Digital Precision Pain Care: Assessment, Treatment, and Monitoring

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No relevant disclosures

Imagine a world…

Clinicians access high quality data to inform assessments and best treatments through clinical decision support systems

Data is continually updated, new data types added dynamically, and the system is continuously learning

Imagine a world…

Targeted delivery of therapies both online and in person based on a patient's characteristics and data

Imagine a world…

Patients access their own health information to improve their education and self-management of pain and other conditions. Patients work collaboratively with their clinicians to empower their individual care.

National Pain Strategy

Prevention & Care

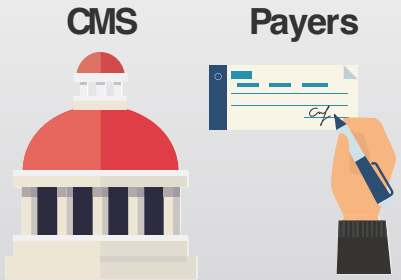
Increase substantially the accessibility and quality of pain care

Disparities

Under-treatment and inappropriate treatment of pain among racial and ethnic minorities

Services & Reimbursement

Public health entities have a role in pain care and prevention

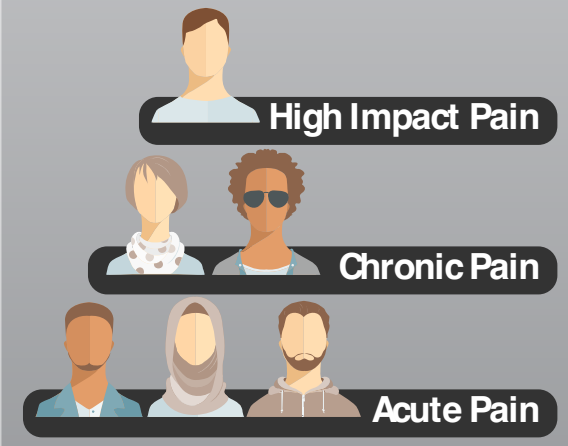


Professional Education

Improve professional education of all providers

Population Research

Improvements in state and national data are needed



Public Education & Communication

High quality, evidence based education programs for patients and the public

"Better data are needed to understand the problem and guide action"

Learning health care systems

- Research happens closer to clinical practice than in traditional university settings
- Scientists, clinicians, and administrators work together
- Studies occur in everyday practice settings
- Aggregates health data for the purpose of learning and continuous structural improvements in healthcare delivery
- Captures data in such a way that can generate new knowledge
- Structures that knowledge so as to be rapidly deployed back into clinical practice

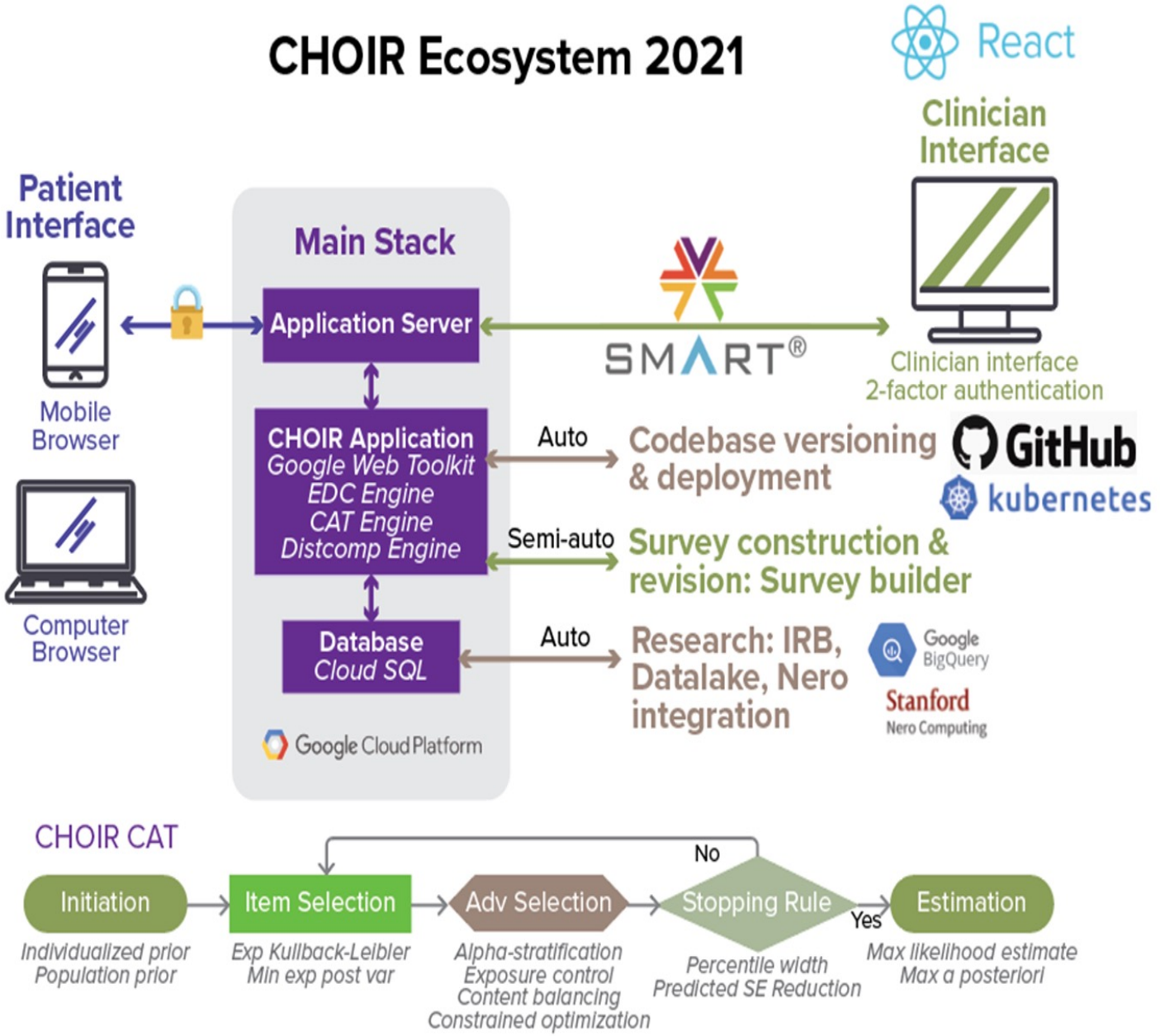
Summary: Evidence informs practice and practice informs evidence

National Academy of Medicine (IOM) 2007

CHOIR

Open source, open standard, highly flexible, and **free** platform for a Learning Health System

(http://choir.stanford.edu)



Learning Health System

Application of precision medicine

Point of Care: The learning engine

Research Studies

Knowledge network

Biomedical research

CHOIR

Research influences practice
Practice influences research

National Academy of Medicine

General Section
Research Paper

OPEN

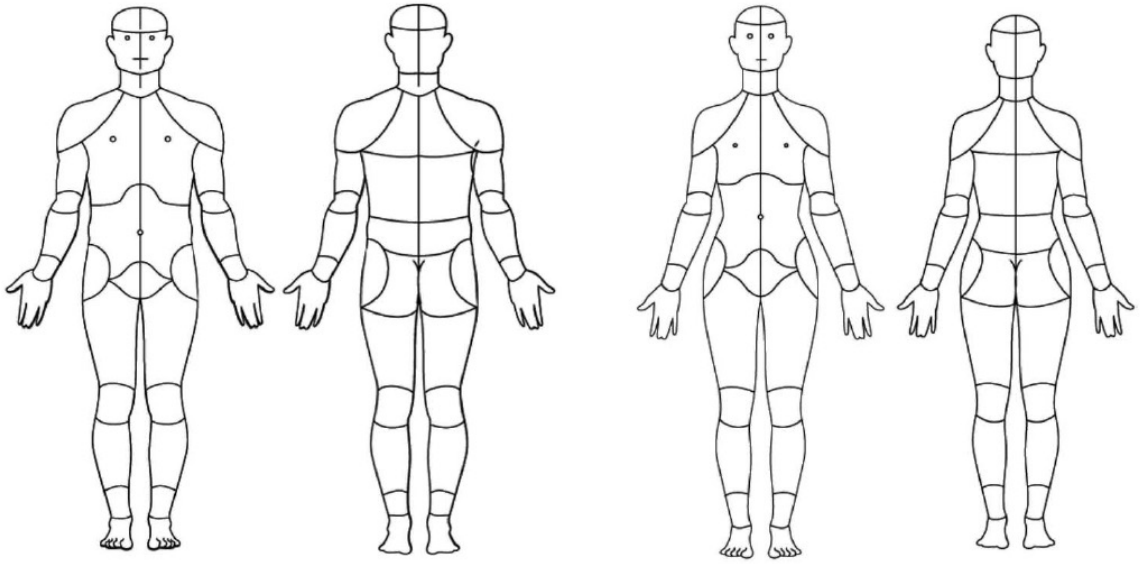
PAIN REPORTS®

January/February 2021 - Volume 6 - Issue 1 - p e8802021

Development and validation of the Collaborative Health Outcomes Information Registry body map

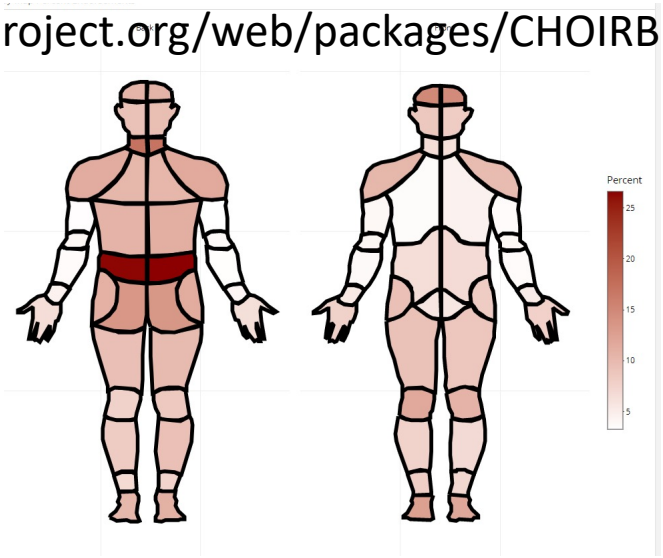
Kristen Hymel Scherrer[a,b], Maisa S. Ziadni[a], Jiang-Ti Kong[a], John A. Sturgeon[c], Vafi Salmasi[a], Juliette Hong[a], Eric Cramer[a], Abby L. Chen[a], Teresa Pacht[a], Garrick Olson[a], Beth D. Darnall[a], Ming-Chih Kao[a], Sean Mackey[a,*]

Select the areas where you are experiencing pain.



