European League Against Rheumatism Criteria for Minimal, Moderate, and Major Clinical Response in Juvenile Dermatomyositis: An International Myositis Assessment and Clinical Studies Group/Paediatric Rheumatology International Trials Organisation Collaborative Initiative.** *Arthritis and Rheumatology*. 2017; 69:911-923.

8. Schulert GS; Fall N; Harley JB; Shen N; Lovell DJ; Thornton S; Grom AA. **Monocyte MicroRNA Expression in Active Systemic Juvenile Idiopathic Arthritis Implicates MicroRNA-125a-5p in Polarized Monocyte Phenotypes.** *Arthritis and Rheumatology*. 2016; 68:2300-2313.

9. Strait RT; Thornton S; Finkelman FD. **C gamma 1 Deficiency Exacerbates Collagen-Induced Arthritis.** *Arthritis and Rheumatology*. 2016; 68:1780-1787.

10. Shaw MA; Gao Z; McElhinney KE; Thornton S; Flick MJ; Lane A; Degen JL; Ryu JK; Akassoglou K; Mullins ES. **Plasminogen Deficiency Delays the Onset and Protects from Demyelination and Paralysis in Autoimmune Neuroinflammatory Disease.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*. 2017; 37:3776-3788.

11. Yu T; Enioutina EY; Brunner HI; Vinks AA; Sherwin CM. **Clinical Pharmacokinetics and Pharmacodynamics of Biologic Therapeutics for Treatment of Systemic Lupus Erythematosus.** *Clinical Pharmacokinetics*. 2017; 56:107-125.

12. Gmuca S; Xiao R; Brandon TG; Pagnini I; Wright TB; Beukelman T; Morgan EM; Weiss PF. **Multicenter inception cohort of enthesitis-related arthritis: variation in disease characteristics and treatment approaches.** *Arthritis Research and Therapy*. 2017; 19:84.

13. Brachat AH; Grom AA; Wulffraat N; Brunner HI; Quartier P; Brik R; McCann L; Ozdogan H; Rutkowska-Sak L; Schneider R. **Early changes in gene expression and inflammatory proteins in systemic juvenile idiopathic arthritis patients on canakinumab therapy.** *Arthritis Research and Therapy*. 2017; 19:13.

14. Phillippi K; Hoeltzel M; Byun Robinson A; Kim S; Childhood Arthritis and Rheumatology Research Alliance (CARRA) Legacy Registry Investigators. **Race, Income, and Disease Outcomes in Juvenile Dermatomyositis.** *The Journal of Pediatrics*. 2017; 184:38-44.e1.

15. Askew RL; Cook KF; Keefe FJ; Nowinski CJ; Cella D; Revicki DA; Morgan DeWitt EM; Michaud K; Trence DL; Amtmann D. **A PROMIS Measure of Neuropathic Pain Quality.** *Value in Health*. 2016; 19:623-630.

16. Tran ST; Guite JW; Pantaleao A; Pfeiffer M; Myer GD; Sil S; Thomas SM; Ting TV; Williams SE; Edelheit B. **Preliminary Outcomes of a Cross-Site Cognitive- Behavioral and Neuromuscular Integrative Training Intervention for Juvenile Fibromyalgia.** *Arthritis Care and Research*. 2017; 69:413-420.

17. Gulati G; Jones JT; Lee G; Altaye M; Beebe DW; Meyers-Eaton J; Wiley K; Brunner HI; DiFrancesco MW. **Altered Blood-Brain Barrier Permeability in Patients With Systemic Lupus Erythematosus: A Novel Imaging Approach.** *Arthritis Care and Research*. 2017; 69:299-305.

18. Jones JT; Carle AC; Wootton J; Liberio B; Lee J; Schanberg LE; Ying J; Morgan DeWitt E; Brunner HI. **Validation of Patient-Reported Outcomes Measurement Information System Short Forms for Use in Childhood-Onset Systemic Lupus Erythematosus.** *Arthritis Care and Research*. 2017; 69:133-142.

19. Yazdany J; Bansback N; Clowse M; Collier D; Law K; Liao KP; Michaud K; Morgan EM; Oates JC; Orozco C. **Rheumatology Informatics System for Effectiveness: A National Informatics-Enabled Registry for Quality Improvement.** *Arthritis Care and Research*. 2016; 68:1866-1873.

