Big Data: How Will It Affect My Practice?

Thomas A. Peterson Ph.D.
Director, UCSF REACH Analytics Core
Director, Laboratory for Computational and
Digital Health Sciences
Assistant Professor

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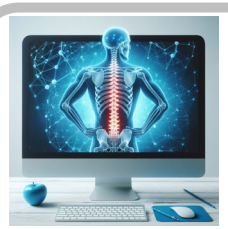


Director, Peterson Laboratory for Computational and Digital Health Sciences (LCDHS)

UCSF Bakar Computational Health Sciences Institute

UCSF Department of Orthopaedic Surgery

Biomedical Informatics:
Data Science & Machine Learning

UCSF Department of Orthopaedic Surgery

UCSF Bakar Computational Health Sciences Institute

UCSF Musculoskeletal Center

UCSF PREMIER Precision Medicine in Rheumatology

San Francisco VA Medical Center

Director, Analytics Core
UCSF Core Center for Patient-centric Mechanistic Phenotyping in Chronic Low Back Pain (UCSF REACH)

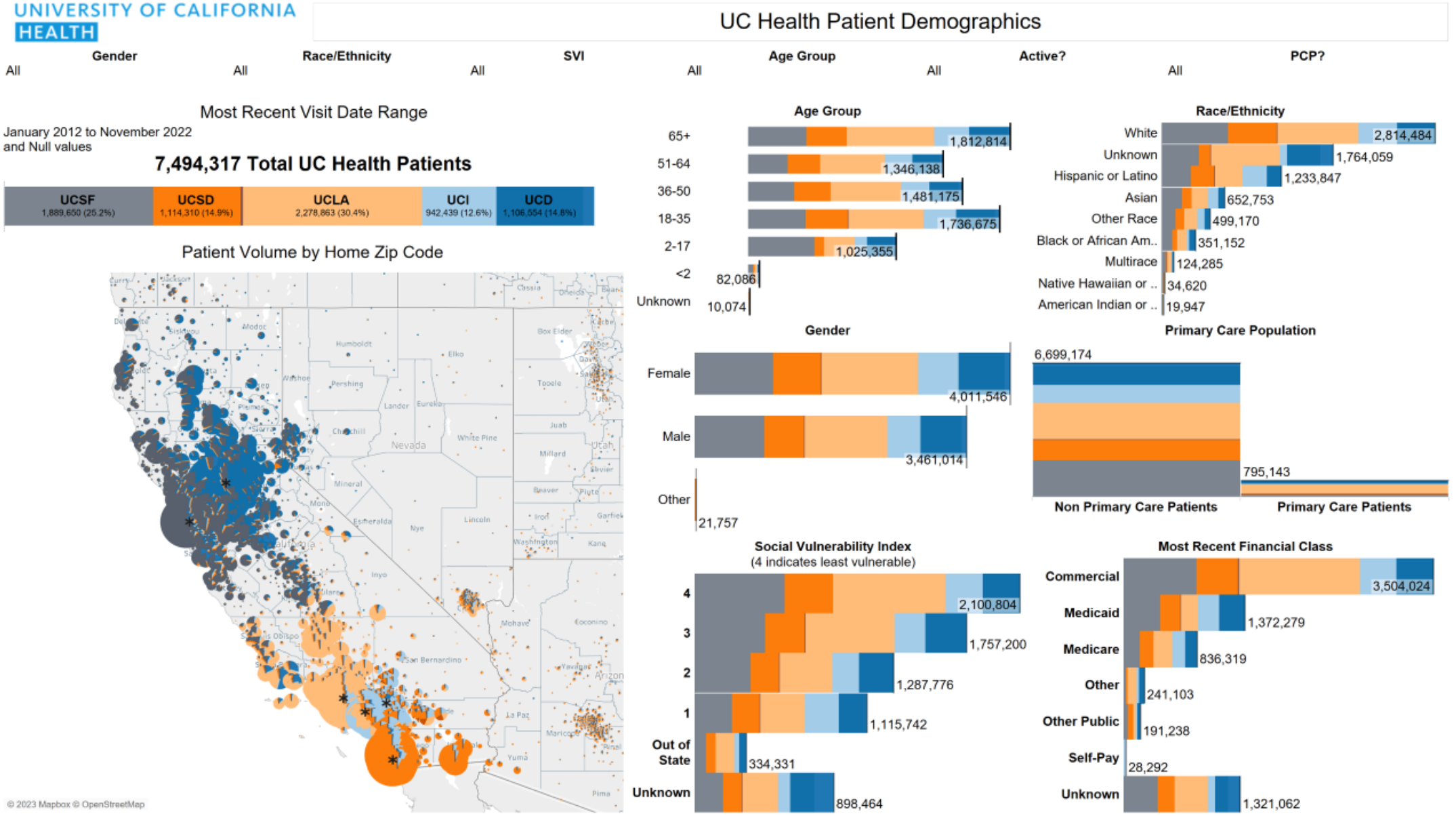
HEAL NIH · Helping to End Addiction Long-term

