

**1. Briefly summarize major accomplishments of this project (2-4 pages)**

**The Premise:** Over 90% of older adult upper extremity fragility fractures are associated with a fall from standing and an underlying balance disorder, and over 80% are associated with osteoporosis. These older adults are at high risk for a new fall and fracture, most commonly of the hip. The focus of prevention efforts after fragility fracture have been on detecting and treating osteoporosis. Balance training is an effective intervention for preventing falls, fractures, and injuries that is rarely offered. In fact, new upper extremity fragility fracture is not recognized as a seminal event requiring intervention to prevent future falls and fractures.

**Accomplishments:**

**1. Characterized the Magnitude of the Problem**

Using previously published methods<sup>[1, 2]</sup> the magnitude of the problem at University of Pittsburgh Medical Center was characterized. Briefly, using International Classification of Diseases (ICD-10) and Common Procedural and Treatment (CPT) codes and age ( $\geq 65$ ) to identify of older patients with upper extremity fracture from July 1, 2015, through August 20, 2020. Among 6,295 UPMC patients with upper extremity fracture, 12% received a PT referral within 3 months, and 11.2% experienced a subsequent fracture (Table 1).

**Table 1. Initial Upper Extremity Fractures, referral to Physical Therapy and Subsequent Fractures: UPMC**

| *Initial fractures from 7/1/2015-6/30/2019. Subsequent fractures through 8/202020.                                 | UPMC Fracture Experience*          | All Upper Extremity Fractures (N = 6,295) | Proximal Humerus Fractures (n = 1,533) | Distal Forearm Fractures (n = 2,515) |
|--|------------------------------------|---|--|--------------------------------------|
|  | Age                                | 76.6 (8.7)                                | 77.6 (8.7)                             | 76.5 (8.8)                           |
|  | Female Sex                         | 5,018 (76.7%)                             | 1,281 (83.6%)                          | 2,116 (84.1%)                        |
|  | Race                               |   |  |                                      |
|  | Asian                              | 39 (0.6%)                                 | 7 (0.5%)                               | 15 (0.6%)                            |
|  | Black / African American           | 165 (2.6%)                                | 35 (2.3%)                              | 64 (2.5%)                            |
|  | Hispanic                           | 19 (0.3%)                                 | 2 (0.1%)                               | 12 (0.5%)                            |
|  | Other                              | 104 (1.7%)                                | 20 (1.3%)                              | 42 (1.7%)                            |
|  | White (Non-Hispanic)               | 5,968 (94.8%)                             | 1,469 (95.8%)                          | 2,382 (94.7%)                        |
| Only 10-15% of older adults with new fracture receive referral for PT to address likely balance and gait disorders | Therapy Prescribed within 6 months |   |  |                                      |
|  | None                               | 5,541 (88.0%)                             | 1,298 (84.7%)                          | 2,261 (89.9%)                        |
|  | Therapy Ordered                    | 754 (12.0%)                               | 235 (15.3%)                            | 254 (10.1%)                          |
|  | Therapy Type if Prescribed         |   |  |                                      |
|  | Hand Therapy                       | 196 (26%)                                 | 3 (1.3%)                               | 131 (51%)                            |
|  | Occupational Therapy               | 164 (21.8%)                               | 19 (8.1%)                              | 92 (35.8%)                           |
|  | Physical Therapy                   | 394 (52.3%)                               | 212 (90.6%)                            | 34 (13.2%)                           |
| High risk of second fracture within one year (10-11%)  | Second Fracture within 12 months   | 704 (11.2%)                               | 156 (10.2%)                            | 280 (11.1%)                          |
|  | Second Fracture Type               |   |  |                                      |
|  | Hip                                | 125 (17.8%)                               | 36 (23.1%)                             | 42 (15%)                             |
|  | Proximal Humerus                   | 67 (9.5%)                                 | 18 (11.5%)                             | 19 (6.8%)                            |
|  | Distal Forearm                     | 223 (31.7%)                               | 16 (10.3%)                             | 18 (17.9%)                           |
|  | Other UEF                          | 289 (41.1%)                               | 86 (55.1%)                             | 169 (60.4%)                          |

**2. Developed Training Materials**

Based on prior research,<sup>[1, 2]</sup> input from clinical champions, the APTA fall risk management clinical practice guideline (CPG)[3] and the Otago fall prevention program,[4, 5] educational materials were developed for orthopaedic providers and for physical therapists.