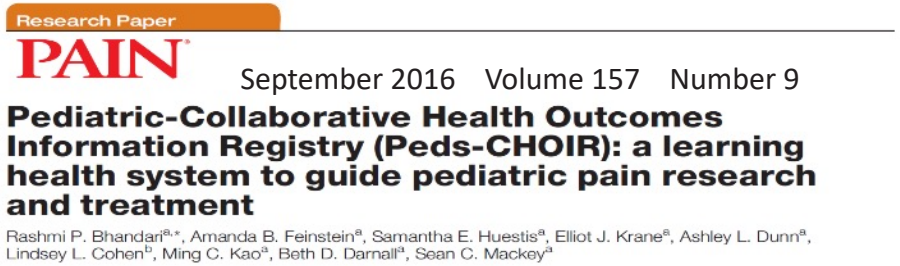
R Code Tools for analysis and visualization of CHOIR Body Map

https://cran.r-project.org/web/packages/CHOIRBM/



CHOIR Multiple Medical Specialties Across the Globe

- Chronic Pain
- Pediatric Pain
- Family Medicine
- Chronic Fatigue Syndrome
- Orthopedic Surgery
- Trauma Surgery
- Pre-Surgery Assessment Clinic
- Interventional Radiology
- Psychiatry
- GI Medicine

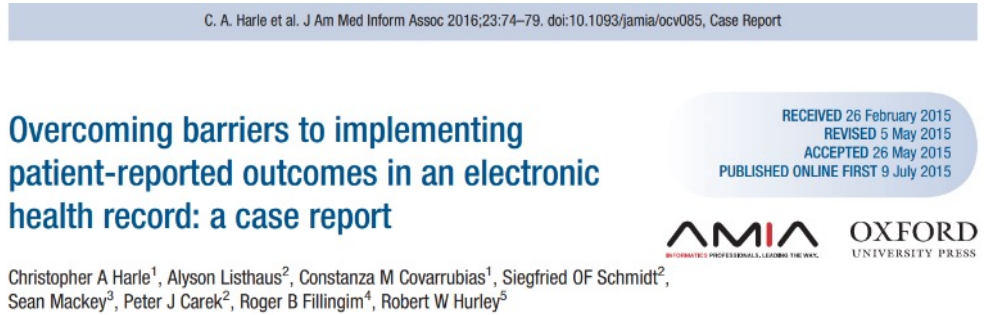

Research Paper

PAIN

September 2016 Volume 157 Number 9

Pediatric-Collaborative Health Outcomes Information Registry (Peds-CHOIR): a learning health system to guide pediatric pain research and treatment

Rashmi P. Bhandari[a,*], Amanda B. Feinstein[a], Samantha E. Huestis[a], Elliot J. Krane[a], Ashley L. Dunn[a], Lindsey L. Cohen[b], Ming C. Kao[a], Beth D. Darnall[a], Sean C. Mackey[a]


C. A. Harle et al. J Am Med Inform Assoc 2016;23:74–79. doi:10.1093/jamia/ocv085, Case Report

Overcoming barriers to implementing patient-reported outcomes in an electronic health record: a case report

RECEIVED 26 February 2015
REVISED 5 May 2015
ACCEPTED 26 May 2015
PUBLISHED ONLINE FIRST 9 July 2015

AMIA OXFORD UNIVERSITY PRESS

Christopher A Harle[1], Alyson Listhaus[2], Constanza M Covarrubias[1], Siegfried OF Schmidt[2], Sean Mackey[3], Peter J Carek[2], Roger B Fillingim[4], Robert W Hurley[5]

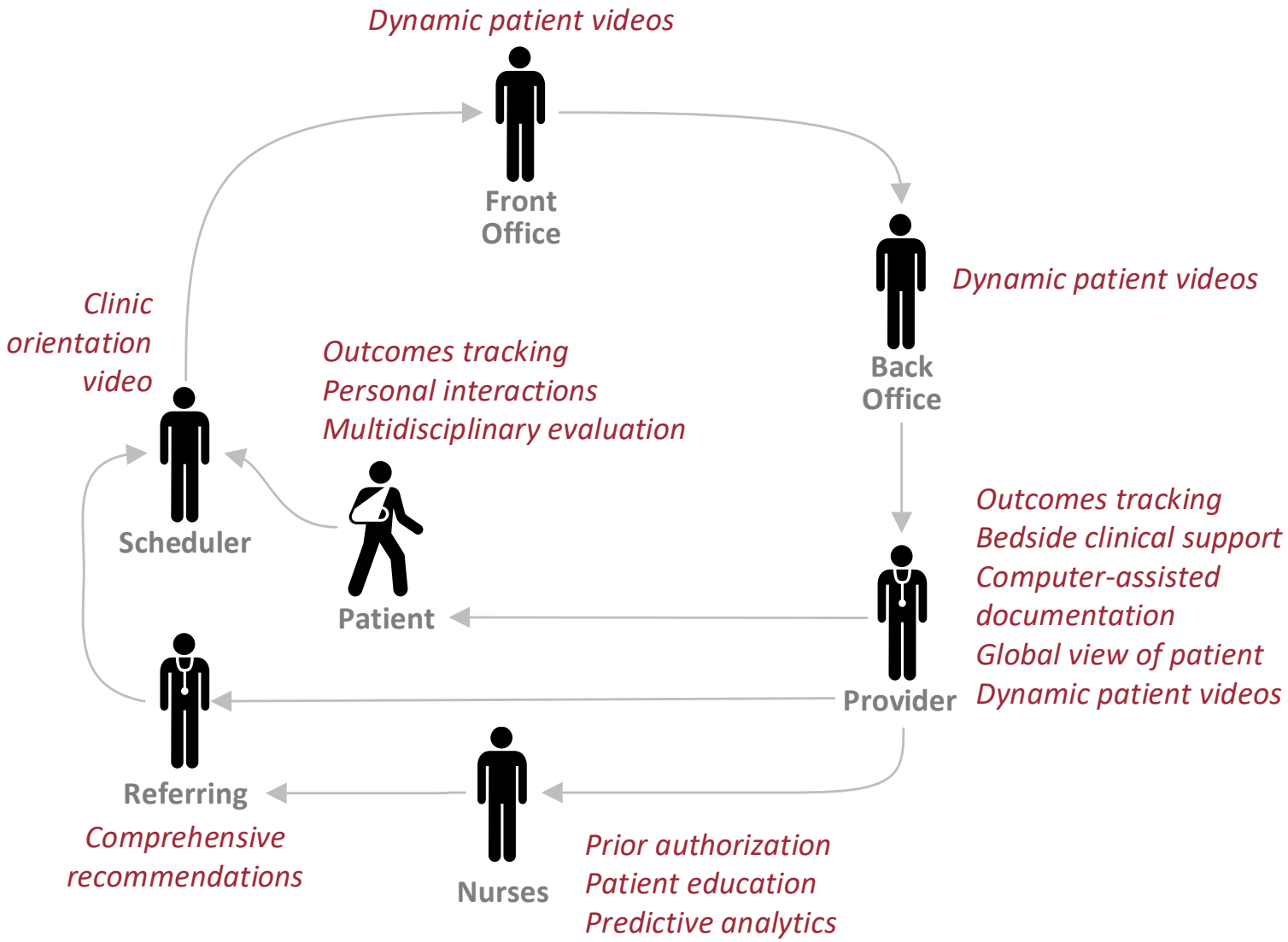

ORIGINAL ARTICLE

Electronic Patient-Reported Outcomes: Semi-Automated Data Collection in the Interventional Radiology Clinic

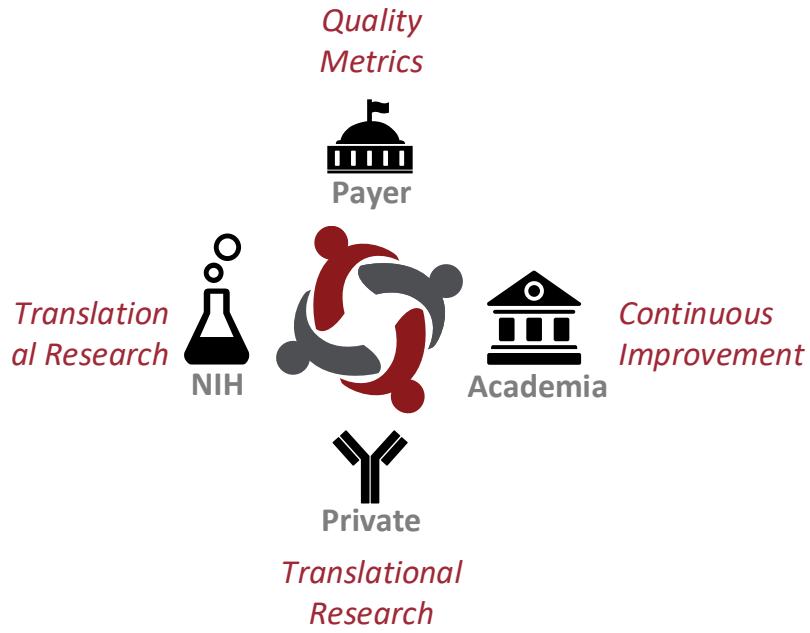
SA-CME

Nam S. Hoang[a], Winifred Hwang[a], Danielle A. Katz[a], Sean C. Mackey, MD, PhD[b], Lawrence V. Hofmann, MD[a]