BACPAC Back Pain Consortium

UCSF REACH

I have no relevant disclosures

UC-Wide Databases Increase Research Potential



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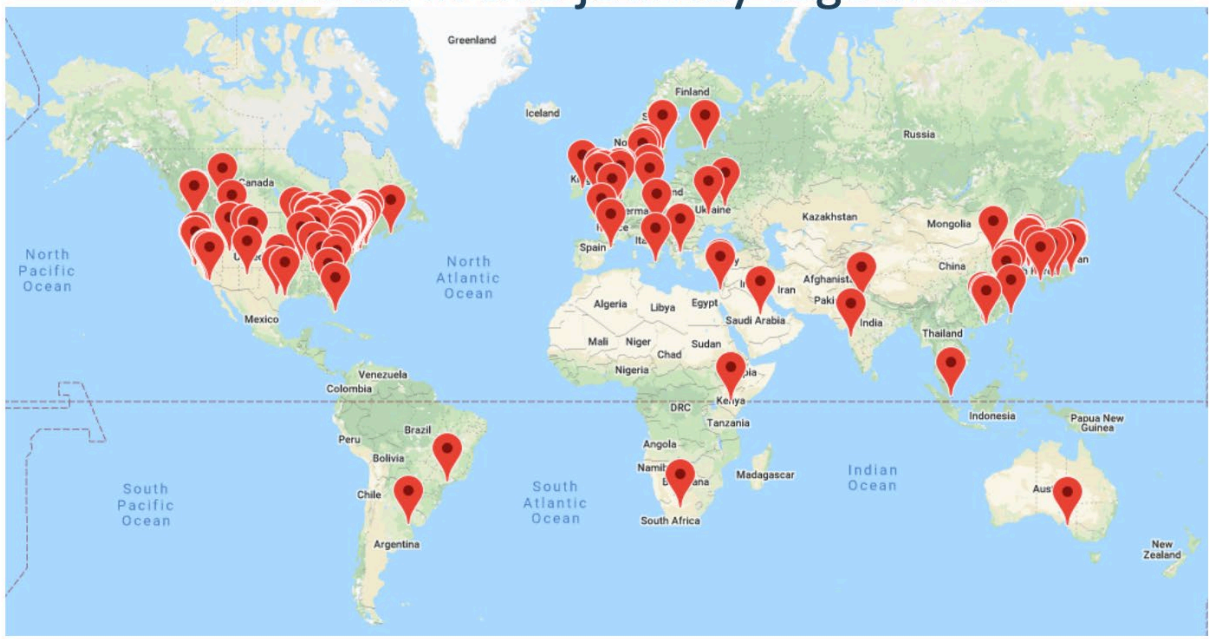
UCSF Bakar Computational Health Sciences Institute

Connected Worldwide EHR Systems

We're all in this journey together…

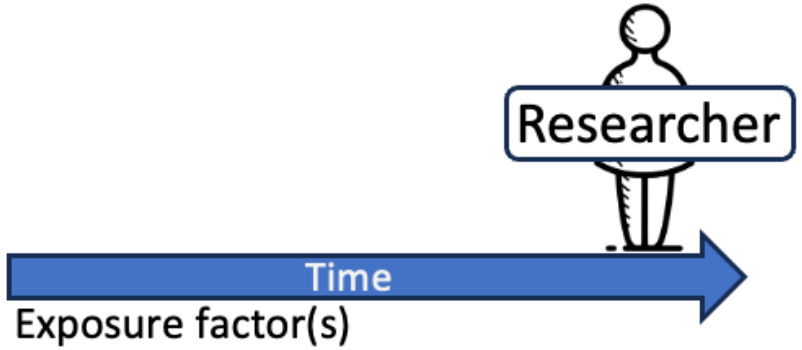


Different stakeholders: academia, medical product industry, regulators, government, payers, technology providers, health systems, clinicians, patients
Different disciplines: computer science, epidemiology, statistics, biomedical informatics, health policy, clinical sciences

- Data in 18 different countries, with >369 million patient records from outside US
- 133 different databases with patient-level data from various perspectives:
  - Electronic health records, administrative claims, hospital systems, clinical registries, health surveys, biobanks

OHDSI
OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

Retrospectively Collected Data



Electronic Health Records & Registries

UC HEALTH Data Warehouse

UC San Diego Health · UCI Health · UCSF Health · UCR HEALTH · UCLA Health · UCDAVIS HEALTH

U.S. Department of Veterans Affairs

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OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

Administrative Claims

CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES

AHRQ Agency for Healthcare Research and Quality

OPTUM Labs®

IBM MARKETSCAN®

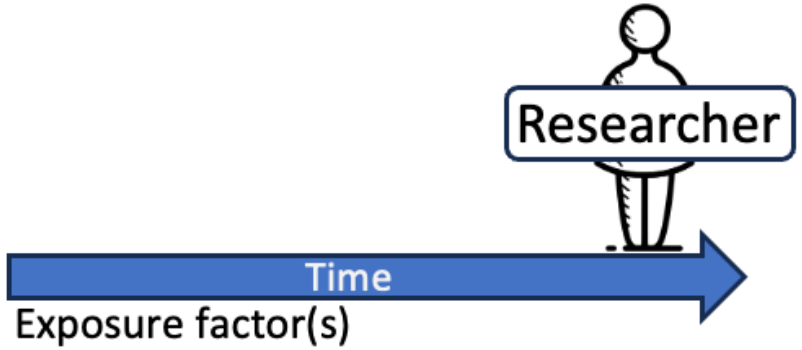
Nationwide Surveys

AMERICAN COMMUNITY SURVEY
U.S. CENSUS BUREAU

nhanes
The Nation's Mobile Health Survey

국민건강영양조사

Retrospectively Collected Data



Electronic Health Records & Registries

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Nationwide Surveys

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nhanes The Nation's Mobile Health Survey

