



# Annual Research & Development Report

Calendar Year 2021

Better outcomes for a better world



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# Introduction

In 2021, our mission to disseminate outcomes specific to Tabula Rasa HealthCare (TRHC) solutions led to an impressive volume of publications. Our researchers published 44 papers in renowned journals, including the *American Journal of Managed Care*, *Drugs & Aging*, *Journal of the American Pharmacists Association*, *Pharmaceutics*, *Journal of Clinical Medicine*, and *International Journal of Molecular Sciences*. Research & Development Pillar members were cited 547 times in the areas of pharmacogenomics, medication risk scores, and medication safety.

Our national team gained stakeholder knowledge as they served in more than 33 leadership roles in professional organizations. Our team contributed to the research community by actively participating as peer reviewers with over 27 leading journals. Additionally, our continued efforts toward dissemination of research in professional arenas led to 18 abstracts and poster exhibits and 21 live scholarly presentations.

Congratulations to our valued members of the TRHC Research & Development Pillar who received more than 21 professional awards last year! As we look forward, we are excited to strengthen our reputation in the healthcare industry as a leading provider of high-quality research, with four papers already in press with prominent journals leading into the new year.



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**Dr. Jacques Turgeon**

*Chief Scientific Officer*  
Tabula Rasa HealthCare

# Research Strategy Committee



**Jenny Bingham, PharmD, BCACP, FAzPA, FNAP**, is President of TRHC's Research Strategy Committee. She promotes excellence and company growth through oversight of research, from project conceptualization to outcomes dissemination. Dr. Bingham is passionate about advancing the role of pharmacists in the telehealth setting and was recognized as the Next-Generation Pharmacist® Technology Innovator of the Year, and she was the recipient of the Jack R. Cole, PhD, Distinguished Alumnus Award from the University of Arizona College of Pharmacy. She is also a member of the American Pharmacists Association Telehealth Advisory Committee, Fellow of the Arizona Pharmacy Association, and Distinguished Fellow and Practitioner of the National Academies of Practice in Pharmacy.



**Veronique Michaud, BPharm, MSc, PhD**, is Chief Operating Officer of TRHC's Precision Pharmacotherapy Research & Development Institute in Orlando. She is an adjunct professor, Faculty of Pharmacy at the Université de Montréal, and has directed a pharmacokinetic and bioanalytic core facility at the University of Montréal Hospital Research Center. Her research investigates the contribution of CYP450 drug-metabolizing enzymes in drug disposition, with a special attention to the role of disease states, focusing on type 2 diabetes. She has earned more than \$22 million in research awards, published more than 75 peer-reviewed journal articles, and mentored graduate students and pharmacy residents. Dr. Michaud completed fellowships at Indiana University–Purdue University in Indianapolis and McGill University in Montréal, and earned her PhD and MSc degrees from the Université de Montréal in Canada.



**Milap Nahata, PharmD, MS**, is Founding Director of the Institute of Therapeutic Innovations and Outcomes and Professor Emeritus of Pharmacy, Internal Medicine, and Pediatrics at Ohio State University. He teaches courses on pharmacotherapy and leadership and oversees a telephonic medication management program serving older adults. Dr. Nahata has published more than 600 journal articles and book chapters, and several books. He has received lifetime achievement awards, distinguished educator awards, and research achievement awards from multiple national organizations. He is an elected member of the National Academy of Medicine, past president of the American Association of Colleges of Pharmacy and American College of Clinical Pharmacy, and Editor-in-Chief of *Annals of Pharmacotherapy*.



**Jacques Turgeon, BPharm, PhD**, is recognized internationally for his excellence in research and pharmacy education. He has earned more than \$70 million in research awards, authored more than 198 peer-reviewed articles, and mentored nearly 70 students. His research interests focus on studying factors responsible for the inter-subject variability in drug response, and he is renowned for his expertise in the role of pharmacogenetics in cardiovascular drug actions. Dr. Turgeon is currently Chief Scientific Officer of TRHC, Professor Emeritus from the Université de Montréal, Fellow of the Canadian Academy of Health Sciences, and Fellow of the Académie Nationale de Médecine, France.



**Terri Warholak, PhD, RPh, CPHQ, FAPhA**, is a professor in the Department of Pharmacy Practice and Science and Assistant Dean of Academic Affairs and Assessment at the University of Arizona College of Pharmacy. Dr. Warholak serves as Co-Director of the University of Arizona College of Pharmacy Outcomes Research Group formed in 2013. She received her BS, MS, and PhD from Purdue University. From 1990 to 1997, Dr. Warholak served as a commissioned officer in the United States Public Health Service that included five years in the Indian Health Service and an assignment at the Food and Drug Administration. In 2015, Dr. Warholak and colleagues won the Duncan Neuhauser Award for Curricular Innovation from the Academy for Healthcare Improvement for the Educating Pharmacists in Quality (EPIQ) program. She serves on many national committees, including the FDA Drug Safety and Risk Management Advisory Committee; the National Quality Forum Scientific Methods Panel; and the Pharmacy Quality Alliance Research Coordinating Committee. Her teaching and research interests include medication error reduction and quality measure development. She has edited a book, published more than 140 papers, and has been invited to present at the local, state, national, and international levels.



**Rhys Axon, PhD, MPharm, MS, MRPharmS**, is an assistant professor in the Department of Pharmacy Practice and Science at the University of Arizona College of Pharmacy, and serves as Co-Director of the Research Group and investigator at the Center for Health Outcomes and PharmacoEconomic Research (the HOPE Center). He received his MPharm from The University of Reading and later practiced community pharmacy in the United Kingdom. He received his master's and doctorate degrees in pharmaceutical economics, policy, and outcomes from the University of Arizona. Dr. Axon's research and teaching interests include improving the economic, clinical, and humanistic outcomes associated with managing chronic conditions, particularly pain and the opioid crisis, using both qualitative and quantitative methodologies. He also supports student pharmacists and pharmacists with scholarly activities and seeks to demonstrate the value of the pharmacy profession. Dr. Axon has published more than 40 peer-reviewed articles and presented his research at both national and international conferences.