**3. Trained PTs in Evidence-based Fall Risk Management for Older Adults with Upper Extremity Fragility Fracture**

Forty-eight PTs working in 20 clinics have been trained to date on the Otago fall prevention program.

**4. Engaged Providers and Patients**

A survey of PTs at UPMC (n=77) was conducted to understand current practice at UPMC including 39% working in outpatient clinics, 33% in acute care hospital, 20% in inpatient rehabilitation facilities, and 7% in skilled nursing facilities. A large proportion (48%) were not familiar with APTA CPG recommendations for fall risk management. The level of confidence in conducting fall risk assessments were: 26% very, 55% somewhat, and 19% not at all confident. Their level of confidence in providing

progressive, challenging balance exercises were: 41% very, 43% somewhat, and 16% not at all confident.

Interviews were conducted with UPMC PTs (n=6), OTs (n=2), orthopaedic providers (n=5), and patients with upper extremity fragility fracture (n=8). While interview analyses are still ongoing, they have revealed that providers think that this is an important problem and are motivated to recommend PT referral for fall risk and balance and gait training. Key insights from older adult patients with recent fracture are that going to PT and engaging in regular, progressive balance exercise are as high or higher priority relative to management of other conditions because their fracture threatened their ability to live alone and to shop, dress, prepare meals and drive.

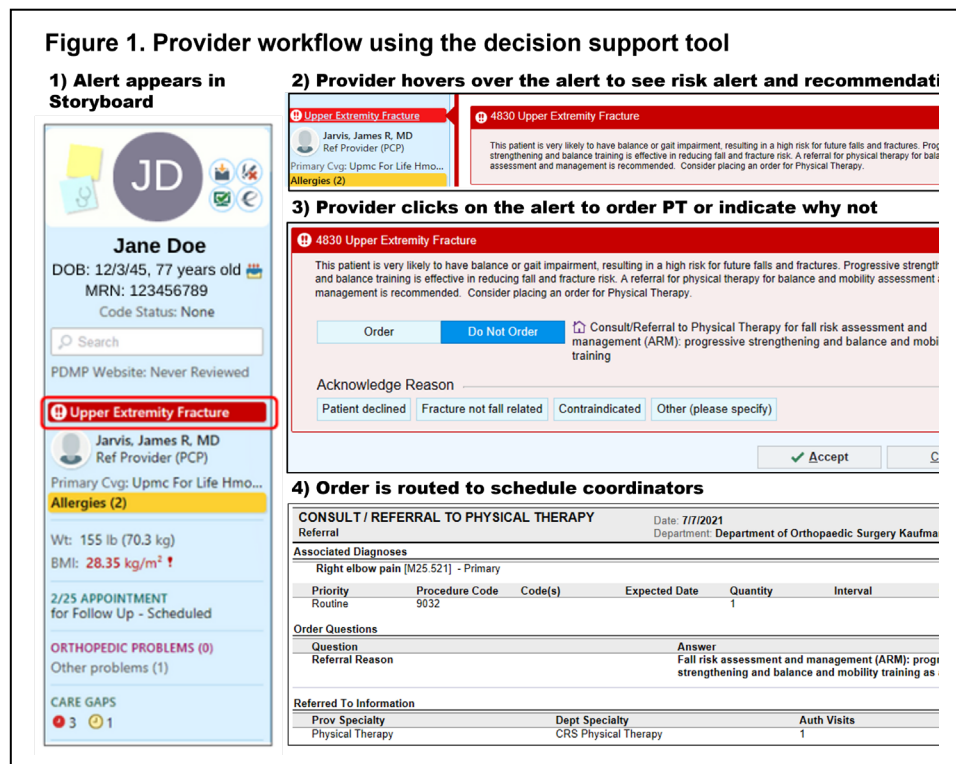
Both surveys and interviews addressed educational and training needs that will be used to refine educational materials, resources and training plans. This will include resources for providers to use in interacting with patients in addition to provider training and resources.

### 5. Analyzed Data from Interviews

Interviews were conducted with UPMC PTs (n=6), OTs (n=2), orthopaedic providers (n=5), and patients with upper extremity fragility fracture (n=8). While interview analyses are still ongoing, they have revealed that providers think that this is an important problem and are motivated to recommend PT referral for fall risk and balance and gait training. Key insights from older adult patients with recent fracture are that going to PT and engaging in regular, progressive balance exercise are as high or higher priority relative to management of other conditions because their fracture threatened their ability to live alone and to shop, dress, prepare meals and drive.