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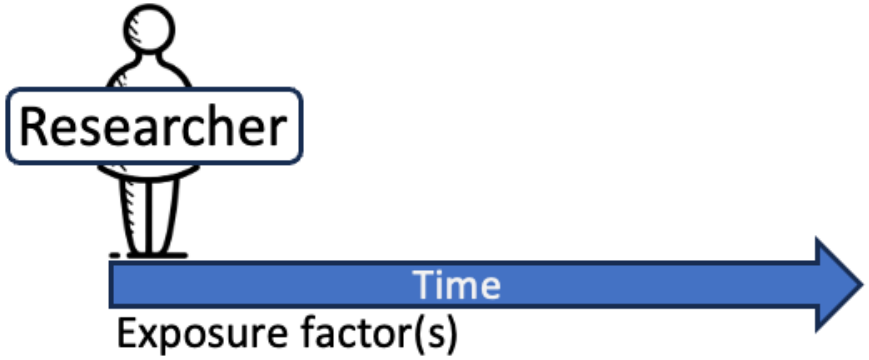
Prospectively Collected Data



Clinical Presentation

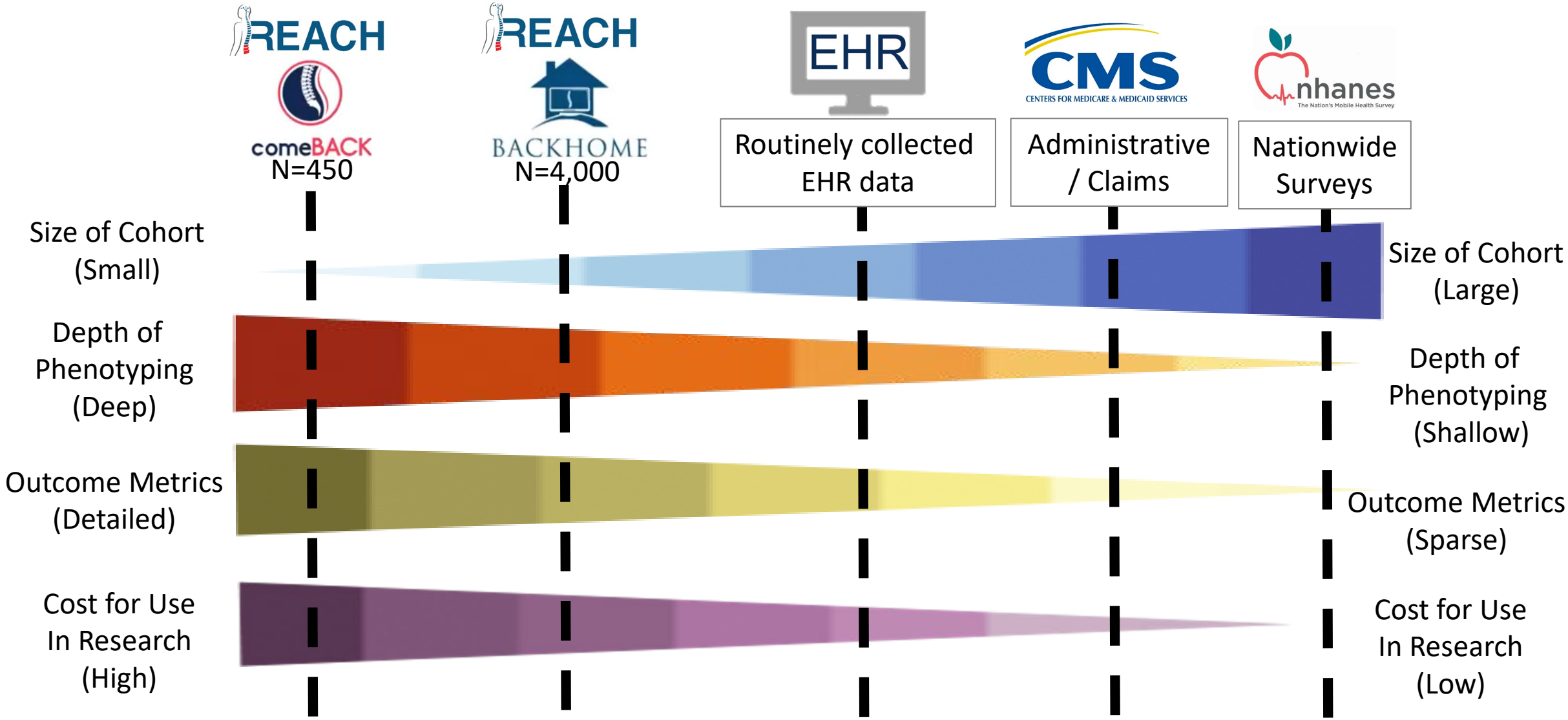
Biomechanical Phenotype

UCSF REACH

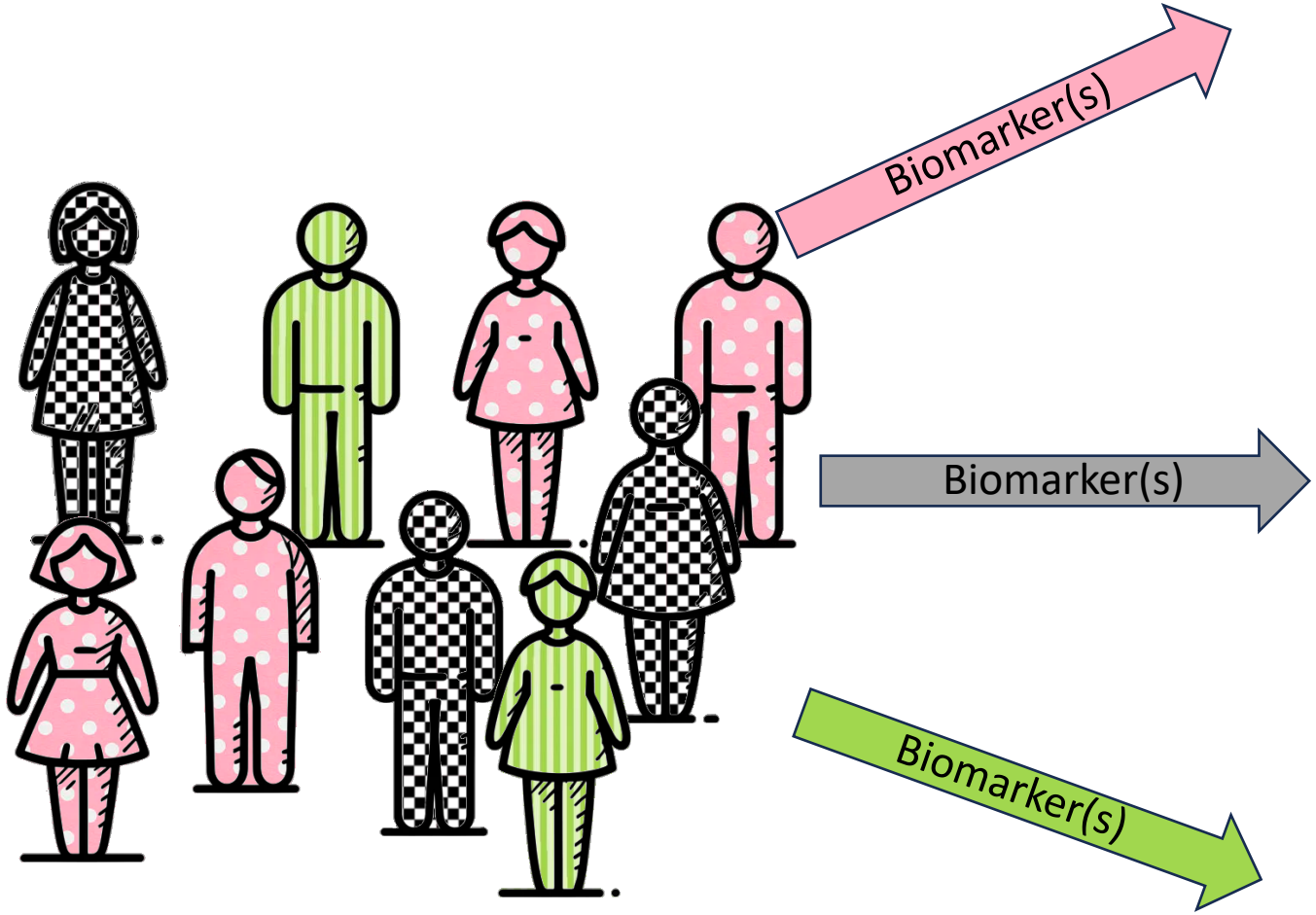
"Deep Phenotyping" for Chronic Low Back Pain

Pathophysical Phenotype

Biobehavioral Phenotype


REACH
comeBACK
N=450
REACH
BACKHOME
N=4,000
EHR
Routinely collected EHR data
CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES
Administrative / Claims
nhanes
The Nation's Mobile Health Survey
Nationwide Surveys
Size of Cohort (Small)
Size of Cohort (Large)
Depth of Phenotyping (Deep)
Depth of Phenotyping (Shallow)
Outcome Metrics (Detailed)
Outcome Metrics (Sparse)
Cost for Use In Research (High)
Cost for Use In Research (Low)

Big Data Can Help Categorize Patients

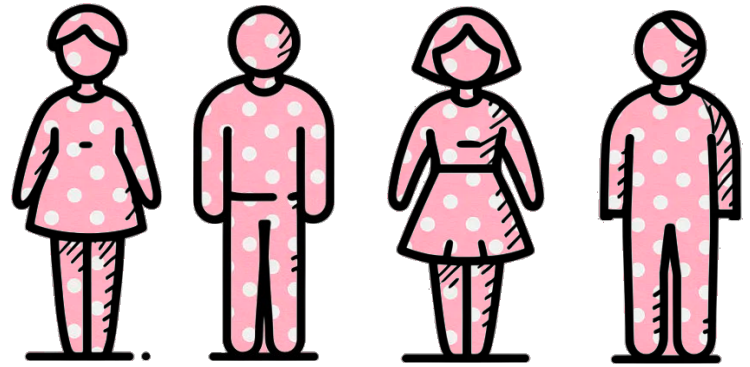


Biomarker(s)