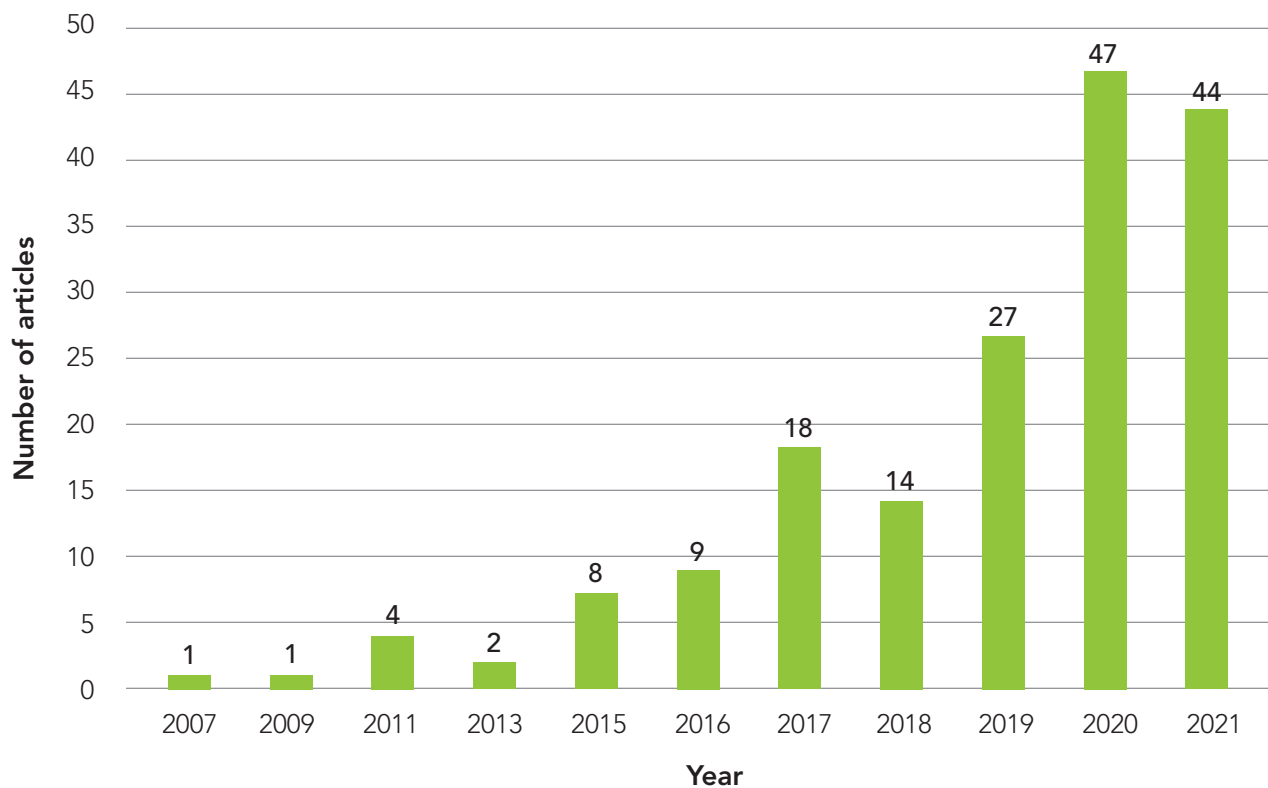


**Nishita Amin, BCGP, BCPS, CMWA**, received her Doctor of Pharmacy from the Philadelphia College of Pharmacy and completed a PGY1 pharmacy practice residency at Northport VA Medical Center. She is a board-certified geriatric pharmacist and board-certified pharmacotherapy specialist. Dr. Amin is a clinical pharmacist providing transition of care services and medication therapy management. She now serves as Director of Pharmacy Residency Programs at TRHC and oversees the PGY1 Pharmacy Residency program, PGY2 Clinical Pharmacogenomics residency program, Advanced Pharmacy Practice Experience students, and Drug Information Resource Center in the Office of Translational Research & Residency Programs under the Research & Development Institute.

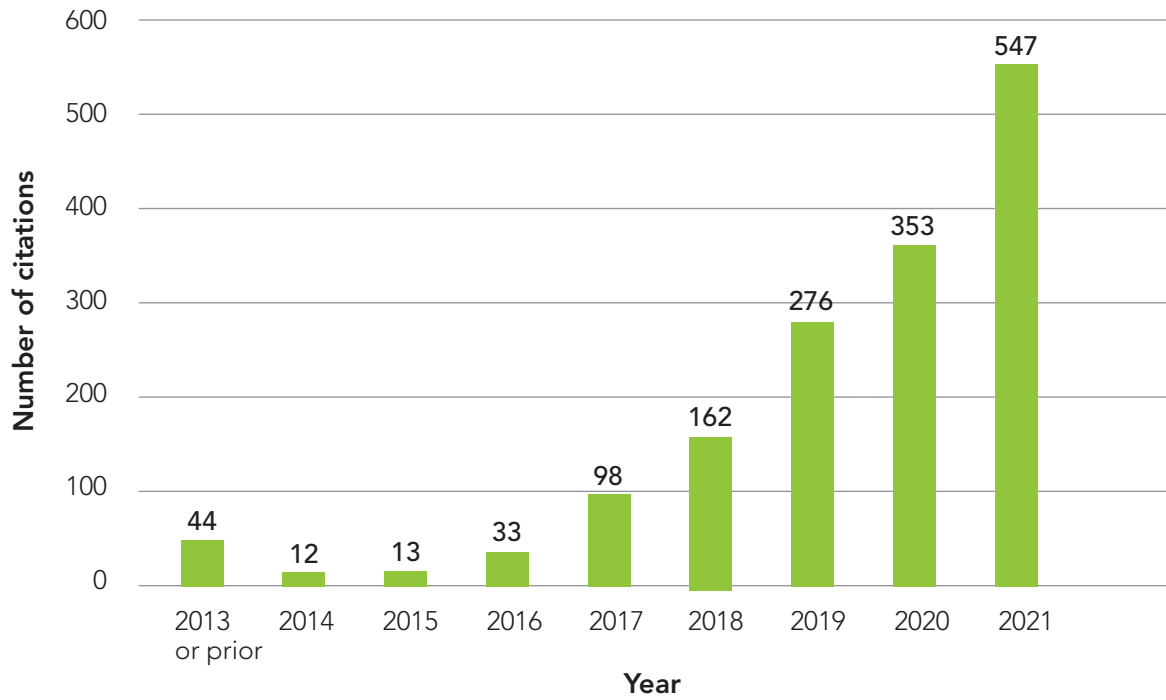
# Research Dissemination

Dissemination	Performance
2021 published articles	44
2021 citations	547
Total citations since 2007	1,538
H-index	19
i10-index	45
2021 median annual impact factor	2.9885

## Annual Published Articles



## Annual Citations





## Peer-reviewed Published Articles

1. Al Rihani SB, Darakjian LI, Deodhar M, Dow P, Turgeon J, Michaud V. Disease-induced modulation of drug transporters at the blood–brain barrier level. *Int J Mol Sci.* 2021;22(7):3742.
2. Al Rihani SB, Deodhar M, Darakjian LI, et al. Quantifying anticholinergic burden and sedative load in older adults with polypharmacy: A systematic review of risk scales and models. *Drugs Aging.* 2021;38(11):977-994.
3. Axon DR, Johnson M, Abeln B, et al. An academic-community collaboration to deliver medication therapy management (MTM) services to patients living in rural counties of a southwestern state in the United States. *Journal of Pharmacy Practice.* 2021:08971900211000219.
4. Badowski ME, Bente JA, Davis EM, et al. Telehealth and technological applications in patient-centered care: Implications for pharmacy learners and clinical pharmacists. *JACCP: Journal of the American College of Clinical Pharmacy.* 2021;4(8):1044-1055.
5. Bankes D, Pizzolato K, Finnel S, et al. Medication-related problems identified by pharmacists in an Enhanced Medication Therapy Management model. *Am J Manag Care.* 2021;27(16 Suppl):S292-S299.
6. Bardolia C, Amin NS, Turgeon J. Emerging non-statin treatment options for lowering low-density lipoprotein cholesterol. *Frontiers in Cardiovascular Medicine.* 2021;8.
7. Bingham J (lead author), DiPietro N, Ramalingam A. "Communication and telehealth applications." Disasters and emergency preparedness: A planning and response guide for pharmacy professionals. Edited by Hoai-An Truong, Meghana Debai, and Sven Normann, *American Pharmacists Association.* 2021;191-206.
8. Bingham J, Michaud V, Wiisanen K, et al. Improving patients' outcomes through the integration of pharmacogenomic testing into comprehensive medication management care models. *Journal of Precision Medicine.* 2021;7(3):28-37.
9. Bingham J, Stanislaw J, Warholak T, et al. Assessment of glycosylated hemoglobin outcomes following an enhanced medication therapy management service via telehealth. *Int J Environ Res Public Health.* 2021;18(12):6560.
10. Bingham J, Tranchina K, Turgeon J. Telepharmacy offers opportunity amid pandemic. *Pharmacy Times.* 2021 January.
11. Bull J, Bice T, Satterwhite W, et al. Turgeon J (contributor). Feasibility and acceptability of a pharmacogenomic decision support system in palliative care. *J Pall Med.* 2021. 10.1089/jpm.2021.0270 (ePub)
12. Campbell PJ, Chinthammit C, Mollon L, et al. Evaluating the relationship between quality measure adherence definitions and economic outcomes in commercial health plans: A retrospective diabetes cohort study. *J Manag Care Spec Pharm.* 2021 January;27(1):64-72.
13. Campbell PJ, Axon DR, Anderson EJ, Ekstrand MJ, Brummel A, Warholak T. Psychometric evaluation of a comprehensive medication management service experience instrument. *J Am Pharm Assoc (2003).* 2022;62(1):218-223.