#1 Reason for clinical informatics system failure: Lack of buy in

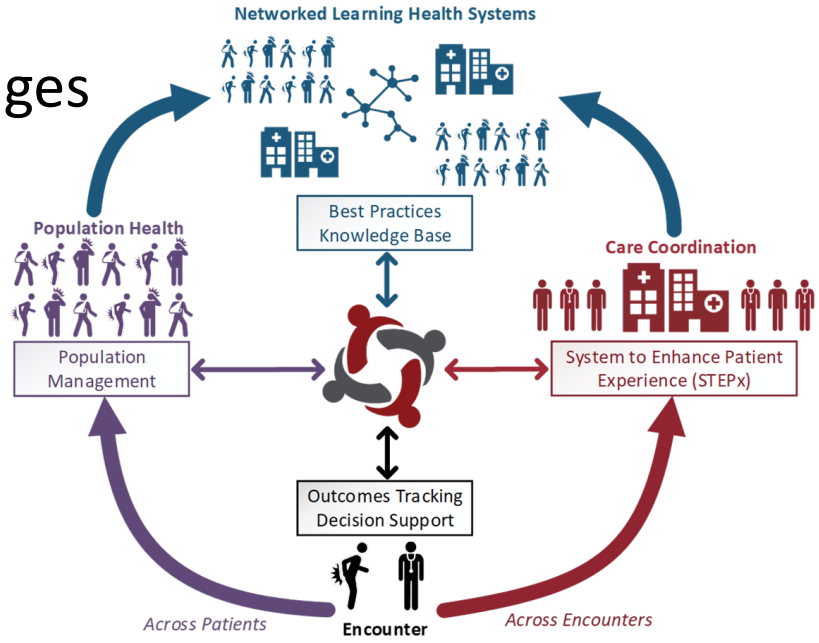


CHOIR is designed to provide value to all stakeholders in the patient's experience



CHOIR Features and Status – Clinical

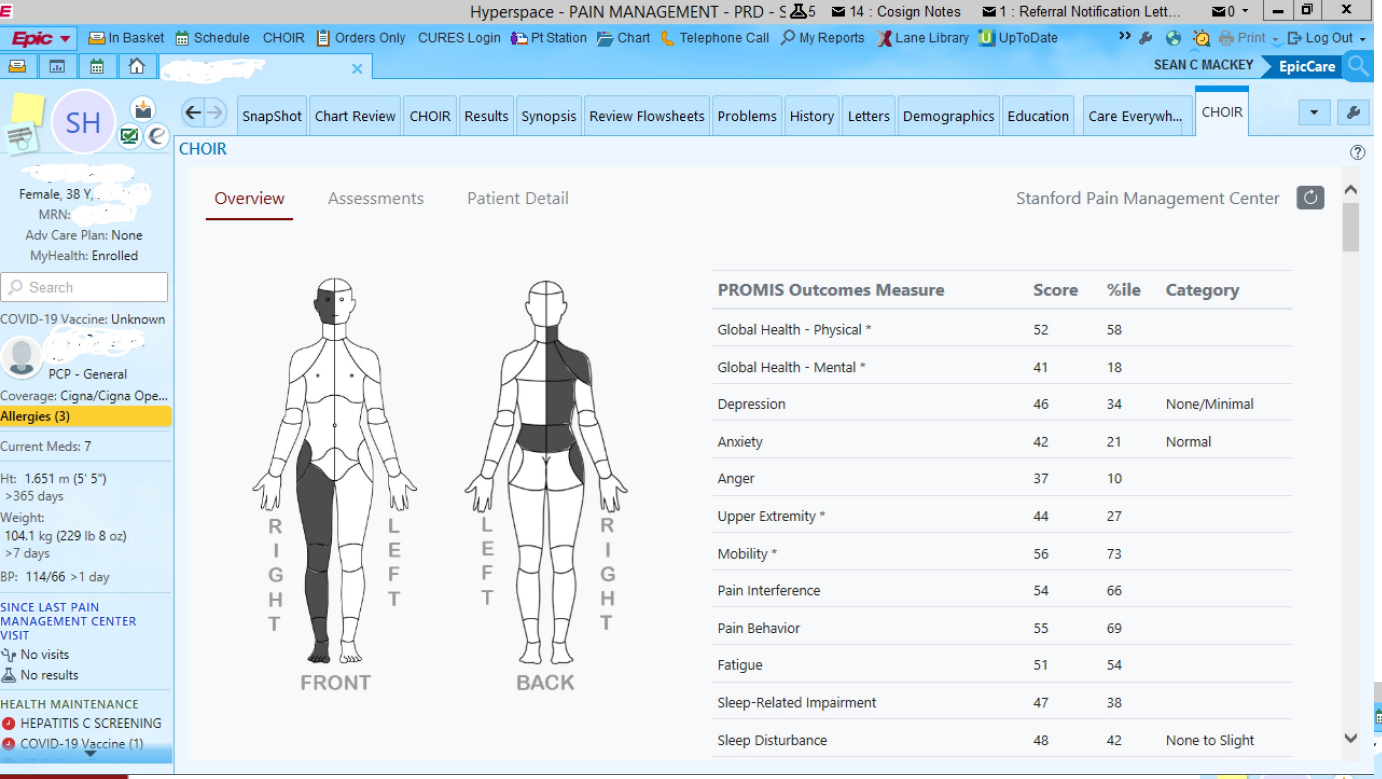
- Seamless and customizable clinic workflow integration
- Automated survey reminders (Email, Text)
- Mobile first, web browser-based; data entry in multiple languages
- Standard and computer adaptive testing surveys (ie PROMIS)
- Targeted assessments and point of care reporting
- Targeted delivery of content based on patient characteristics
- Clinical tools: E.g., Automated clinic note generator, clinical calculators
- >100,000+ longitudinal assessments (Stanford Pain only)
- Open-source (free) licensing with minimal restrictions
- Cloud based and on-premise options

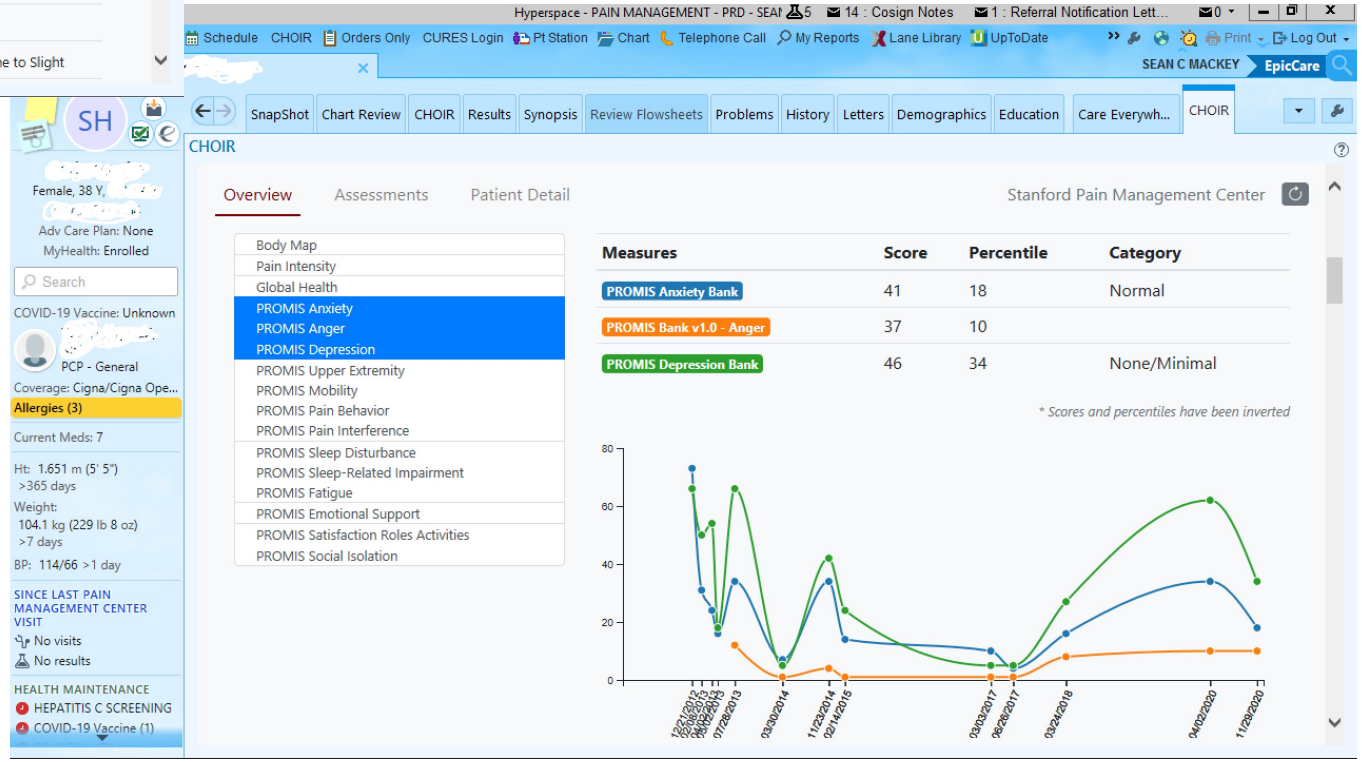


Changed the culture of how we care for people!