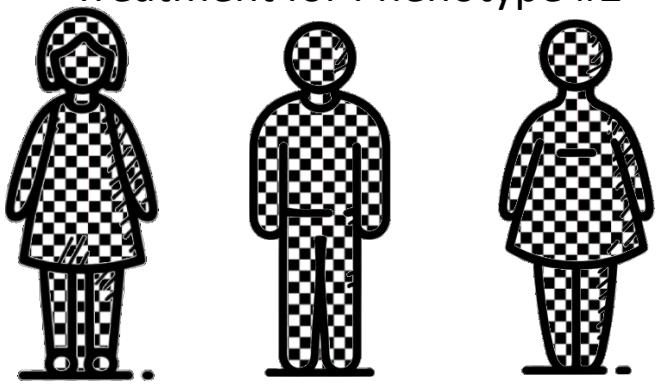
Biomarker(s)

Biomarker(s)

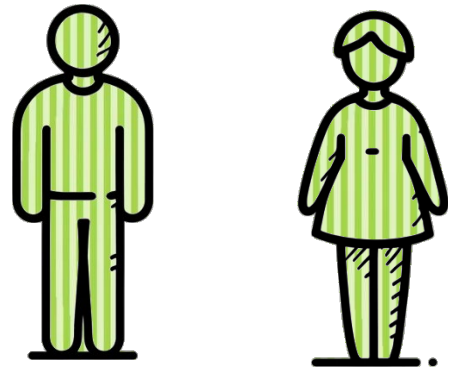
Treatment for Phenotype #1



Treatment for Phenotype #2



Treatment for Phenotype #3

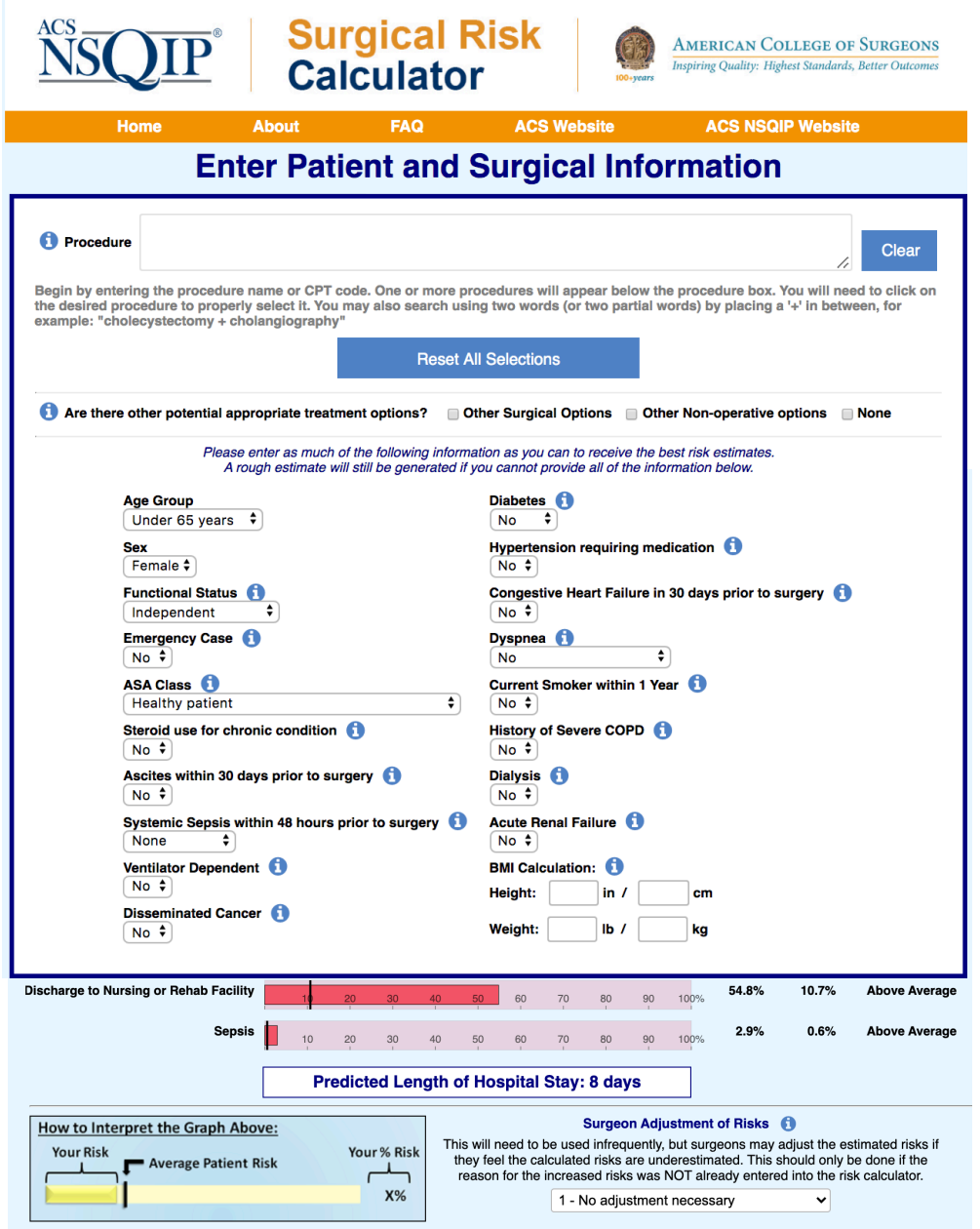


AL/ML for Predicting Patient-Specific Treatment Response

Why predict patient-specific Length of Stay (LOS) and Discharge Disposition?