14. Campbell PJ, Axon DR, Taylor AM, et al. Hypertension, cholesterol, and diabetes medication adherence, health care utilization and expenditure in a Medicare supplemental sample. *Medicine (Baltimore)*. 2021;100(35):e27143.
15. Chinthammit C, Bhattacharjee S, Lo-Ciganic WH, et al. Association of low-income subsidy, Medicaid dual eligibility, and disability status with high-risk medication use among Medicare part D beneficiaries. *Res Social Adm Pharm*. 2021.
16. Darakjian L, Deodhar M, Turgeon J, Michaud V. Chronic inflammatory status observed in patients with type 2 diabetes induces modulation of cytochrome p450 expression and activity. *Int J Mol Sci*. 2021;22(9):4967.
17. De Santiago A, Bingham JM, Vaffis S, et al. Evaluating the role and value of a clinical pharmacist in a concierge primary care clinic. *Journal of the American Pharmacists Association*. 2021;61(3):240-247;e241.
18. Del Toro-Pagán NM, Matos A, Thacker D, Turgeon J, Amin NS, Michaud V. Pharmacist-led medication evaluation considering pharmacogenomics and drug-induced phenoconversion in the treatment of multiple comorbidities: A case report. *Medicina (Kaunas)*. 2021;57(9).
19. Deodhar M, Rihani SBA, Darakjian L, Turgeon J, Michaud V. Assessing the mechanism of fluoxetine-mediated CYP2D6 inhibition. *Pharmaceutics*. 2021;13(2).
20. Deodhar M, Turgeon J, Michaud V. Contribution of CYP2D6 functional activity to oxycodone efficacy in pain management: Genetic polymorphisms, phenoconversion, and tissue-selective metabolism. *Pharmaceutics*. 2021;13(9).
21. Grangeon A, Clermont V, Barama A, Gaudette F, Turgeon J, Michaud V. Determination of CYP450 expression levels in the human small intestine by mass spectrometry-based targeted proteomics. *Int J Mol Sci*. 2021;22(23):12791.
22. Le LD, Paulk IR, Axon DR, Bingham JM. Comprehensive medication review completion in medically underserved areas and populations. *J Health Care Poor Underserved*. 2021;32(3):1301-1311.
23. Ha M, Amin N, Meyer K, et al. Balancing sleep and motor symptoms: A case report of managing insomnia in Parkinson's disease. *Clin Case Rep J*. 2021;11(5):1-4.
24. Ha M, Meyer K, Matos A, Turgeon J, Bardolia C. Optimizing medications in patients with cardiovascular disease: A case report on unrecognized prescribing cascades in older adults. *Clin Case Rep J*. 2021;2(3):1-5.
25. Leal S. Be the voice. *J Am Pharm Assoc*. 2021;61(4):e8-e9.
26. Long T, Cristofolletti R, Cicali B, et al. Physiologically based pharmacokinetic modeling to assess the impact of CYP2D6-mediated drug-drug interactions on tramadol and o-desmethyltramadol exposures via allosteric and competitive inhibition. *The Journal of Clinical Pharmacology*. 2022;62(1):76-86.
27. Lott BE, Anderson EJ, Villa Zapata L, et al. Expanding pharmacists' roles: Pharmacists' perspectives on barriers and facilitators to collaborative practice. *Journal of the American Pharmacists Association*. 2021;61(2):213-220.e211.
28. Matos A±, Dow P±, Bingham JM±, et al. Tabula Rasa HealthCare company profile: Involvement in pharmacogenomic and personalized medicine research. *Pharmacogenomics*. 2021;22(12):731-735.

29. Michaud V, Bikmetov R, Smith MK, et al. Use of drug claims data and a medication risk score to assess the impact of CYP2D6 drug interactions among opioid users on healthcare costs. *Journal of Personalized Medicine*. 2021;11(11).
30. Michaud V, Dow P, Turgeon J. Illustrative and historic cases of phenoconversion. *Am J Transl Res*. 2021;13(12):13328-13335.
31. Michaud V, Smith MK, Bikmetov R, et al. Association of the MedWise Risk Score™ with health care outcomes. *Am J Manag Care*. 2021;27(16 Suppl):S280-S291.
32. Michaud V, Turgeon J. Precision medicine: Applied concepts of pharmacogenomics in patients with various diseases and polypharmacy. *Pharmaceutics*. 2021;13(2).
33. Moghadam SS, Leal S. How should physicians and pharmacists collaborate to motivate health equity in underserved communities? *AMA J Ethics*. 2021;23(2):e117-126.
34. Pizzolato K, Meyer K, Matos A, et al. Pharmacist-led medication review identifies and mitigates fall-risk-increasing drugs and multi-drug interactions. *Clin Case Rep*. 2021;11(7).
35. Pizzolato K, Thacker D, Toro-Pagán ND, et al. Cannabis dopaminergic effects induce hallucinations in a patient with Parkinson's disease. *Medicina (Kaunas, Lithuania)*. 2021;57(10):1107.
36. Ratigan AR, Michaud V, Turgeon J, et al. Longitudinal association of a medication risk score with mortality among ambulatory patients acquired through electronic health record data. *Journal of Patient Safety*. 2021;17(4):249-255.
37. SanFilippo S, Michaud V, Wei J, Bikmetov R, Turgeon J, Brunetti L. Classification and assessment of medication risk in the elderly (care): Use of a medication risk score to inform patients' readmission likelihood after hospital discharge. *J Clin Med*. 2021;10(17):3947.
38. Silva-Almodóvar A, Hackim E, Wolk H, Nahata MC. Potentially inappropriately prescribed medications among Medicare medication therapy management eligible patients with chronic kidney disease: An observational analysis. *J Gen Intern Med*. 2021;36(8):2346-2352.
39. Silva Almodóvar A, Nahata MC. Implementing clinical decision support tools and pharmacovigilance to reduce the use of potentially harmful medications and health care costs in adults with heart failure. *Front Pharmacol*. 2021;12:612941.
40. Smith MK, Bikmetov R, Al Rihani SB, et al. Adverse drug event risk assessment by the virtual addition of COVID-19 repurposed drugs to Medicare and commercially insured patients' drug regimens: A drug safety simulation study. *Clin Transl Sci*. 2021;14(5):1799-1809.
41. Stein A, Finnel S, Bankes D, et al. Health outcomes from an innovative Enhanced Medication Therapy Management model. *Am J Manag Care*. 2021;27(16 Suppl):S300-S308.
42. Tranchina K, Turgeon J, Bingham J. Integrating a novel medication risk score and use of an advanced clinical decision support system into a pharmacist and nurse-coordinated transition of care program to mitigate drug interactions. *Clin Case Rep J*. 2021;2(1):1-5.
43. Turgeon J, Munger MA, Pace WD. Letter to the Editor: Geriatric emergency department revisits after discharge with potentially inappropriate medications: A retrospective cohort study. *Am J Emerg Med*. 2021.
44. Wani A, Al Rihani SB, Sharma A, et al. Crocetin promotes clearance of amyloid- $\beta$  by inducing autophagy via the STK11/LKB1-mediated AMPK pathway. *Autophagy*. 2021:1-20.