CHOIR Clinician Functionality: EMR (EPIC) integration for clinicians

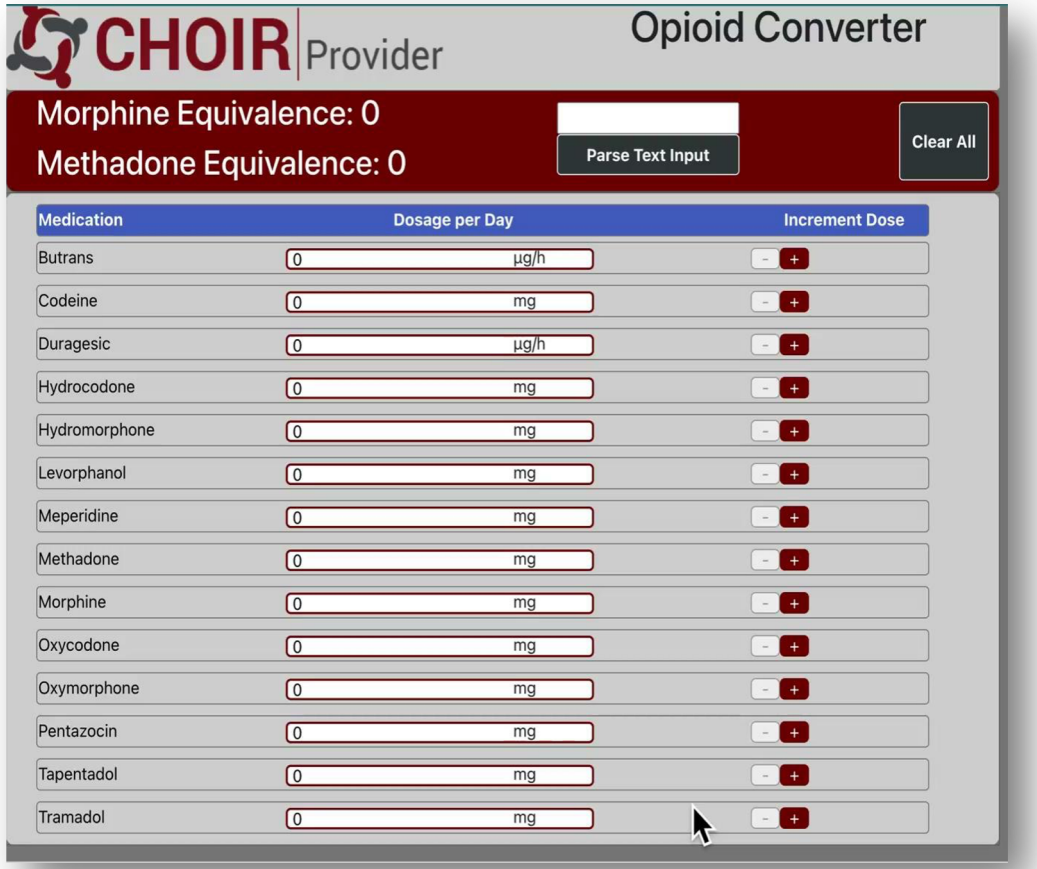
SMART on FHIR®©

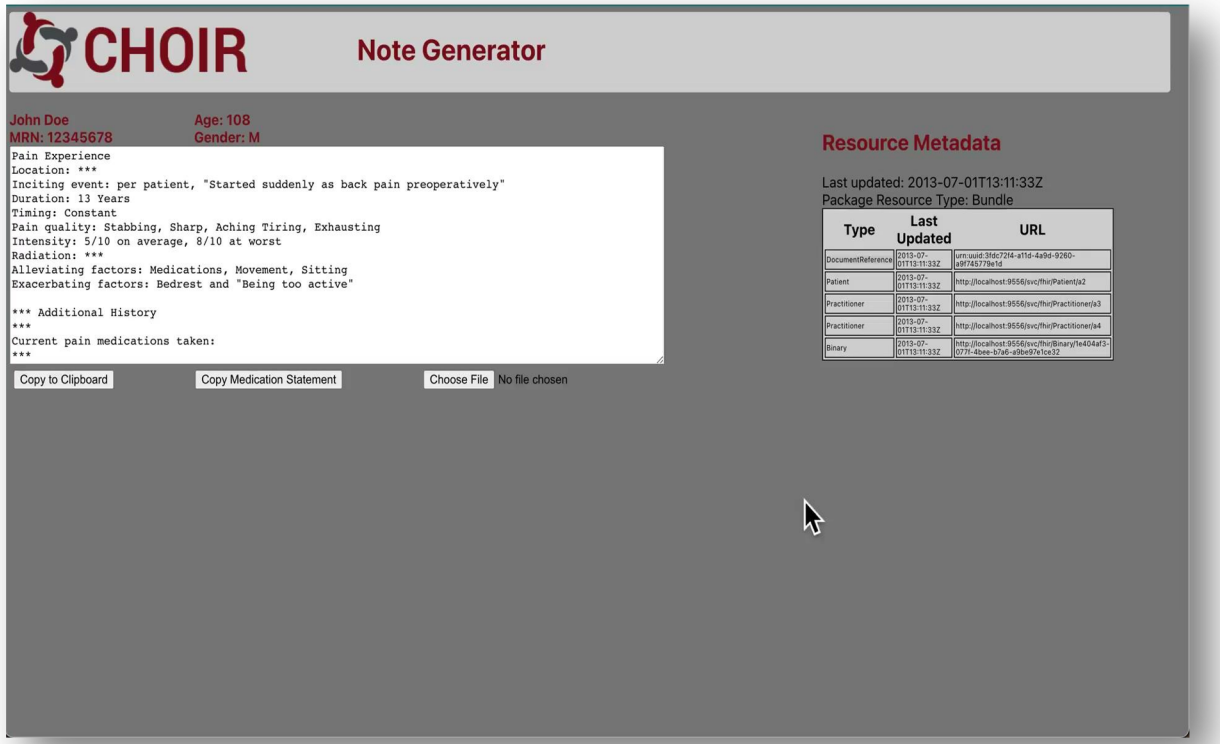




CHOIR on FHIR Apps – Seamless EMR Integration to Improve Clinician Workflow and Patient Care

SMART on FHIR®©





- Parse EPIC JSON files directly into readable formats
- Includes metadata and contents
- Input different EPIC files (Document Reference, Diagnostic Report, Medication Statement, etc)

CHOIR Features and Status – Research and QI

- Recruitment emails and eligibility surveys (electronic consent/enrollment)
- Research and clinical contact database (10's of thousand
- Rapid pilot data in real-world patients
- Point of care randomization for clinical trials (e.g. EMPOWER)
- Amazon gift cards for completing assessments
- Distributed computational registry to connect sites
- >30 publications; >$30M in grants obtained
- Evidence informs practice and practice informs evidence

pcori
PATIENT-CENTERED OUTCOMES RESEARCH INSTITUTE

EMPOWER

Research Paper

PAIN

September 2016 Volume 157 Number 9

Pediatric-Collaborative Health Outcomes Information Registry (Peds-CHOIR): a learning health system to guide pediatric pain research and treatment

Rashmi P. Bhandari[a,*], A
Lindsey L. Cohen[b], Ming

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ORIGINAL ARTICLE

Electronic Patient-Reported Outcomes: Semi-Automated Data Collection in the Interventional Radiology Clinic

SA-CME

Nam S. Hoang[a], Winifred Hwang[a], Danielle A. Katz[a], Sean C. Mackey, MD, PhD[b], Lawrence V. Hofmann, MD[a]

Journal of Pain Research

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

From Catastrophizing to Recovery: a pilot study of a single-session treatment for pain catastrophizing

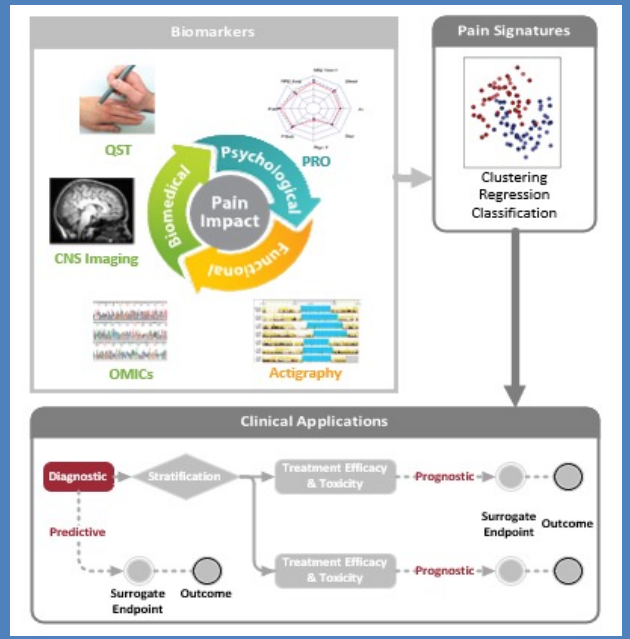
This article was published in the following Dove Press journal:
Journal of Pain Research
25 April 2014
Number of times this article has been viewed

Beth D Darnall
John A Sturgeon
Ming-Chih Kao
Jennifer M Hah
Sean C Mackey

Background: Pain catastrophizing (PC) – a pattern of negative cognitive-emotional responses to real or anticipated pain – maintains chronic pain and undermines medical treatments. Standard PC treatment involves multiple sessions of cognitive behavioral therapy. To provide efficient treatment, we developed a single-session, 2-hour class that solely treats PC entitled "From Catastrophizing to Recovery" [FCR].