### 6. Implemented Clinical Decision Support

With collaboration of orthopaedic and PT clinical champions, the Department of Orthopaedic Surgery leadership, the Wolff Center for Quality, Safety and Innovation, UPMC Epic Clinical Decision Support (CDS) team, and UPMC Clinical Analytics we developed and implemented a CDS tool within the UPMC Epic electronic health record in two practices. The alert, entitled “Upper Extremity Fracture” appears in the patient’s “Storyboard” and is triggered based on based



on age  $\geq 65$ , and ICD-10 codes for upper extremity fracture or x-ray within the past 6 months.[1, 2] As in our prior published studies, codes for infection, cancer and multi-trauma, and ongoing fracture management will be used to exclude patients who are not likely to have sustained a new fracture due to a fall. With these exclusions the large majority of fractures identified will be fall-related.[6-9] The provider decides whether to make the referral, and once executed, patient information is sent electronically to RI scheduling coordinators. RI schedulers call the patients to schedule the PT evaluation in the desired practice with a trained PT (see Figure 1 above). Provider education materials on fracture and fall risk, evidence-based treatment and the CDS tool were developed as part of the QI initiative. They will be reviewed by the Steering Committee and Advisory Panel finalized based on their input. Providers (physicians and physician extenders) will receive one of eight practice-based 45-minute in-services at an existing departmental meeting educating them about the evidence to practice gap, the decision support tool, and provider and patient resources.

### **7. Began Development of a Natural Language Processing Algorithm to Analyze PT Notes on Balance Training**

In prior work, collaborators developed and tested a natural language processing (NLP) algorithm to analyze text in PT notes describing exercise[10] and to identify falls.[11] Our team has begun expanding this algorithm to include balance exercise to support assessment of treatment fidelity. The steps that have been taken are: developed definitions of evidence-based PT, extracted data from 165 selected patient charts, and identified key words representing balance interventions. Work is ongoing to develop and test the algorithm focusing on evidence-based balance training for fall risk management.

### **8. Submitted R01 proposal to the National Institute on Aging**

A brief summary of the proposal is provided below.

The proposed study will address the evidence-to-practice gap in secondary fracture prevention by testing interventions for implementation of a PT referral of older adults with recent upper extremity fracture for balance and gait training within eight ambulatory orthopaedic practices in one large integrated health care delivery and financing system.

This hybrid type 3 implementation-effectiveness study is built on a quality improvement initiative that includes the use of the electronic health record and administrative data to achieve the proposed specific aims. Aim 1: Determine if the use of audit and feedback in addition to decision support and provider training increase PT referral for evidence-based management by conducting a cluster randomized trial of 8 orthopaedic practices in 17 locations, and 3262 older adults with upper extremity fracture to compare 1) a decision support tool combined with training to 2) decision support tool, training and audit and feedback. Aim 2: use semi-structured interviews to explore implementation determinants and explain findings from Aim 1 to inform large scale implementation. Aim 3: Determine the cost and cost-effectiveness of the implementation strategies from the health system, payer and societal perspectives using study and published data and Markov modelling using PT referral and fall-related injuries as the effectiveness term. The project will result in new knowledge about what works and why for a scalable approach to reduce refracture in a high-risk population.

**2. Provide a one-paragraph summary of results or abstract suitable for posting on the Academy website.**

Over 90% of older adult upper extremity fragility fractures are associated with a fall from standing and an underlying balance disorder, and over 80% are associated with osteoporosis. These older adults are at high risk for a new fall and fracture, most commonly of the hip. The focus of prevention efforts after fragility fracture have been on detecting and treating osteoporosis. Balance training is an effective intervention for preventing falls, fractures, and injuries that is rarely offered. In fact, new upper extremity fragility fracture is not recognized as a seminal event requiring intervention to prevent future falls and fractures. In this project, a cohort study was conducted to understand the magnitude of the problem in one health system. This analysis of fractures and PT referrals for the health system population over one year found that among 6,295 upper extremity fractures (1,533 proximal humerus, 2,515 distal forearm) 12% received a prescription for physical or occupational therapy for balance or gait disturbance. The proportion who had a second fracture within one year was 11%. The team developed and tested a clinical decision support tool within the electronic health record that identifies patients age 65 and older attending a clinic visit for a new upper extremity fracture. The alert was implemented in two orthopaedic surgery practices. An audit and feedback report was developed that identifies proportion of patients with new upper extremity fragility fracture that received a referral to PT for balance training, and the proportion who attended PT. A survey of 77 PTs was conducted to understand current practice. Interviews were conducted with orthopaedic surgery providers, PTs, OTs and patients, which revealed that orthopaedic surgery providers think that this is an important problem and are motivated to recommend PT referral for fall risk and balance and gait training. PTs reported that the risk warrants action and that adding management of fall risk to fracture rehabilitation is feasible. Key insights from older adult patients with recent fracture are that going to PT and engaging in regular, progressive balance exercise are as high or higher priority relative to management of other conditions because their fracture threatened their ability to live alone and to shop, dress, prepare meals and drive. PTs provided input on training plan and materials, and PTs in 21 outpatient clinics were trained in evidence-based fall risk management for older adults after upper extremity fragility fracture. A proposal was submitted to NIH to test implementation strategies in orthopedic clinics.