# Article-level Metrics and Summaries

## 2021 Top Downloaded Paper List – *International Journal of Molecular Sciences*

Darakjian L, Deodhar M, Turgeon J, Michaud V. Chronic inflammatory status observed in patients with type 2 diabetes induces modulation of cytochrome P450 expression and activity. *Int J Mol Sci*. 2021 May 7;22(9):4967.

## 2021 Top Downloaded Paper List – *Pharmaceutics*

Deodhar M, Al Rihani SB, Arwood MJ, Darakjian L, Dow P, Turgeon J, Michaud V. Mechanisms of CYP450 inhibition: Understanding drug-drug interactions due to mechanism-based inhibition in clinical practice. *Pharmaceutics*. 2020 Sep 4;12(9):846.

### 1. Al Rihani SB, Deodhar M, Darakjian LI, et al. Quantifying anticholinergic burden and sedative load in older adults with polypharmacy: A systematic review of risk scales and models. *Drugs Aging*. 2021;38(11):977-994.

- Medications with anticholinergic and sedative properties place older adults at higher risk of adverse drug events (ADEs) related to poor cognitive and physical outcomes
- The systematic review assessed 13 existing medication-related anticholinergic burden and sedative load scales used in older adults
- Findings highlight the importance of taking into consideration drug-induced anticholinergic and sedative side effects in clinical practice
- Additional emphasis is placed on the critical need to assess this in patients with polypharmacy to reduce the risk of dementia and associated cognitive impairment
- **Article metrics:** Attention Score 32 (Top five percent of all Altmetric research outputs), the 93rd percentile (ranked 25,381st) of the 397,015 tracked articles of a similar age in all journals and the 86th percentile (ranked 2nd) of the 15 tracked articles of a similar age in *Drugs & Aging* (Sources: Altmetric & Springer; Effective: January 19, 2022)

### 2. Bankes D, Pizzolato K, Finnel S, et al. Medication-related problems identified by pharmacists in an Enhanced Medication Therapy Management model. *Am J Manag Care*. 2021;27(16 Suppl):S292-s299.

- Retrospective analysis of the types of interventions pharmacists made when conducting MedWise® Safety Reviews (MSRs) (n=23,000) in Enhanced Medication Therapy Management (EMTM) plan years 2018 and 2019
- Clinically actionable medication-related problems (MRPs) were identified in more than 80 percent of patients, where three MRPs pertaining to medication safety—adverse drug reactions, drug interactions, and drug use without indication—accounted for 85 percent of all MRPs identified
- To resolve MRPs, pharmacists frequently proposed deprescribing or changing agents (about 33 percent each)
- If all recommendations were implemented, MSRs were capable of lowering the average MedWise Risk Score by about 4.7 points in this population (19 to 14.3)

- Collectively, results suggest that risk stratification worked as intended; pharmacists were able to identify a substantial number of actionable MRPs that may cause or contribute to ADEs and then act accordingly to decrease risk
  - **Article metrics:** 1,103 page views (811 unique), 94 downloads (Source: *The American Journal of Managed Care*; Effective: October 18, 2021)
3. Bingham J, Michaud V, Wiisanen K, et al. Improving patients' outcomes through the integration of pharmacogenomic testing into comprehensive medication management care models. *J Prec Med.* 2021;7(3):28-37.
    - Pharmacogenomic clinical initiatives have shifted to a pre-emptive model
    - As clinicians embark on comprehensive medication management services (CMM), the white paper educates on the value of precision medicine and pharmacogenomic testing in CMM models to mitigate polypharmacy and optimize medication regimens, patient outcomes, and cost-savings
    - It further explores methods to implement and seek reimbursement for CMM pharmacogenomic services
  4. Matos A±, Dow P±, Bingham JM±, et al. Tabula Rasa HealthCare company profile: Involvement in pharmacogenomic and personalized medicine research. *Pharmacogenomics.* 2021;22(12):731-735.
    - The company profile provides an overview of TRHC's goal to create patient-specific, data-driven technology and solutions that empower pharmacists, providers, and patients to optimize medication regimens
    - It highlights the impact of MedWise Science on medication outcomes, hospitalizations, healthcare costs, and risk
    - In addition, the profile provides evidence to support the influence of MedWise Science on medication safety knowledge, particularly pharmacogenomic-informed pharmacy systems
    - **Article metrics:** 213 downloads (Source: Future Medicine; Effective January 19, 2022)
  5. Michaud V, Dow P, Turgeon J. Illustrative and historic cases of phenoconversion. *Am J Transl Res.* 2021;13(12):13328-13335.
    - Intersubjective variability in drug response, whether related to efficacy or toxicity, is well recognized clinically; results have accumulated in the literature with numerous examples demonstrating the value of pharmacogenomics (PGx) to improve drug response or prevent drug toxicity
    - The clinical application of PGx knowledge remains difficult for most clinicians under real-world conditions in patients with numerous chronic conditions and polypharmacy; this may be due to phenoconversion, a condition where there is a discrepancy between the genotype-predicted phenotype and the observed phenotype
    - Phenoconversion complicates the interpretation of PGx results and may lead to inappropriate recommendations and clinical decision making
    - This mini-review presents cases (mexiletine, propafenone, clopidogrel, warfarin, codeine, procainamide) from historical observations where drug response was modified by phenoconversion, and illustrates that we need advanced clinical decision systems to manage conditions associated with phenoconversion, especially in patients with polypharmacy

6. Michaud V, Smith MK, Bikmetov R, et al. Association of the MedWise Risk Score with health care outcomes. *Am J Manag Care*. 2021;27(16 Suppl):S280-S291.

- Older patients are especially vulnerable to drug-related problems due to taking multiple prescription drugs, which increases their risk of drug-drug interactions and ADEs
- This study aimed to examine outcomes associated with the MedWise Risk Score in a Medicare Part D population, including total medical expenditures, ADEs, falls, mortality, emergency department (ED) visits, hospital admissions, and length of stay (LOS)
- This study shows that patient risk scores were associated with health outcomes and could be used to identify patients at increased risk of negative outcomes based primarily on their medication regimens
- **Article metrics:** 884 page views (701 unique), 72 downloads (Source: *The American Journal of Managed Care*; Effective: October 18, 2021)

7. Ratigan AR, Michaud V, Turgeon J, et al. Longitudinal association of a medication risk score with mortality among ambulatory patients acquired through electronic health record data. *Journal of Patient Safety*. 2021;17(4):249-255.