Advancing Precision Pain Care: Integration of Biomarkers, AI and Learning Healthcare Systems

Biomedical research



Knowledge network

Application of precision medicine

CHOIR

Research influences practice

Practice influences research

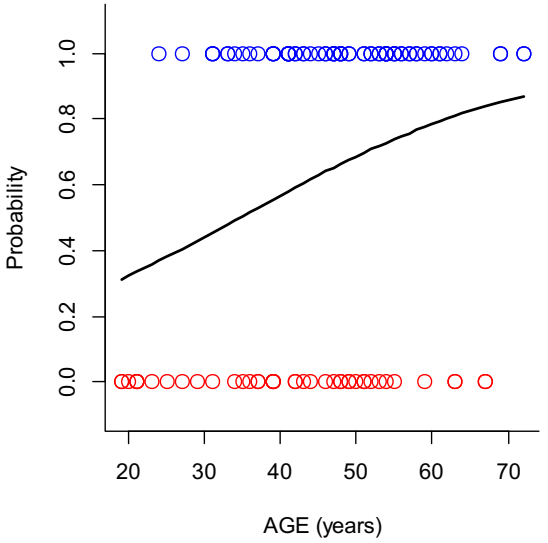
Point of Care: the learning engine

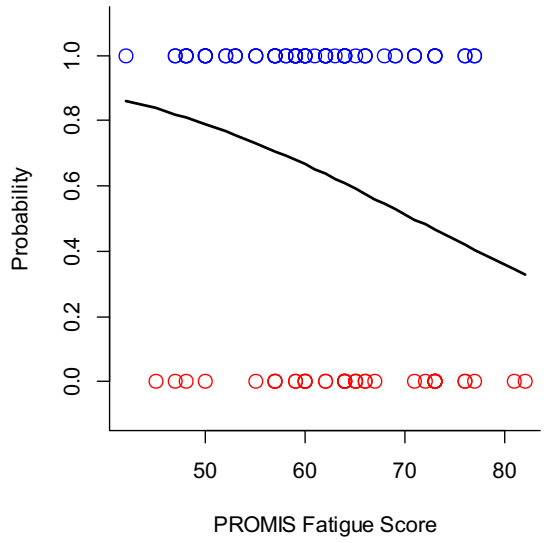
Research Studies

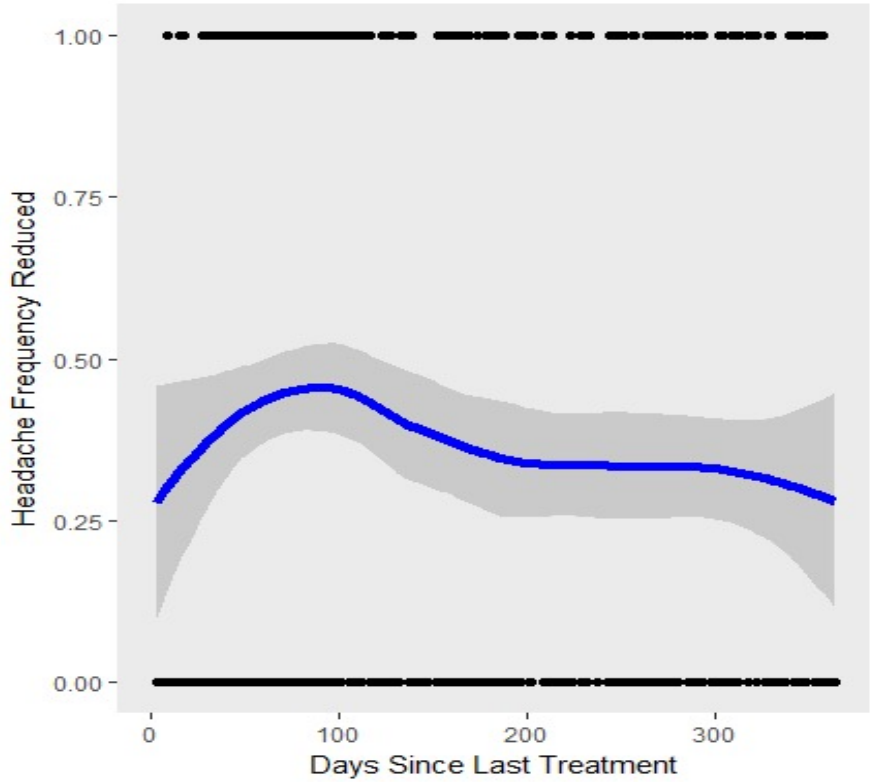
CHOIR Collaborative Health Outcomes Information Registry

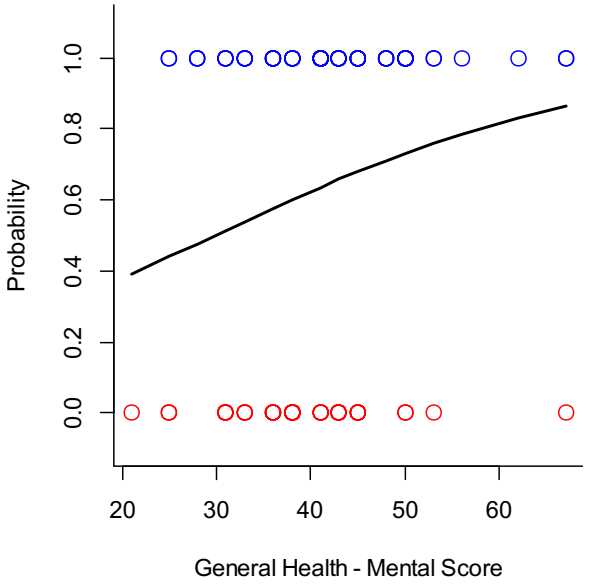
Botox for Migraine

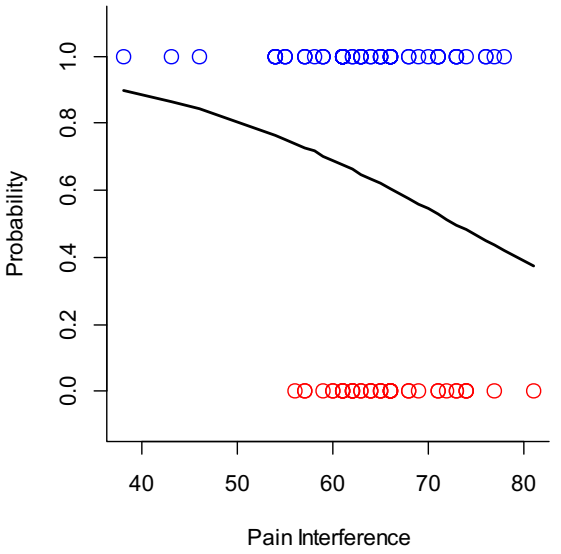
- Objective To define individual patient level predictors of response to the Phase III REsearch Evaluating Migraine Prophylaxis Therapy (PREEMPT) protocol among high complexity pain patients in practice
- 658 observations of 183 subjects











Regional Anesthesia & Pain Medicine. 2019 Jun;44(6):660-668

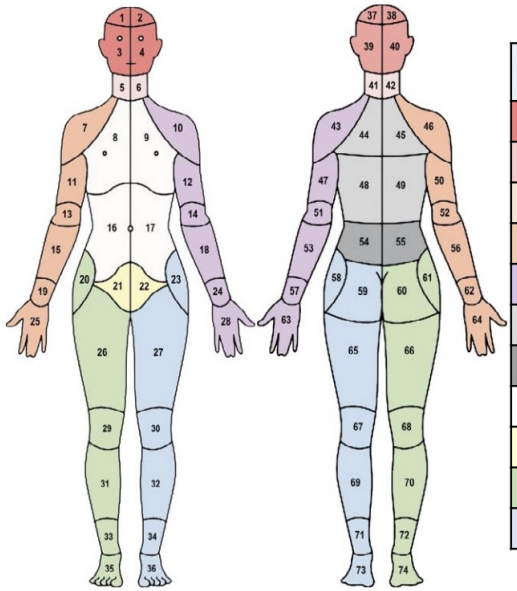
Received: 23 December 2020 | Accepted: 12 April 2021

DOI: 10.1111/head.14129

RESEARCH SUBMISSIONS Headache

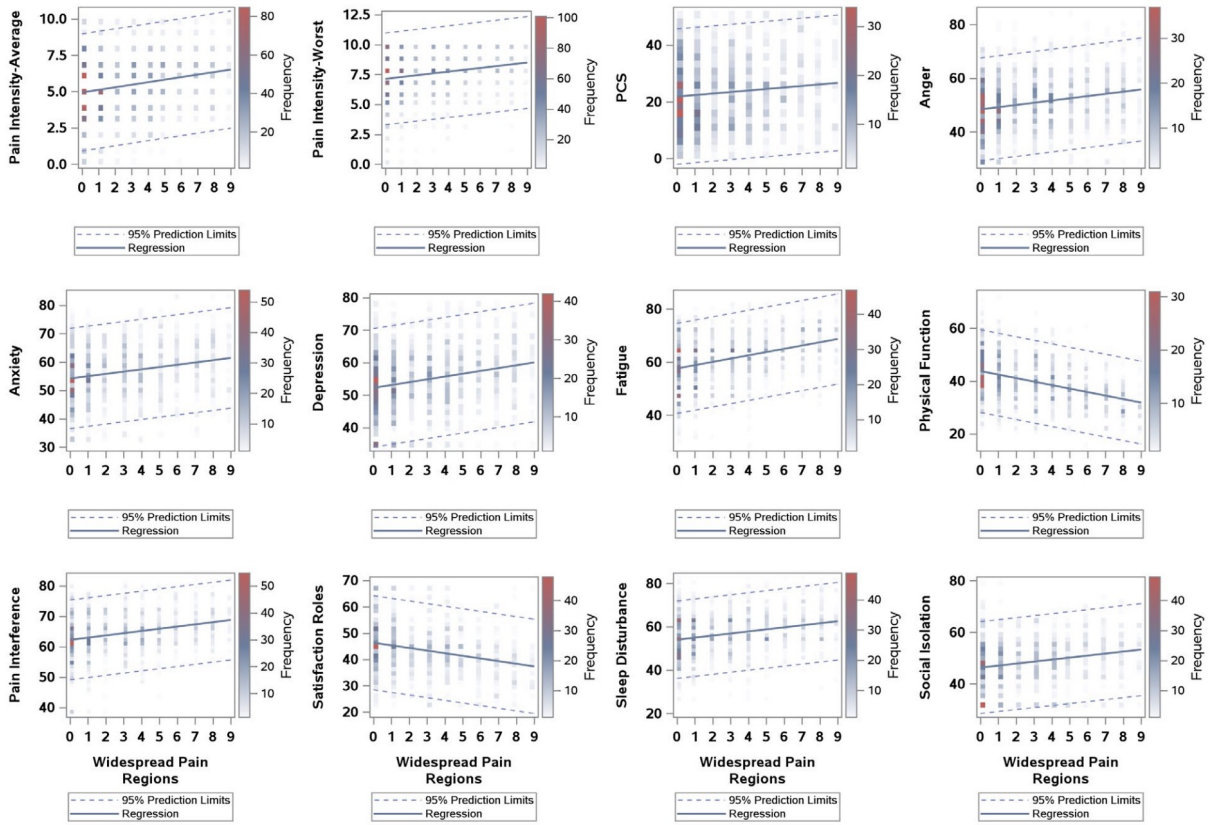
Characterization of chronic overlapping pain conditions in patients with chronic migraine: A CHOIR study