- Anticipating Outcomes:
  - Perioperative spine surgery complication is common [1], and AI/ML tools can help predict how a specific patient will respond to treatment, which is not a simple statistical association

- Anticipating Economic Impact:
  - Extended LOS in hospital after surgery has been identified as a reliable predictor for catastrophic costs over $100,000 following spine surgery [2]
  - Usage of rehabilitation services can account for 30% of the cost of care [3,4]. Hence, an extended LOS and discharge to rehabilitation care reflect worsening patient morbidity, cost, and postoperative outcome.



1. Reis RC, de Oliveira MF, Rotta JM, Botelho RV. Risk of complications in spine surgery: a prospective study. *Open Orthop J.* 2015;9:20-25. Published 2015 Jan 31. doi:10.2174/1874325001509010020
2. Klineberg EO, Passias PG, Jalai CM, Worley N, Sciubba DM, Burton DC, Gupta MC, Soroceanu A, Zebala LP, Mundis GM Jr, Kim HJ, Hamilton DK, Hart RA, Ames CP, Lafage V; International Spine Study Group. Predicting Extended Length of Hospital Stay in an Adult Spinal Deformity Surgical Population. Spine (Phila Pa 1976). 2016 Jul 1;41(13):E798-E805. doi: 10.1097/BRS.0000000000001391. PMID: 26679876.
3. Soroceanu A, Burton DC, Oren JH, Smith JS, Hostin R, Shaffrey CI, Akbarnia BA, Ames CP, Errico TJ, Bess S, Gupta MC, Deviren V, Schwab FJ, Lafage V; International Spine Study Group. Medical Complications After Adult Spinal Deformity Surgery: Incidence, Risk Factors, and Clinical Impact. Spine (Phila Pa 1976). 2016 Nov 15;41(22):1718-1723. doi: 10.1097/BRS.0000000000001636. PMID: 27105460.

EHR

1,484,912 Patients in the UCSF Electronic Health Records
(June 2012-April 2020)

Inclusion

9,906 Patients with CPT codes indicating
Spinal Fusion Surgery

Exclusion

6,228 Patients removed for indication of
non-LSLFS, non-elective surgeries,
or missing BMI / hospital length of stay

3,678 Patients Undergoing
Spinal Fusion Surgery

Beginning of Patient's
Medical History

Present Day

?

How long will this
patient stay in the
hospital after surgery?

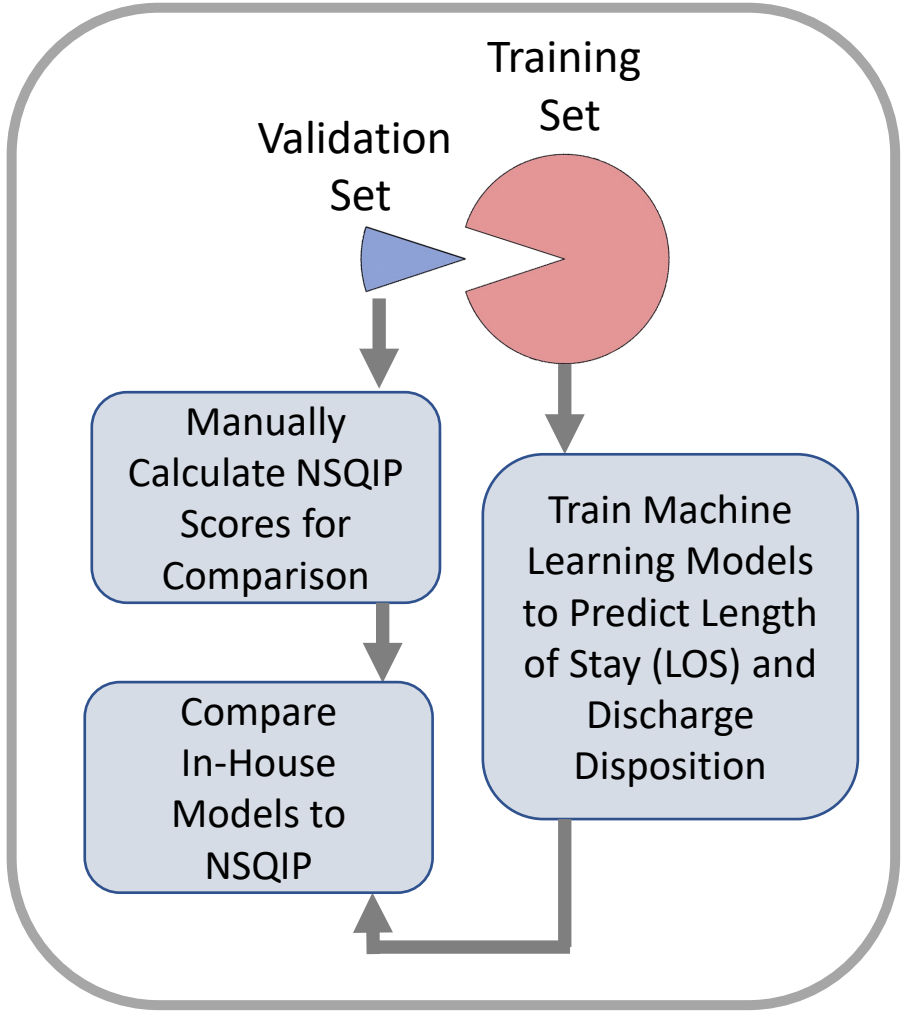
Index Date: Patient Undergoes
Spinal Fusion Surgery