- The current observational study was conducted as part of the safety work of the DARTNet Institute subcomponent Patient Safety Organization (PSO)
- We hypothesized that the MedWise Risk Score was an independent predictor of death among a cohort of ambulatory patients (n=427,103) obtained through electronic health record (EHR) data
- Examining the association of the categorized risk score with death, the highest rates were seen among the 30- to 49-year-old age group, followed by the 50- to 64-year-old age group, and lastly those 65 years or older; those aged 30 to 49 years with a risk score of 20 to 30 had a 795 percent increase in the hazard of death compared to those with a risk score lower than 20
- Our results suggest that pharmacist-directed interventions targeted to those who have an elevated risk score could improve medication safety for ambulatory patients taking multiple medications
- **Article metrics:** 661 full-text views, 1,660 abstract views, 446 downloads, 73 citations, ranked in the 99th percentile (163,827th) in all journals, ranked 8th of 947 tracked articles of a similar age in all journals, picked up by 23 news outlets (Source: *Journal of Patient Safety*; Effective: February 2, 2022)



8. SanFilippo S, Michaud V, Wei J, Bikmetov R, Turgeon J, Brunetti L. Classification and assessment of medication risk in the elderly (care): Use of a medication risk score to inform patients' readmission likelihood after hospital discharge. *J Clin Med.* 2021;10(17):3947.
  - There is a lack of risk tools that holistically assess an entire medication regimen
  - Retrospective data was analyzed for patients aged 65 years and older, who were admitted for at least 48 hours, and prescribed at least five medications on discharge
  - Medication risk scores of 20 or higher were associated with a 1.8-fold increased risk of readmission in patients discharged home from the hospital
  - **Article metrics:** 311 full text and 525 abstract views (Source: MDPI; Effective: January 19, 2022)
  
9. Stein A, Finnel S, Bankes D, et al. Health outcomes from an innovative Enhanced Medication Therapy Management model. *Am J Manag Care.* 2021;27(16 Suppl):S300-S308.
  - Retrospective, pre-post study that evaluated several outcomes of patients in two cohorts: one that received MSRs (n=4,384 patients) and a comparable group that did not (n=7,052)
  - Those who received MSRs outperformed those who did not; specifically, improvements were demonstrated in:
    - Total medical costs (\$958 savings/year, representing 7.5 percent annual savings; P = .042)
    - Hospitalizations (3.9 fewer admissions/100 beneficiaries/year, representing a 10 percent annual reduction in admissions; P = .032),
    - ED visits (6.2 fewer visits/100 beneficiaries/year, representing a 10 percent reduction in annual ED visits; P = .014)
    - Mortality (2.1 percent fewer deaths in 2019; P < .001)
  - Each outcome remained significant even after adjusting for baseline comorbidities
  - Collectively, results indicate that MSRs were effective at improving annual healthcare costs, hospitalizations, ED visits, and mortality in Medicare beneficiaries who received MSRs in an EMTM model
  - **Article metrics:** 722 page views (602 unique), 61 downloads (Source: *The American Journal of Managed Care*; Effective: October 18, 2021)

# Published Abstracts and Posters at Scientific Meetings

1. Arku D, Almatruk Z, Axon D, Warholak T. Assessing the reliability and validity of an instrument used to measure student pharmacists' experiences of teamwork in a quality improvement course. Paper presented at: The International Society of Pharmacogenomics and Outcomes Research (ISPOR) Europe; November–December 2021; Virtual.
2. Axon R. Identification of medication-related problems among rural community-dwelling patients receiving telephonic medication therapy management services. Paper presented at: The International Society of Pharmacogenomics and Outcomes Research (ISPOR) Europe; November–December 2021; Virtual.
3. Bingham J, Baugham L, Hilaneh A, Tranchina K, Turgeon J. Assessing the impact of medication safety reviews on an existing transitional care model. Paper presented at: American College of Clinical Pharmacy Annual Meeting & Exposition; October 2021; Virtual.
4. Bingham J, Kazemnia I, Patel N, Carbonneau W. Assessing pharmacy technicians' perceptions of a medication reconciliation protocol enhancement in a medication therapy management setting. Paper presented at: American Pharmacists Association Annual Meeting & Exposition; March 2021; Virtual.
5. Bingham J, Rojas H, Urban-Tovar A, Davis L, Boesen K, Schnackenberg J, Kearney D, Madhat F. Exploring the perceived value of the patient engagement center patient relationship management solution in a pharmacy setting. Paper presented at: American Pharmacists Association Annual Meeting; March 2021; Virtual.
6. Boskie B, DeCuir D, Green R, Le D, Pawlowski M, Pour N, Bingham J. Impact of the COVID-19 pandemic on the prevalence of no-show visits at a local primary care clinic. Poster presented at: The University of Arizona College of Pharmacy Poster Session; April 2021.
7. Choe J, Daniel V, Duenas G, Francis B, Matz G, Rubio J, Bingham J. Investigating Medicaid telehealth reimbursement policies and laws in connection to the COVID-19 pandemic. Poster presented at: The University of Arizona College of Pharmacy Poster Session; April 2021.
8. Choi B, Obeng-Kusi M, Axon D, Cooley J, Warholak T. Improving a rating scale: Applying Rasch analysis to student pharmacists' perceptions of their professional identity. Paper presented at: The Professional Society for Health Economics and Outcomes Research (ISPOR) Europe; November–December 2021; Virtual.
9. Del Toro-Pagan N. Pharmacist-led medication evaluation considering pharmacogenomics and drug-induced phenoconversion in the treatment of multiple comorbidities: A case report. Paper presented at: Eastern States Conference for Pharmacy Residents & Preceptors; April 2021; Virtual.
10. Marupuru S. Impact of pharmacist provided MTM services versus no MTM services on clinical outcomes among patients with hypertension, dyslipidemia, and diabetes: A systematic review. Paper presented at: The International Society of Pharmacogenomics and Outcomes Research (ISPOR) Europe; November–December 2021; Virtual.



11. Marupuru S, Dhatt H, Bingham J, Warholak T. Evaluating the association of a novel adherence intervention with the proportion of days covered rate. Poster presented at: Academy of Managed Care Pharmacy (AMCP) 2021; April 2021; Virtual.
  12. Morrison D, Page A, Sandoval J, Forbes S. Identifying the effects of drug pricing and cost barriers on adherence. Poster presented at: The University of Arizona College of Pharmacy Poster Session. April 2021; Virtual.
  13. Ramey O, Silva-Almodovar A, Nahata M. Assessment of medication prescribing and adherence in older adults with asthma and chronic obstructive pulmonary disease. Poster presented at: Academy of Managed Care Pharmacy (AMCP) Nexus 2021; October 2021; Denver, CO.
  14. Ramey O, Silva-Almodovar A, Nahata M. Assessment of medication prescribing and adherence in older adults with asthma and chronic obstructive pulmonary disease. Poster presented at: Academy of Managed Care Pharmacy (AMCP) 2021; April 2021; Virtual.
  15. Silva-Almodovar A, Glatz N, Copley J, Nahata M. Identifying opportunities to improve the appropriate use of medications among older adults with chronic opioid use. Poster presented at: Academy of Managed Care Pharmacy (AMCP) 2021; April 2021; Virtual.
  16. Silva-Almodovar A, Storc A, Patton H, Nahata M. Assessment of SOAP notes to characterize the impact of pharmacist's intervention with a comprehensive medication review. Poster presented at: Academy of Managed Care Pharmacy (AMCP) 2021; April 2021; Virtual.
  17. Stein A, Finnel S, Jin H, Yang S. Impact of medication safety interventions in a complex elderly population. Paper presented at: 2021 Pharmacy Quality Alliance (PQA) Annual Meeting; May 2021; Virtual.
  18. Whaley S, Binawad N, Warholak T, Axon D. Validation assessment of a pain interference questionnaire among student pharmacists at a United States university. Paper presented at: The International Society of Pharmacogenomics and Outcomes Research (ISPOR) Europe; November-December 2021; Virtual.
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## Live Presentations

1. Amundson C. Cultivating vaccine confidence in the COVID-19 pandemic. Presented at: TRHC University; November 2021; Virtual.
2. Bingham J, Michaud V. ACE2, ACE, ARBs, and prescribing habits in connection to the COVID-19 pandemic. Presented at: CareKinesis; March 2021; Virtual.
3. Bingham J. Driving the pharmacy profession forward through telehealth. Presented at: Arizona Pharmacy Podcast Network; September 2021; Virtual.
4. Bingham J. Integrating telehealth into your practice. Presented at: American Pharmacists Association; November 2021; Virtual.
5. Bingham J. Telehealth episode. Presented at: The University of Arizona College of Pharmacy PharmCAST Podcast; September 2021; Virtual.