Meredith J. Barad MD[1] | John A. Sturgeon PhD[2] | Juliette Hong MS, MEd[1] | Anuj K. Aggarwal MD[1] | Sean C. Mackey MD, PhD[1]



Body Map Pain Regions	Overall (n=1601)
Head Front	93.8%
Head Back	74.7%
Neck	59.9%
Right Shoulder/Arm	40.3%
Left Shoulder/Arm	39.5%
Upper Back	31.6%
Lower Back	24.5%
Chest/Abdomen	13.6%
Pelvic	5.8%
Right Hip/Buttock/Leg	24.1%
Left Hip/Buttocks/Leg	24.2%

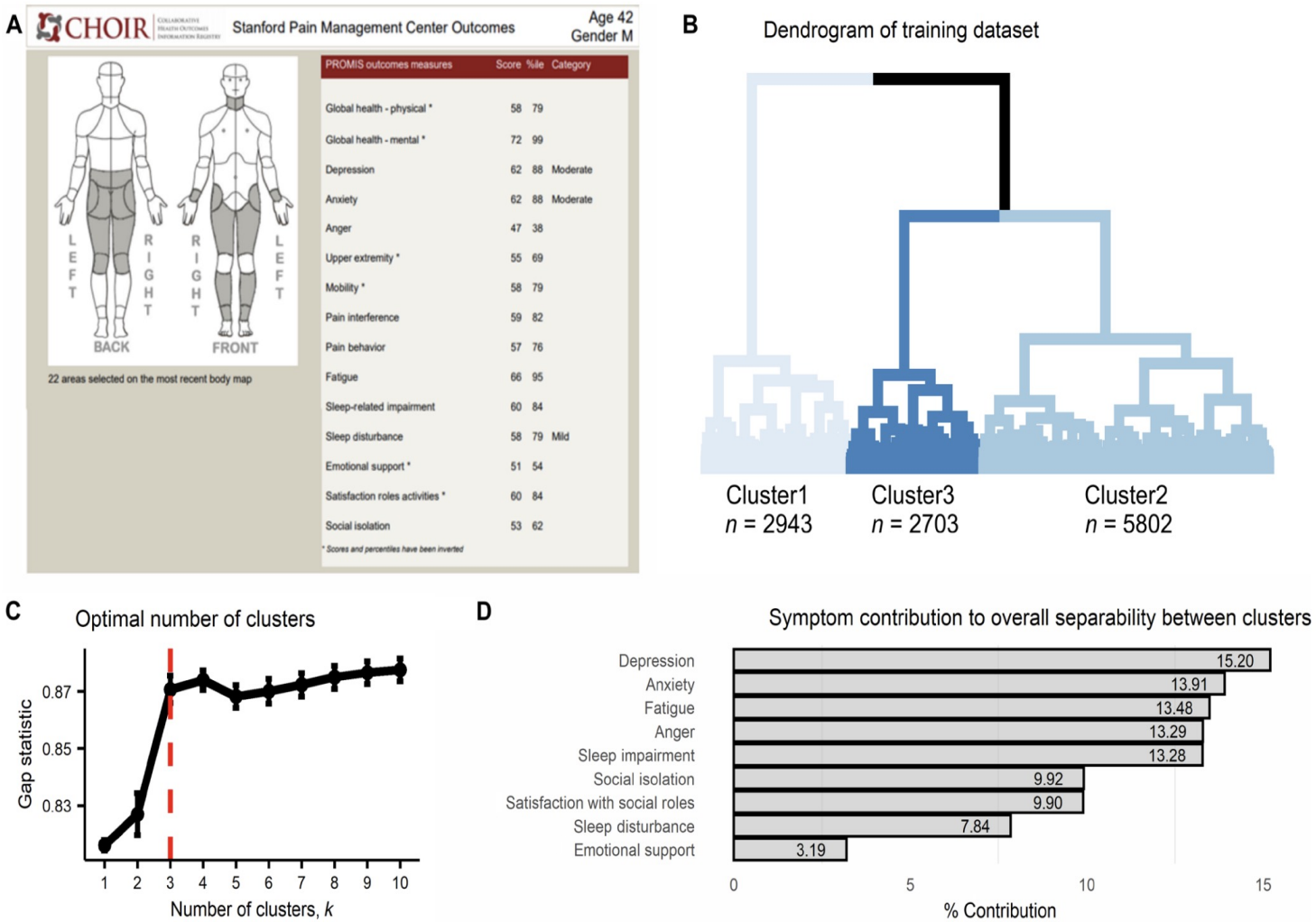
Number of Regions	%
Migraine alone	29.4%
+ 1	17.9%
+ 2	8.1%
+ 3	10.9%
+ 4	9.7%
+ 5	7.1%
+ 6	5.0%
+ 7	5.3%
+ 8	4.9%
+ 9	1.7%



HEALTH AND MEDICINE

Classifying chronic pain using multidimensional pain-agnostic symptom assessments and clustering analysis

Gadi Gilam*, Eric M. Cramer, Kenneth A. Webber II, Maisa S. Ziadni, Ming-Chih Kao, Sean C. Mackey



Gilam et al., Sci. Adv. 2021; 7 : eabj0320 8 September 2021

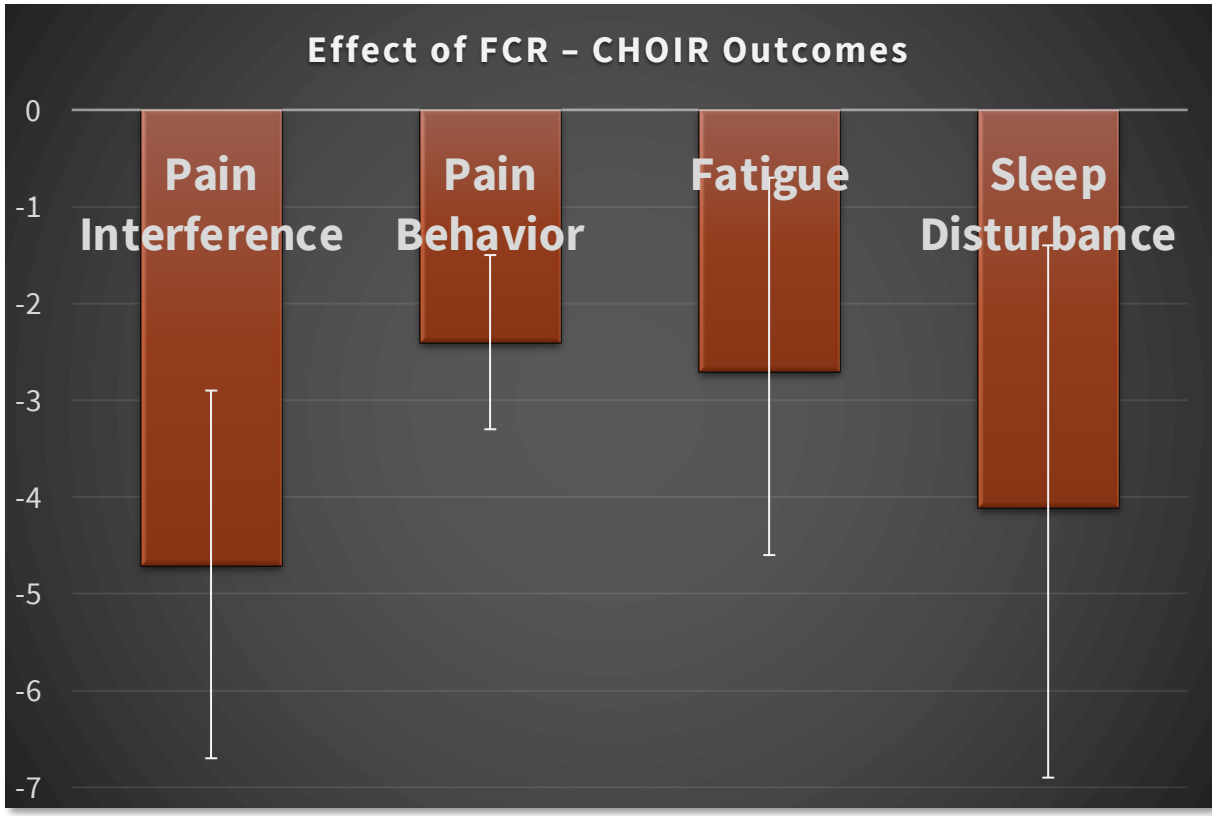
Single Session Pain Catastrophizing Class to Reduce Pain

N=57 with chronic pain
Single session class
PCS = Pain Catastrophizing Scale

Empowered Relief™

Train your brain away from pain

Time Point	PCS Mean (SD)
Baseline	26.1 (10.8)
Post-Treatment Week 2	16.5 (9.9)
Post-Treatment Week 4	13.8 (9.5)



Darnall, B, Sturgeon, J, Kao, MC, Hah, J, Mackey, S (2014). *Journal of pain research, 7*, 219.

CHOIR

Translating evidence into novel and effective therapies

JAMA Network | Open

Original Investigation | Physical Medicine and Rehabilitation

Comparison of a Single-Session Pain Management Skills Intervention With a Single-Session Health Education Intervention and 8 Sessions of Cognitive Behavioral Therapy in Adults With Chronic Low Back Pain

A Randomized Clinical Trial

Beth D. Darnall, PhD; Anuradha Roy, MSc; Abby L. Chen, BS; Maisa S. Ziadni, PhD; Ryan T. Keane, MA; Dokyoung S. You, PhD; Kristen Slater, PsyD; Heather Poupore-King, PhD; Ian Mackey, BA; Ming-Chih Kao, PhD, MD; Karon F. Cook, PhD; Kate Lorig, DrPH; Dongxue Zhang, MS; Juliette Hong, MS, MEd; Lu Tian, PhD; Sean C. Mackey, MD, PhD

JOURNAL OF MEDICAL INTERNET RESEARCH

Original Paper

Efficacy of a Single-Session "Empowered Relief" Zoom-Delivered Group Intervention for Chronic Pain: Randomized Controlled Trial Conducted During the COVID-19 Pandemic

Maisa S Ziadni[1], MS, PhD; Lluvia Gonzalez-Castro[1], BS; Steven Anderson[1], PhD; Parthasarathy Krishnamurthy[2], PhD; Beth D Darnall[1], PhD

Empowered Relief™

Train your brain away from pain

pcori

Comparative Effectiveness of Online Cognitive Behavioral Therapy vs. An Online Single-Session Pain Relief Skills Class for Chronic Pain

CHOIR Provides Research Trainee Opportunities

- Provides opportunities for junior investigators and trainees to easily conduct a research study.
  - Junie Carrière (McGill University).