Variables Included (Before or on Index Date):

Demographics
- BMI & age at time of surgery
- Smoking status
- Race / ethnicity
- Diagnosis codes

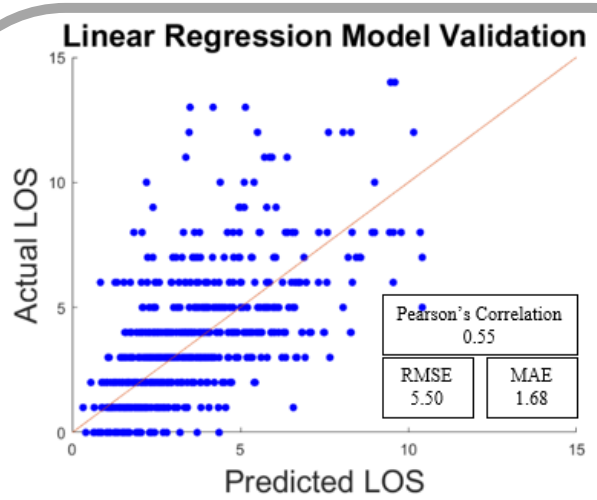
Variables Describing Operation
- Type of instrumentation
- Staged procedure
- Additional Anterior / Anterolateral Approach
- Prior spinal fusion surgeries

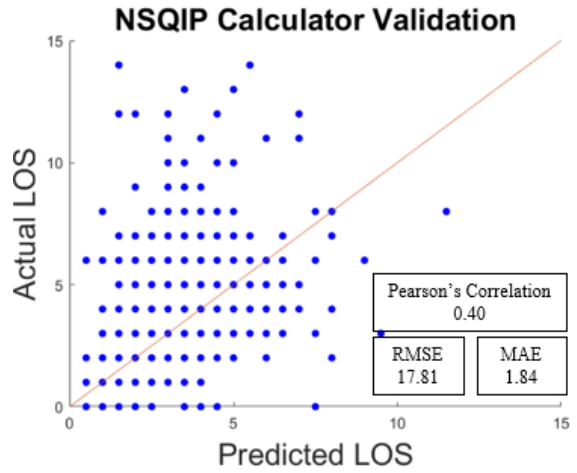
Data Flow for Machine Learning Model Creation & Validation



Prediction Models for Length of Stay and Discharge Disposition in Elective Spine Surgery and Comparison to ACS NSQIP Risk Calculator. Ayush Arora, BSE, Deeptee Jain, MD, Dmytro Lituiev, PhD, Dexter Hadley, MD, PhD, Atul J. Butte, MD, PhD, Sigurd Berven, MD, **Thomas Peterson, PhD.** Spine,2022

Predicting LOS





Different model from 2018 achieved a Pearson's correlation of 0.50 using data not available in the EHR

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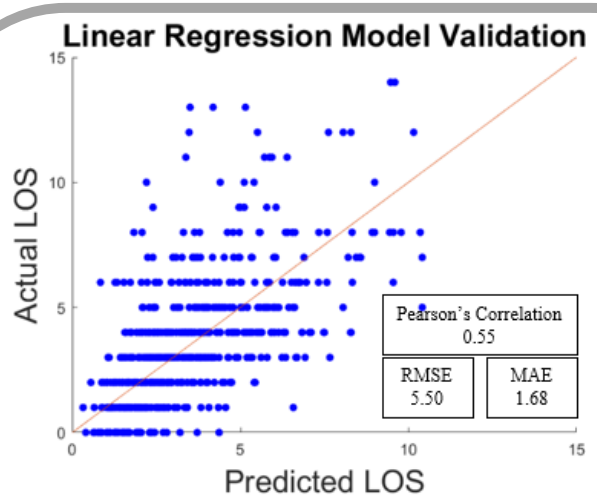