6. Bingham J. Telepharmacy: Lunch & Learn. Presented at: Society of Health Policy Young Professionals Telehealth Summit; March 2021; Virtual.
7. Bingham J. Telepharmacy: The role of pharmacists in telehealth beyond the pandemic. Presented at: Nigerian Association of Pharmacists and Pharmaceutical Scientists in the Americas; July 2021; Virtual.
8. Del Toro-Pagan N. Pharmacogenomics of NSAIDs and PPIs. Presented at: TRHC University; April 2021; Virtual.
9. Ha M. Genitourinary disorders: Therapeutic management of urinary incontinence in older adults. Presented at: TRHC University; February 2021; Virtual.
10. Ha M. Pharmacist-driven interventions to reduce the anticholinergic burden associated with urinary antimuscarinics in the Program of All-Inclusive Care for the Elderly (PACE). Presented at: Eastern States Conference for Pharmacy Residents & Preceptors; April 2021; Virtual.
11. Lipsy R. New drug update. Presented at: Arizona Pharmacy Association Annual Meeting; June 2021; Virtual.
12. Lipsy R. New drug update. Presented at: Arizona Pharmacy Association Spring Clinical Conference; February 2021; Virtual.
13. Pizzolato K. Neurological conditions: Optimizing patient care in Alzheimer's disease. Presented at: TRHC University Webinar; March 2021; Virtual.
14. Pizzolato K. The impact of pharmacist-delivered medication reviews on the MedWise Risk Score in the Program of All-inclusive Care for the Elderly (PACE). Presented at: Eastern States Conference for Pharmacy Residents & Preceptors; April 2021; Virtual.
15. Scovis N, Bingham J. Telehealth part I: Health care's answer to a pandemic. Presented at: American Pharmacists Association Annual Meeting & Exposition; March 2021; Virtual.
16. Sreeram A. A comparison of potentially clinically relevant drug interactions identified by three-drug interaction software in newly enrolled participants in the Program of All-Inclusive Care for the Elderly (PACE). Presented at: Eastern States Conference for Pharmacy Residents & Preceptors; April 2021; Virtual.
17. Sreeram A. Outpatient management of common bacterial infections in the elderly: Community-acquired pneumonia, clostridium difficile infection, and urinary tract infection. Presented at: TRHC University; May 2021; Virtual.
18. Thacker D, Del Toro-Pagan N, Hanna A. Case discussion: Implementing PGx to promote medication regimen optimization of opioids. Presented at: Clinical Advisory Panel (CAP) Meeting; September 2021; Virtual.
19. Tranchina K. Assessing the impact of medication safety reviews on an existing transitional care model. Presented at: Southwestern States Residency Conference; June 2021; Virtual.
20. Turgeon J. Improving patient outcomes through the integration of pharmacogenomic testing into comprehensive medication management care models. Presented at: Journal of Precision Medicine Panel Discussion; October 2021; Virtual.
21. Turgeon J. Personalized medicine: How far are we? Presented at: Group of Metabolism and Pharmacokinetics Symposium; October 2021; Virtual. 7



# Grant Awards

## National Institutes of Health (NIH) Awards

**Project Title:** *Modulatory role of blood-brain barrier and enzymatic activity in an innovative human model of cholinergic drug-induced dementia*

This grant uses Hesperos Inc.'s patented multi-organ functional systems to investigate drug-induced dementia and Alzheimer's disease (AD) in terms of deficits in basic information processing in the presence of anticholinergic drugs in the presence of liver and a blood-brain barrier. TRHC's MedWise Risk Score will measure the risk of ADEs in elderly patients to help decrease risk, decrease hospitalizations, and reduce overall medical costs. This research is imperative as there are few in vitro models that examine anticholinergic drug properties in the central nervous system (CNS) while assessing their association between anticholinergic burden and risk of dementia, including AD. Therefore, this grant seeks to fill the need for a preclinical screening model based on functional assays composed of normal and AD mutant human cells to evaluate the effects of anticholinergic drugs in conditions mimicking aspects of AD. This will enable a platform for understanding multiplicative effects and inform TRHC's pharmacokinetic/pharmacodynamic clinical models. This study aims to:

- Establish and validate two acetylcholine receptor (AChR) antagonist (anticholinergic) drug-induced dementia (DID) disease models
- Establish and validate a liver, blood-brain barrier, iPSC-cortical neuron DID three-organ disease model using acute anticholinergic drug treatment
- Evaluate the effects of chronic AChR antagonist exposure on organ module physiology using the DID single-organ and three-organ disease models

Project Dates: August 15, 2021–July 31, 2023

**Parent Project:** *Multi-organ human-on-a-chip system to address overdose and acute and chronic efficacy and off-target toxicity*

During this study, using TRHC's MedWise Science, algorithms, and PK-PD-based simulations of the five-organ disease models will be established and validated. Drug-induced Long QT Syndrome (di-LQTS) and CYP450 drug interaction burden are at the center of this proposed study with opioids and COVID-19 drugs. The results of this study will better inform TRHC's algorithms on multi-drug interactions and improve predictive models. Simulations will be performed using TRHC's medication risk stratification strategy to compute the impact of different repurposed drugs for COVID-19 on the risk of inducing ADEs when added to drug regimens containing opioids for patients with polypharmacy.

Project Dates: May 1, 2020–July 31, 2021

## Health Resources & Services Administration (HRSA)

**Project Title:** *Evidence-based tele-behavioral health network program (FAIN G0142535)*

The objective of this study is to evaluate an Evidence-Based Telehealth Network Program (EB THNP) service involving activities designed to improve control of hypertension, diabetes, and weight management, resulting in reduced hospital readmissions. Health marker data are routinely collected by the EB THNP provider using remote patient monitoring, patient interventions, and claims data for Medicare, Medicaid, and dual-eligible beneficiaries. The EB THNP reports this existing data to the health system in response to patient referrals from the system. The EB THNP services also provide team-based comprehensive medication management and telehealth services to improve medication safety and health outcomes. The EB THNP team consists of a health coach, nurse, pharmacist, and primary care provider. All services are provided using telehealth delivery models. First, patients complete a comprehensive health assessment with a health coach. Next, patients who are taking more than 10 medications receive a medication safety review by a certified pharmacist. Patients who do not meet these criteria will continue to receive remote monitoring and regular contacts with health coaches. For patients who meet the medication threshold, the pharmacist relays recommendations to improve medication safety and avoid hospital readmissions to the primary care provider and EB THNP. Patients enrolled in the EB THNP service receive monthly follow-up consultations from the health coach as part of their action plan. Subjects will be invited to voluntarily participate in the retrospective analysis of program outcomes upon completion of the grant award.