  - Social injustice and acceptance in chronic pain.
  - 800 deeply phenotyped patients in several weeks

Journal of Pain Research

Dovepress

ORIGINAL RESEARCH

Pain behavior mediates the relationship between perceived injustice and opioid prescription for chronic pain: a Collaborative Health Outcomes Information Registry study

This article was published in the following Dove Press journal:
Journal of Pain Research
7 March 2017

Junie S Carriere[1]
Marc-Olivier Martel[2,3]
Ming-Chih Kao[4]
Michael JL Sullivan[5]
Beth D Darnall[4]

[1]Department of Psychology, [2]Faculty

Background and purpose: Perceived injustice has been defined as an appraisal regarding the severity and irreparability of loss associated with pain, blame and a sense of unfairness. Recent findings have identified perceived injustice as an important risk factor for pain-related outcomes. Studies suggest that perceived injustice is associated with opioid prescription in patients with pain conditions. However, the mechanisms by which perceived injustice is linked to opioid prescription are not well understood. The primary objective of this study was to examine the potential mediating roles of pain intensity, depressive symptoms and pain behavior in the asso-

ORIGINAL ARTICLE

The Impact of Perceived Injustice on Pain-related Outcomes

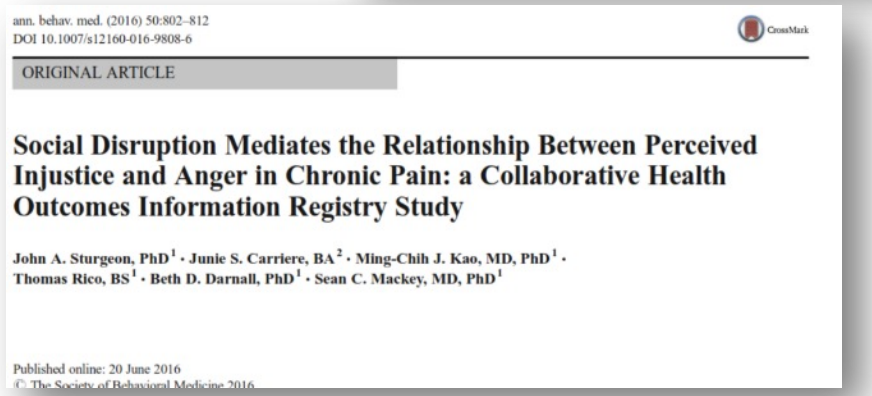
A Combined Model Examining the Mediating Roles of Pain Acceptance and Anger in a Chronic Pain Sample

Junie S. Carriere, PhD, John A. Sturgeon, PhD,† Esther Yakobov, PhD,* Ming-Chih Kao, MD, PhD,† Sean C. Mackey, MD, PhD,† and Beth D. Darnall, PhD†*

Objective: Perceived injustice (PI) has been identified as an important risk factor for pain-related outcomes. To date, research has shown that pain acceptance and anger are mediators of the association between PI and pain-related outcomes. However, a combined conceptual model that addresses the interrelationships between these

Key Words: chronic pain, perceived injustice, pain acceptance, physical function, opioid use

(*Clin J Pain* 2018;34:739–747)



ann. behav. med. (2016) 50:802–812
DOI 10.1007/s12160-016-9808-6

ORIGINAL ARTICLE

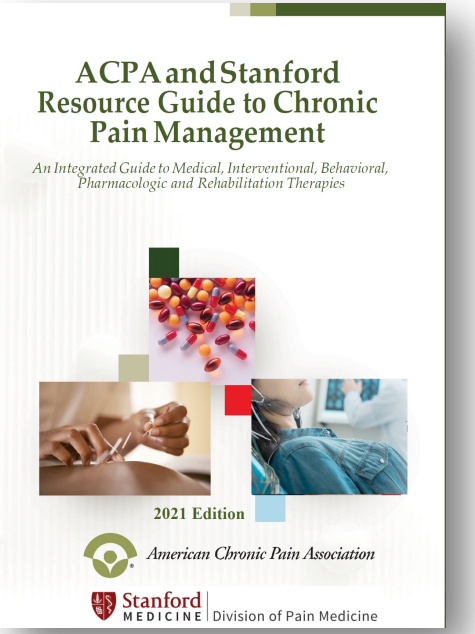
Social Disruption Mediates the Relationship Between Perceived Injustice and Anger in Chronic Pain: a Collaborative Health Outcomes Information Registry Study

John A. Sturgeon, PhD[1] · Junie S. Carriere, BA[2] · Ming-Chih J. Kao, MD, PhD[1] · Thomas Rico, BS[1] · Beth D. Darnall, PhD[1] · Sean C. Mackey, MD, PhD[1]

Published online: 20 June 2016

CHOIR Collaborative Health Outcomes Information Registry

CHOIR The Future

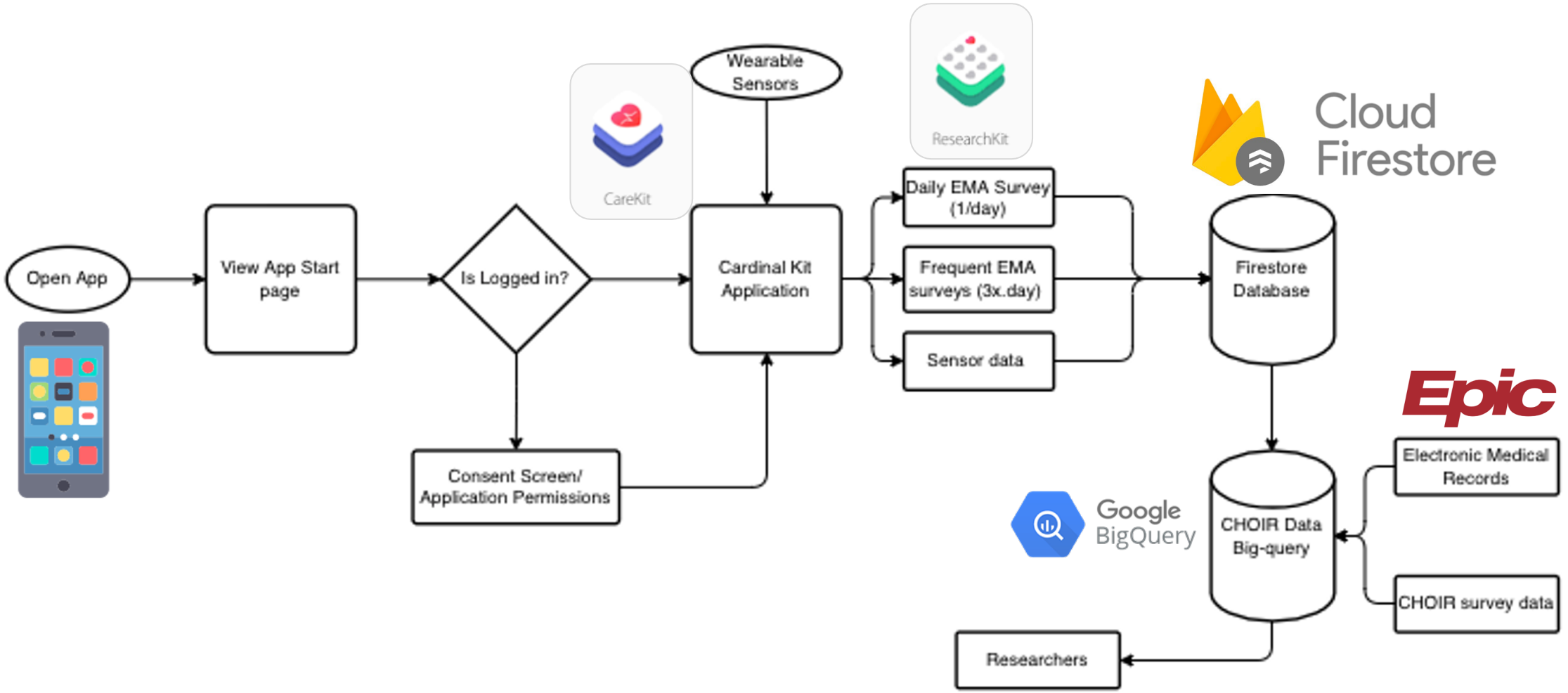


- Targeted intervention tracking (achieved)
- Public dashboard for data visualization (done)
- Public facing version (in progress)
- Targeted delivery of content and referrals
  - Patient education
  - Digital behavioral medicine (e.g. EMPOWERED Relief)
- EMR integration (SMART on FHIR)
  - Visualizations/dashboards for clinicians
- Distributed registry (in progress; pilot successful)
- Opening up data for broader collaborative projects? - (soliciting feedback)