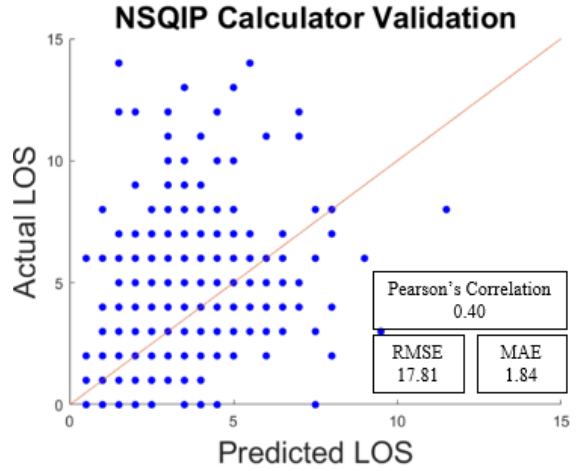

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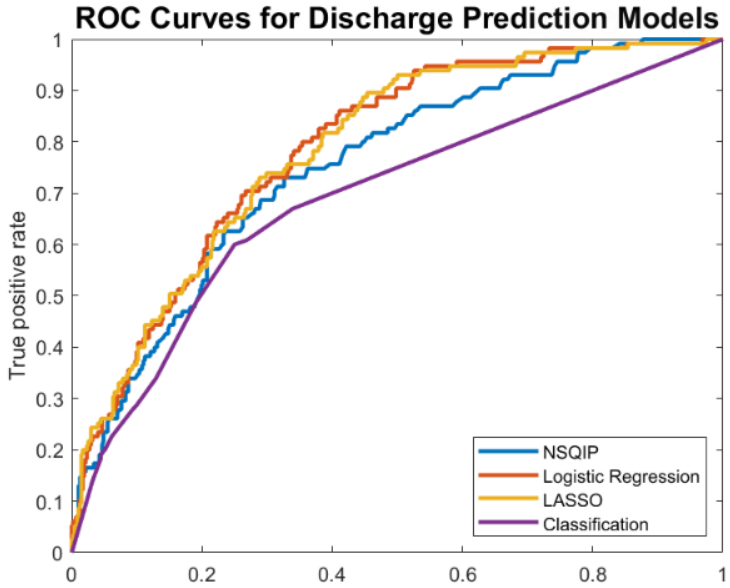
Predicting Discharge Disposition



'NSQIP'	0.7521
'Logistic'	0.7882
'Classification'	0.6925
'LASSO'	0.7874

Current / Future Work with BACPAC

THE UNIVERSITY OF UTAH

knowledge FORUM AOSPINE Degen/Biologics

VANDERBILT UNIVERSITY

Proud To Be

Making wise choices...

Spine Patient Outcomes Research Trial

Part of the Answer

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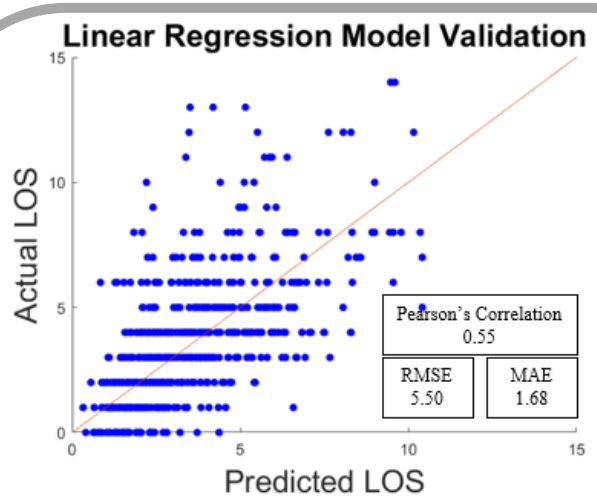
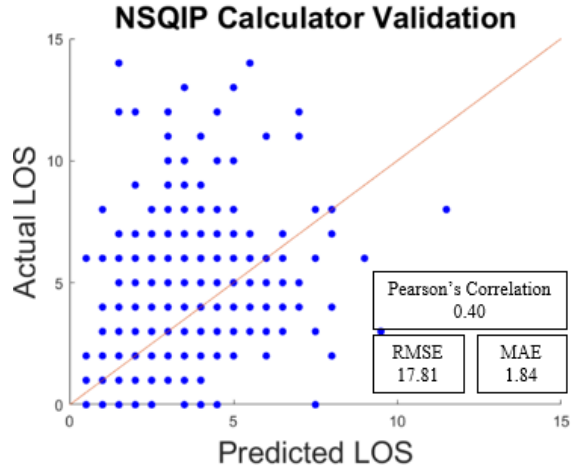
Predicting LOS





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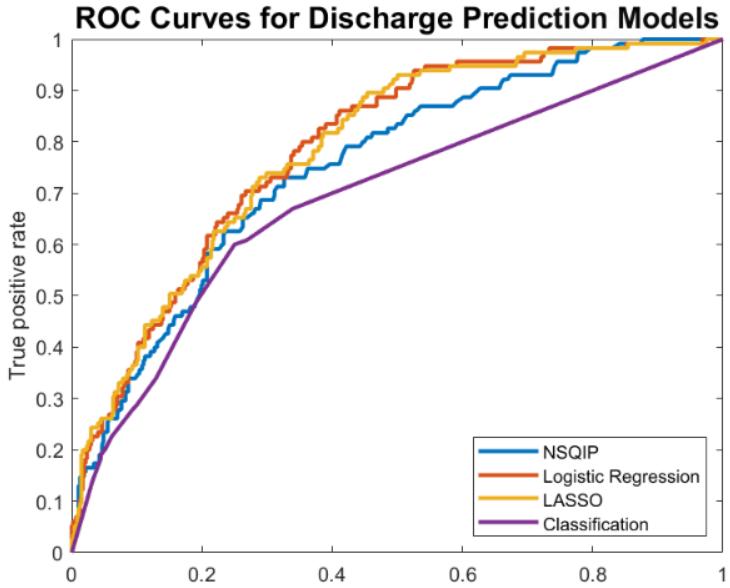
Predicting Discharge Disposition



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Takeaways:

- Prediction models built in-house outperform the ACS NSQIP. This could be attributed to:
  - Task-specific models (trained specifically for spine fusion)
  - Site-specific data

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Fast Healthcare Interoperability Resources (FHIR)

- FHIR is a system that securely interacts with Electronic Health Records

- **Potential Uses:**
  - Dashboards
  - Apps
  - Wearable Devices

- **Potential Users:**
  - Patients
  - Provider
  - Payers

Thanks!

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