Project Dates: September 1, 2021–August 31, 2026





## Professional Achievements

- **Meghan J. Arwood, PharmD, MS, BCPS, CMWA** – Certified MedWise Advisor™, Tabula Rasa HealthCare
- **Jenny Bingham, PharmD, BCACP, FAzPA, FNAP** – Inductee, Distinguished Practitioner and Fellow, National Academies of Practice in Pharmacy; Awardee, Fellowship Award, Arizona Pharmacy Association; Awardee, Top Poster Award, University of Arizona College of Pharmacy; Finalist, New Preceptor Award, American Society of Health-System Pharmacists Foundation Pharmacy Residency Excellence Awards; Nominee, Theodore G. Tong Distinguished Leadership and Service Award, University of Arizona College of Pharmacy; Nominee, Pharmacist of the Year, Arizona Pharmacy Association
- **Lauren Condon, MPH, CNMT, RT(N)** – Recipient, Cornell University Certificate in Data Analytics
- **Pamela Dow, MS, PHR, SHRM-CP** – Awardee, Thrive Impact Fund Healthcare Fellow, Central Florida Foundation; Awardee, Gerald-Mark Breen Memorial Scholarship, University of Central Florida; Awardee, Reuel Buchanan Aspire to Inspire Scholarship Awardee, University of Central Florida; Nominee, Athena International Emerging Women Leader Fellowship, University of Central Florida
- **Edward Merle Johnson II, PharmD, RPH, PhD, MBA, BCPS, CMWA** – Certified MedWise Advisor, Tabula Rasa HealthCare
- **Srujitha Marupuru, PharmD, MS, PhD Candidate** – Recipient, International Society for Pharmacoeconomics and Outcomes Research (ISPOR) Student Chapter Leader Distinguished Service Awardee; Recipient, Katheryne B. Willock Library Research Award; Recipient, Outstanding Researcher in Health and Pharmaceutical Outcomes; Recipient, The William & Betty Milleson Fink Graduate Student Fellowships, University of Arizona College of Pharmacy
- **Matt Smith, PhD** – Recipient, Biostatistics Certificate, The Institute for Statistics Education
- **David Thacker, PharmD, RPh, CMWA** – Certified MedWise Advisor, Tabula Rasa HealthCare
- **Michael Ujhelyi, PharmD, FCCP** – Outstanding Reviewer, *Pharmacotherapy*
- **Shannon Vaffis, MPH, PMP, MS, PhD Candidate** – Recipient, University of Arizona Graduate and Professional Student Council Research and Project Grant

# Professional Leadership Roles

- **Daniel Arku, MS, MBA** – Student Representative, University of Arizona College of Pharmacy Graduate Student Council
- **Meghan Arwood, PharmD, MS, BCPS, CMWA** – Chair, American Society for Clinical Pharmacology and Therapeutics Pharmacogenomics Community
- **Rhys Axon, PhD, MPharm, MS, MRPharmS** – Member, Academy of Managed Care Pharmacy (AMCP); Member, American Association of Colleges of Pharmacy (AACP); Member, International Society for Pharmacoeconomics and Outcomes Research (ISPOR); Member, Royal Pharmaceutical Society (RPS)
- **Jenny Bingham, PharmD, BCACP, FAzPA, FNAP** – Member, American Pharmacists Association (APhA) Telehealth Advisory Committee; Member, APhA Telehealth Special Interest Group; Member, Arizona Pharmacy Association Mentor Connection Program; Member, Southwestern States Residency Conference Planning Committee; Member, GTMRx Institute Precision Medicine Enablement via Advanced Diagnostics Workgroup; Member, GTMRx Institute Telehealth Delivery of Comprehensive Medication Management Workgroup; Technical Expert Panelist, Pharmacy Quality Alliance (PQA) Antidepressant Medication Management; Member, PQA Executive Research Advisory Council
- **Srujitha Marupuru, PharmD, MS, PhD Candidate** – Member, Academy of Managed Care Pharmacy (AMCP), Graduate Campus Ambassador, Regeneron Pharmaceuticals, Member, University of Arizona International Society of Pharmacoeconomics and Outcomes Research (ISPOR) student chapter
- **Veronique Michaud, BPharm, MSc, PhD** – Reviewer of Board of Grants, American Foundation for Pharmaceutical Education (AFPE); Member, Women Business Leaders of the U.S. Health Care Industry Foundation
- **Jacques Turgeon, BPharm, PhD** – Reviewer of Board of Grants, American Foundation for Pharmaceutical Education (AFPE); Reappointed as Treasurer, American Society for Clinical Pharmacology and Therapeutics
- **Terri Warholak, PhD, RPh, CPHQ, FAPhA** – Member at Large, Assessment Special Interest Group (SIG), American Association of Colleges of Pharmacy (AACP); Member, Communications and Networking Committee, AACP; Member, Institutional Research and Assessment Committee, AACP; Chair, Education Standing Committee, American Pharmacists Association (APhA); Member, Food and Drug Administration (FDA) Drug Safety and Risk Management (DSaRM) Advisory Committee; Reviewer, National Science Foundation, Small Business Innovation Research/Small Business Technology Transfer grant program; Member, Scientific Methods Panel, National Quality Forum; Member, Research Coordinating Committee, Pharmacy Quality Alliance (PQA); Member, Expert Panel, United States Pharmacopeial (USP) Convention



# Peer Reviewers

- **Meghan Arwood, PharmD, MS, BCPS, CMWA** – *Clinical and Translational Science*
- **Sweilem B. Al Rihani, PharmD, PhD** – *Antioxidants; Biomolecules; Clinical Interventions in Aging; International Journal of Environmental Research and Public Health; International Journal of General Medicine; International Journal of Molecular Sciences; Journal of Personalized Medicine; Medical Sciences; Pharmaceuticals; Pharmaceutics; Pharmacy; Psychology Research and Behavior Management; Scientia Pharmaceutica; Viruses*
- **Rhys Axon, PhD, MPharm, MS, MRPharmS** – *BMJ Open; Currents in Pharmacy Teaching and Learning; International Journal of Pharmacy Practice; Journal of Managed Care & Specialty Pharmacy; Pharmacy*
- **David Bankes, PharmD, BCGP** – *Healthcare*
- **Jenny Bingham, PharmD, BCACP, FAzPA, FNAP** – *American Journal of Health-System Pharmacy; BMJ Open; Healthcare; Journal of the American Pharmacists Association; Journal of Health Care for the Poor and Underserved*
- **Jacques Turgeon, BPharm, PhD** – *Biomedicines; Clinical Microbiology and Infection; Expert Review of Clinical Pharmacology; Journal of the American Pharmacists Association; Journal of Clinical Microbiology*
- **Terri Warholak, PhD, RPh, CPHQ, FAPhA** – *Applied Clinical Informatics; Exploratory Research in Clinical and Social Pharmacy; INNOVATIONS in Pharmacy; Journal of the American Pharmacists Association; Journal of Evaluation in Clinical Practice*



# Postgraduate Residency Programs

## **Postgraduate Year-2 (PGY2) Ambulatory Care Residency**

*Site Name: University of Arizona College of Pharmacy/Tabula Rasa HealthCare*

The University of Arizona College of Pharmacy, in partnership with TRHC, offers a post-graduate residency training program in ambulatory care pharmacy. The program is a 12-month program accredited by the American Society of Health-System Pharmacists (ASHP) and was established in 2012. A pharmacist completing the PGY2 Ambulatory Care Residency Program will be prepared for the role of an ambulatory care specialist, clinical coordinator, and/or adjunct faculty member in an area of ambulatory care pharmacy, and specifically be prepared to develop new financially sustainable ambulatory care services in various roles.