20. Brunner HI; Bennett MR; Abulaban K; Klein-Gitelman MS; O'Neil KM; Tucker L; Ardoin SP; Rouster-Stevens KA; Onel KB; Singer NG. **Development of a Novel Renal Activity Index of Lupus Nephritis in Children and Young Adults.** *Arthritis Care and Research*. 2016; 68:1003-1011.

21. Wenderfer SE; Ruth NM; Brunner HI. **Advances in the care of children with lupus nephritis.** *Pediatric Research*. 2017; 81:406-414.

22. Zeft AS; Prahalad S; Schneider R; Dedeoglu F; Weiss PF; Grom AA; Mix C; Pope Rd CA. **Systemic onset juvenile idiopathic arthritis and exposure to fine particulate air pollution.** *Clinical and Experimental Rheumatology*. 2016; 34:946-952.

23. Consolaro A; Morgan EM; Giancane G; Rosina S; Lanni S; Ravelli A. **Information technology in paediatric rheumatology..** *Clinical and Experimental Rheumatology*. 2016; 34:S11-S16.

24. Morgan EM; Mara CA; Huang B; Barnett K; Carle AC; Farrell JE; Cook KF. **Establishing clinical meaning and defining important differences for Patient-Reported Outcomes Measurement Information System (PROMISA (R)) measures in juvenile idiopathic arthritis using standard setting with patients, parents, and providers.** *Quality of Life Research*. 2017; 26:565-586.

25. Lipstein EA; Lovell DJ; Denson LA; Kim SC; Spencer C; Ittenbach RF; Britto MT. **High Levels of Decisional Conflict and Decision Regret When Making Decisions About Biologics.** *Journal of Pediatric Gastroenterology and Nutrition*. 2016; 63:e176-e181.

## Grants, Contracts, and Industry Agreements

### Annual Grant Award Dollars

| Investigator | Title | Sponsor | ID | Dates | Amount |
|---|---|---|---|---|---|
| Hermine Brunner, MD | Optimization of Outcome Measures For Clinical Trials in Children with Lupus | National Institutes of Health | U01 AR067166 | 09/15/2014 - 07/31/2018 | $196,023 |
| Grant S Schulert, MD | Scientist Development Award_Grant Schulert | Rheumatology Research Foundation | RRF_Schulert | 07/01/2015 - 06/30/2018 | $75,000 |
| Esi M Morgan, MD | Patients, Advocates and Rheumatology Teams Network for Research and Service (PARTNERS) | Patient-Centered Outcome Research Inst. (Duke University) | PPRN-1306-04601 | 09/13/2015 - 09/12/2018 | $77,032 |
| Alexei A Grom, MD | Cincinnati Training Program in Pediatric Rheumatology Research | National Institutes of Health | T32 AR069512 | 05/01/2016 - 04/30/2021 | $145,153 |
| Sherry L Thornton, PhD | SH800 Cell Sorter | National Institutes of Health | S10 OD023410 | 03/01/2017 - 02/28/2018 | $318,039 |
| Sheila T Angeles-Han, MD | Risk Markers for Childhood Uveitis | Rheumatology Research Foundation | RRF_Angeles-Han | 02/07/2017 - 09/14/2017 | $62,537 |
| Sheila T Angeles-Han, MD | Outcomes of Children with Juvenile Idiopathic Arthritis-associated Uveitis | National Institutes of Health | K23 EY021760 | 04/01/2017 - 08/31/2017 | $48,428 |
| **Total Annual Grant Award Dollars** | | | | | **$922,212** |

### Annual Industry Award Dollars

| Investigator | Industry Sponsor | Amount |
|---|---|---|
| Daniel Joe Lovell, MD | Bristol -Myers Squibb | $395,385 |

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| Daniel Joe Lovell, MD | Genentech, Inc. | $78,804 |
| Hermine Brunner, MD | Novartis Pharmaceuticals | $97,608 |
| Hermine Brunner, MD | Pfizer, Inc. | $2,445,889.13 |
| Jennifer L Huggins, MD | Abbott Laboratories | $40,000 |
| **Total Annual Industry Award Dollars** | | **$3,057,686.13** |