CHOIR mobile

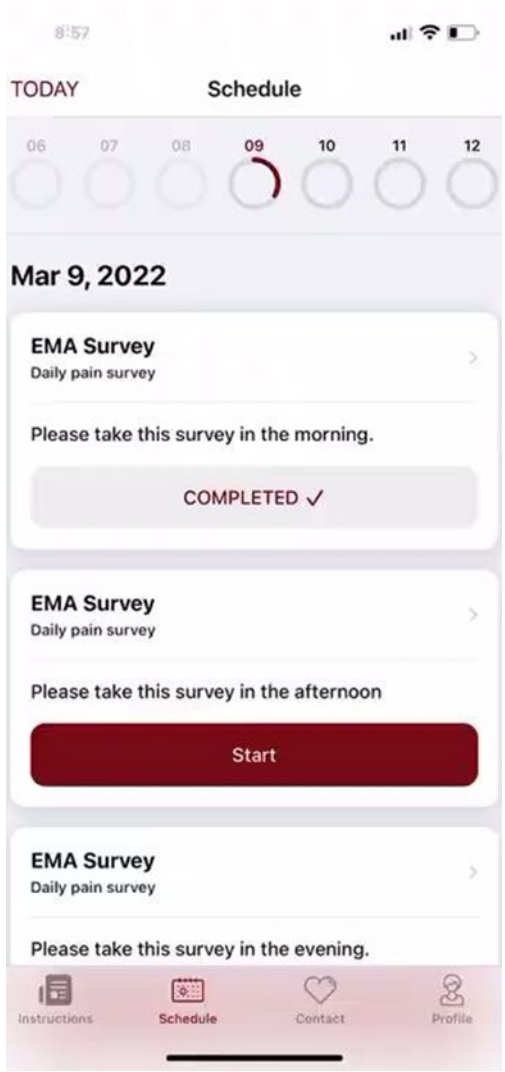
STANFORD BYERS CENTER FOR BIODESIGN

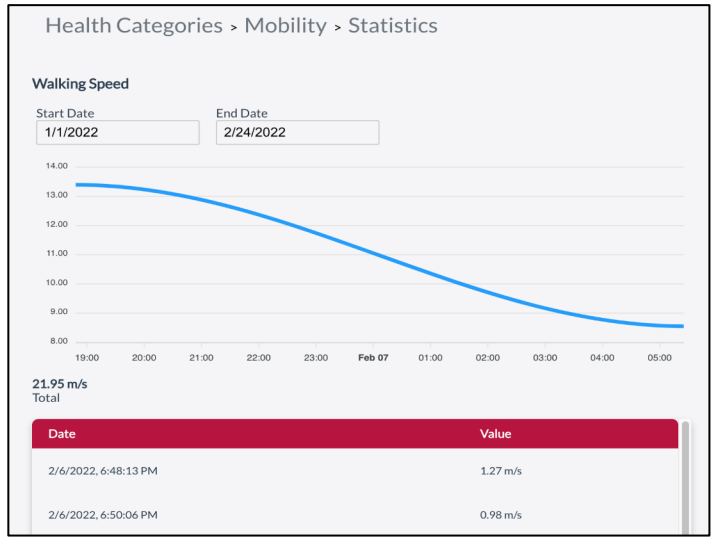
Project Architecture

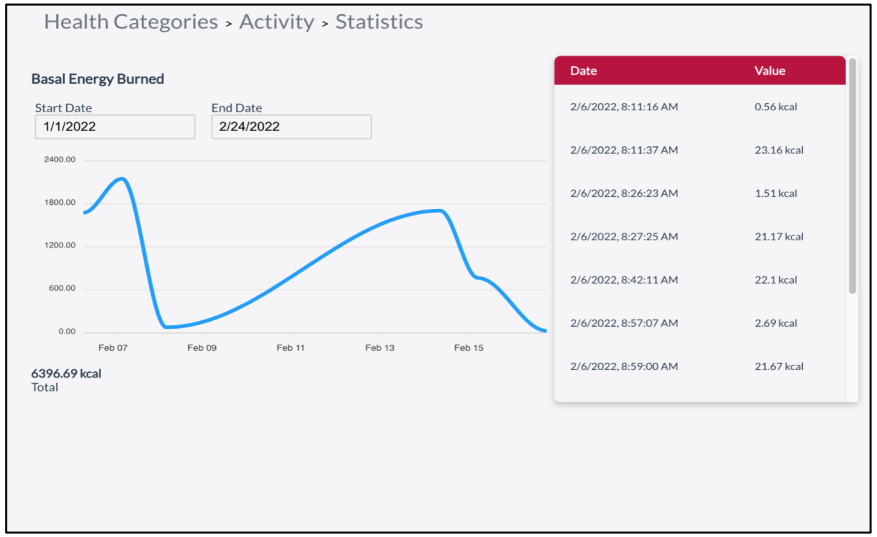


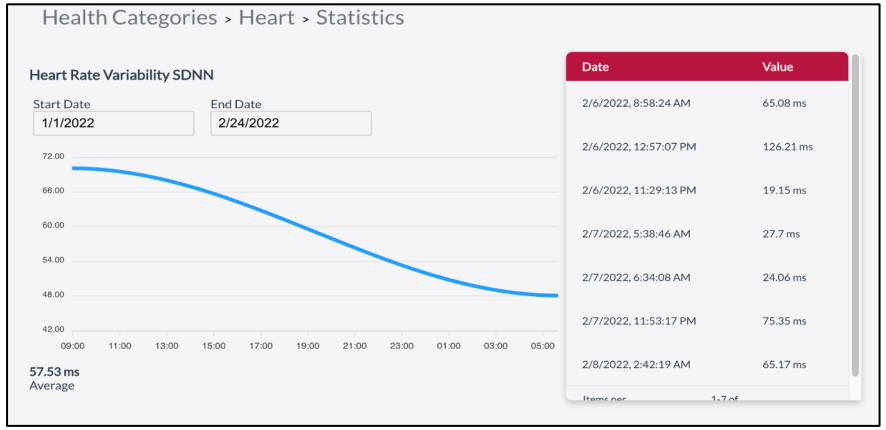
CHOIR mobile

STANFORD BYERS CENTER FOR BIODESIGN









Global Edition Health and Wellness

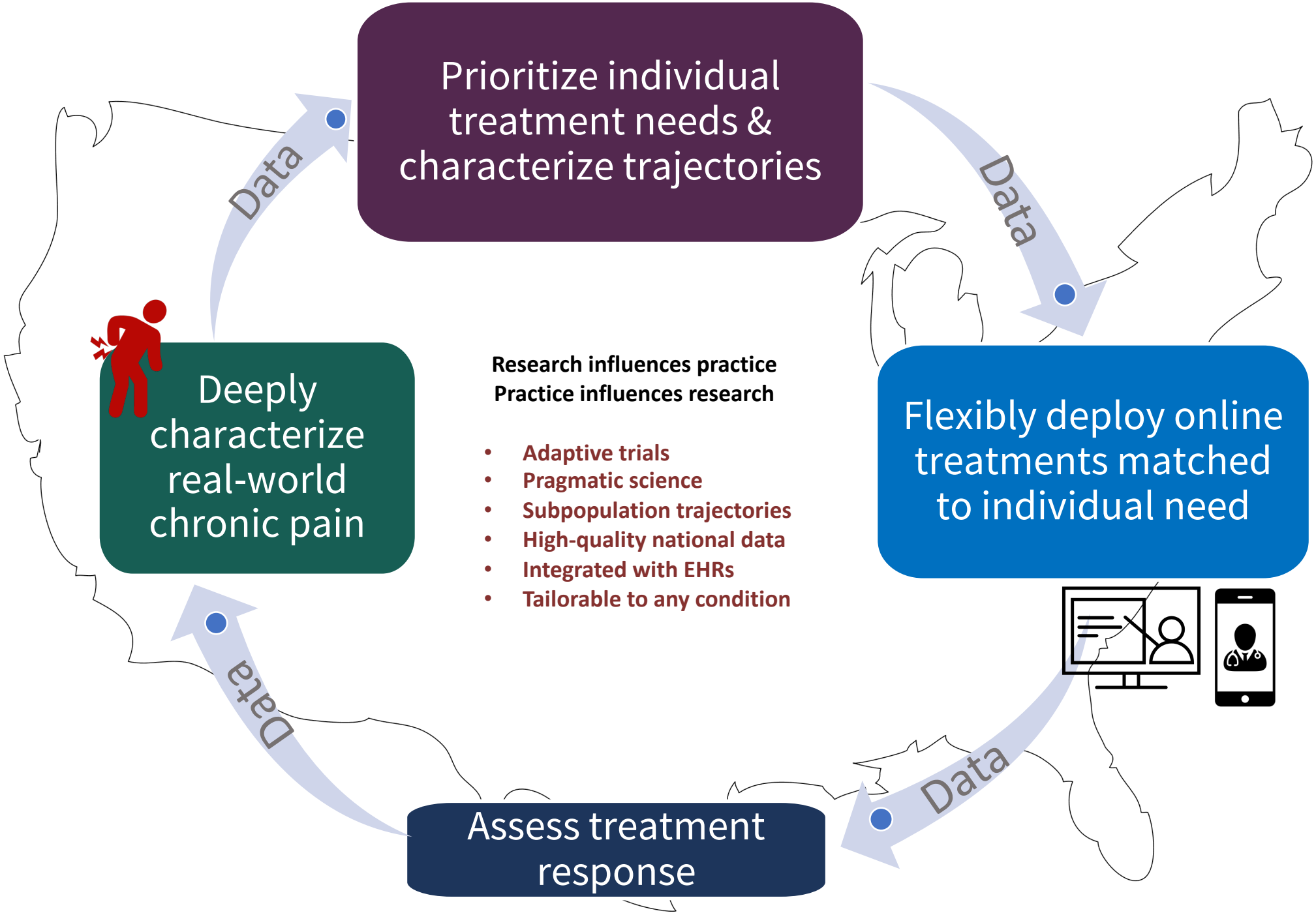
Contributed: The biggest merger in digital health should be between behavioral and data sciences

Digital tools have to do more than just feed people data. They must also keep them engaged and motivate them to make healthier decisions. This is where behavioral science comes in.

By **Dan Goldner, PhD, and Dr. Harpreet Nagra** | November 19, 2021 | 09:51 am

The Future: Personalizing delivery of digital therapies

CHOIR + Empowered Relief™


Prioritize individual treatment needs & characterize trajectories
Data
Flexibly deploy online treatments matched to individual need
Data
Assess treatment response
Data
Deeply characterize real-world chronic pain
Data
Research influences practice
Practice influences research
Adaptive trials
Pragmatic science
Subpopulation trajectories
High-quality national data
Integrated with EHRs
Tailorable to any condition

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- Redlich Pain Research Endowment
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- PCORI
- Redlich Pain Research Endowment
- Dodie and John Rosekrans Pain Research Endowment
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