3. **Attach a list of your publications published or accepted during the past year, or currently being written.** Send reprints when available. List presentations made and abstracts accepted for presentation based on this work. Indicate with an asterisk (\*) those publications supported by Academy of Orthopaedic Physical Therapy funding.
- a. Christine M. McDonough, Mark E. Baratz, Stefanie C. Altieri Dunn, Alison E Bank, Jonathan D Arnold, Jeff McKibben, John R. Fowler. Preventing New Injuries after Upper Extremity Fracture in Older Adults: Opportunities in Orthopaedics and Physical Therapy Referrals. Poster presentation at ACRM annual meeting, Atlanta, GA Nov 1, 2023.
  - a. \*Christine M. McDonough, Mark E. Baratz, Stefanie Altieri Dunn, Alison E. Bank, Jonathan D. Arnold, Jeffrey McKibben, John R. Fowler. Advancing Fall Prevention after Upper Extremity Fracture in Older Adults: Opportunities in Orthopaedic Surgery Platform presentation at APTA's CSM, Boston, MA, February 2024.\*
  - b. Currently drafting a manuscript to be submitted to Journal of Hand Surgery Global Online (JHS GO).

## References

1. Bynum, J.P., et al., *Second fractures among older adults in the year following hip, shoulder, or wrist fracture*. Osteoporos Int, 2016. **27**(7): p. 2207-15.
2. McDonough, C.M., et al., *Falling Down on the Job: Evaluation and Treatment of Fall Risk Among Older Adults With Upper Extremity Fragility Fractures*. Phys Ther, 2017. **97**(3): p. 280-289.
3. Avin, K.G., et al., *Management of Falls in Community-Dwelling Older Adults: A Clinical Guidance Statement From the Academy of Geriatric Physical Therapy of the American Physical Therapy Association*. Phys Ther, 2015. **95**(6): p. 815-34.
4. Shubert, T.E., et al., *Otago Exercise Program in the United States: Comparison of 2 Implementation Models*. Phys Ther, 2017. **97**(2): p. 187-197.
5. Thomas, S., S. Mackintosh, and J. Halbert, *Does the 'Otago exercise programme' reduce mortality and falls in older adults?: a systematic review and meta-analysis*. Age Ageing, 2010. **39**(6): p. 681-7.
6. Centers for Disease Control and Prevention. *Important Facts about Falls*. 2017 6/2/2018]; Available from: <https://www.cdc.gov/homeandrecreationalafety/falls/adultfalls.html>.
7. Hayes, W.C., et al., *Impact near the hip dominates fracture risk in elderly nursing home residents who fall*. Calcif Tissue Int, 1993. **52**(3): p. 192-8.
8. Kelsey, J.L., et al., *Risk factors for fractures of the distal forearm and proximal humerus. The Study of Osteoporotic Fractures Research Group.*[Erratum appears in Am J Epidemiol 1992 May 15;135(10):1183]. American Journal of Epidemiology, 1992. **135**(5): p. 477-89.
9. Tytherleigh-Strong, G., N. Walls, and M.M. McQueen, *The epidemiology of humeral shaft fractures*. J Bone Joint Surg Br, 1998. **80**(2): p. 249-53.
10. Shaffran SW, et al., *Extracting Physical Rehabilitation Exercise Information from Clinical Notes: a Comparison of Rule-Based and Machine Learning Natural Language Processing Techniques*. . arXiv 2023. **preprint** (arXiv:2303.13466).
11. Oniani, D., et al., *ReDWINE: A clinical datamart with text analytical capabilities to facilitate rehabilitation research*. International Journal of Medical Informatics, 2023. **177**: p. 105144.