## **Postgraduate Year-1 (PGY1) Pharmacy Residency**

*Site Name: Tabula Rasa HealthCare*

In line with the ASHP PGY1 Program purpose, the purpose of this residency program is to train pharmacists to bring together cutting-edge clinical data, research, and technology in order to tailor medication regimens for individual patients from diverse backgrounds and to excel in their future professional endeavors.

## **Postgraduate Year-2 (PGY2) Clinical Pharmacogenomics Pharmacy Residency**

*Site Name: Tabula Rasa HealthCare*

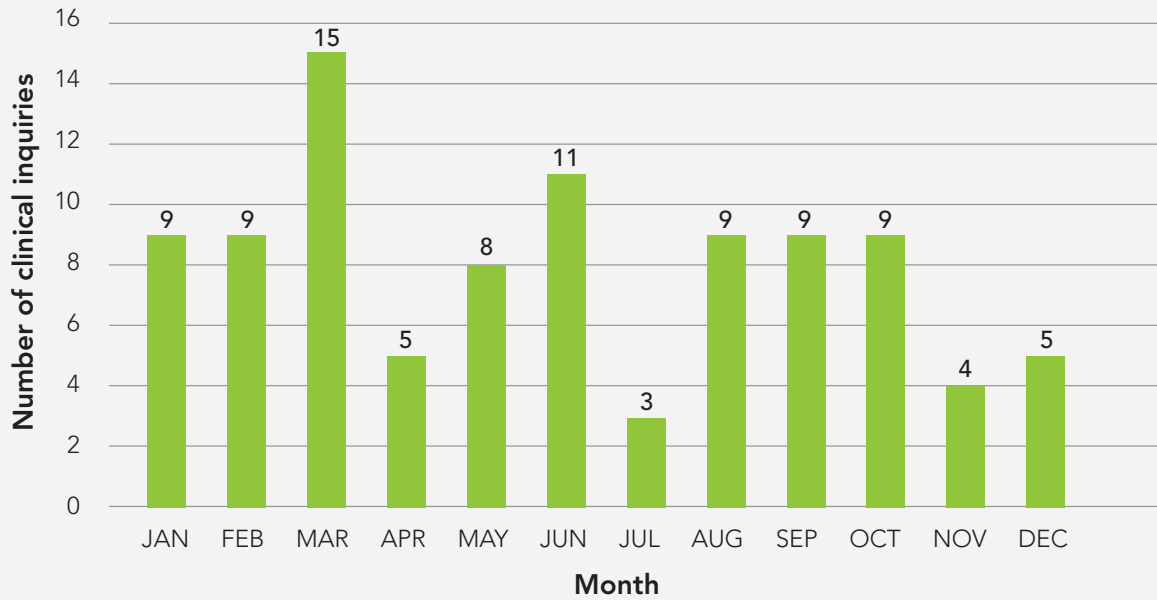
In line with ASHP PGY2 Program purpose, the purpose of the PGY2 pharmacy residency program is to build on Doctor of Pharmacy (PharmD) education and PGY1 pharmacy residency programs to contribute to the development of clinical pharmacists in clinical pharmacogenomics (PGx). The goal of this PGY2 program is for the resident to gain an understanding of the fundamentals of clinical pharmacology and PGx as well as have the ability to apply the necessary clinical skills in order to independently practice clinical PGx and enhance patient care. Upon completion of the residency program, the resident will be prepared for advanced patient care, academia, or other specialized positions, and for board certification, if available.



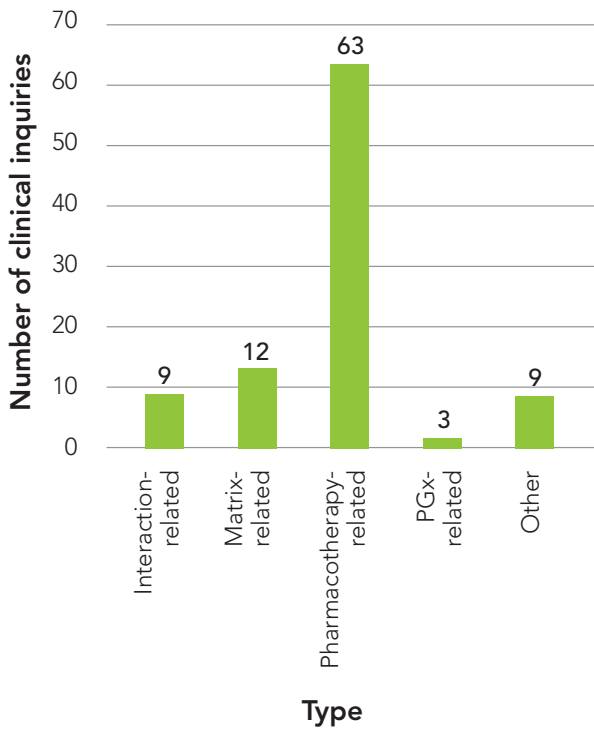
# Drug Information Resource Center (DIRC)

2021 clinical inquiries received: **96** (6.7% increase from 2020)

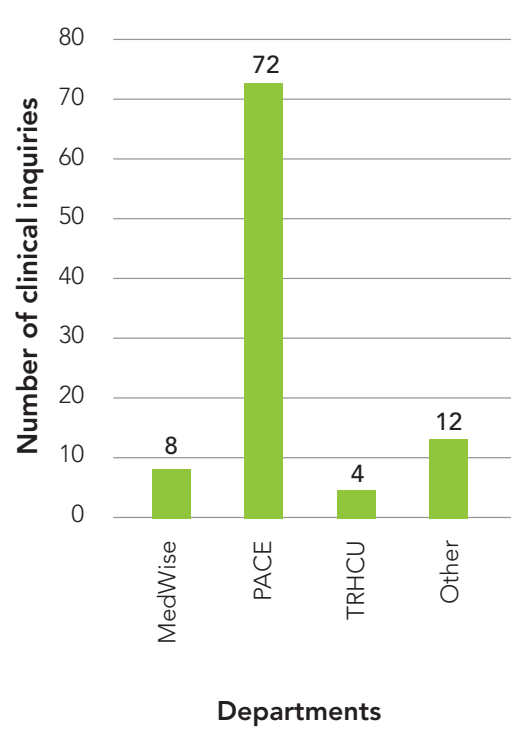
Clinical Inquiries by Month



Clinical Inquiries by Type



Clinical Inquiries by Department



**2021 Clinical Inquirer issues: 12**

- APPE student contributions: 4 articles
- PGY1 contributions: 5 articles
- PGY2 contributions: 10 articles

**Global cost appropriateness initiative algorithms created in collaboration with TRHC University: 4**

**Total clinical inquiries received to date: 220**

**Total DIRC inquiries uploaded in centralized repository: 225**

**2021 DIRC user satisfaction (out of 5):**

**5.0**  
Average  
rating

**46**  
User  
reviews

**User comments and feedback:**

*"Thank you, DIRC, for continuing to provide clinically relevant information and going the extra mile with finding pricing information for my specific request."*

*"Very quick to respond and just what the prescribers were looking for. Thank you!"*

*"I am so amazed with the high quality of the responses provided by our DIRC. As always, thank you for doing such an amazing job, and for going above and beyond to validate your findings with the top dogs."*


*"Thank you for all of your hard work on compiling a clear, concise response, as always!"*

*"Just fantastic and timely."*



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