Privacy Preserving Record Linkage (PPRL)

Previously Referred to as Blinded Record Index (BRI)

The Need

- Link data sources to get better outcome data
  - Currently available
    - Electronic health record, anesthesia record, ACS-NSQIP, STS locally using MRN
    - Michigan Value Collaborative payer data using date of service, age, hospital
  - Allow persistence of linkage for future datasets
    - State-specific mortality databases
    - BCBS of Michigan
    - Medicare, other payers
    - Pharmacy databases
  - Ensure no single point of security or privacy failure

A wise man once told me

- "When you have two choices, the one that is more work for you is almost always the right one" – Mike Englesbe
  - Applies to clinical decisions
  - Also applies to privacy and security

- We must NOT communicate or store real identifiers at the MPOG central server, even if the IRB allows us to do so
  - Do you want your family's SSN sitting at the coordinating center?

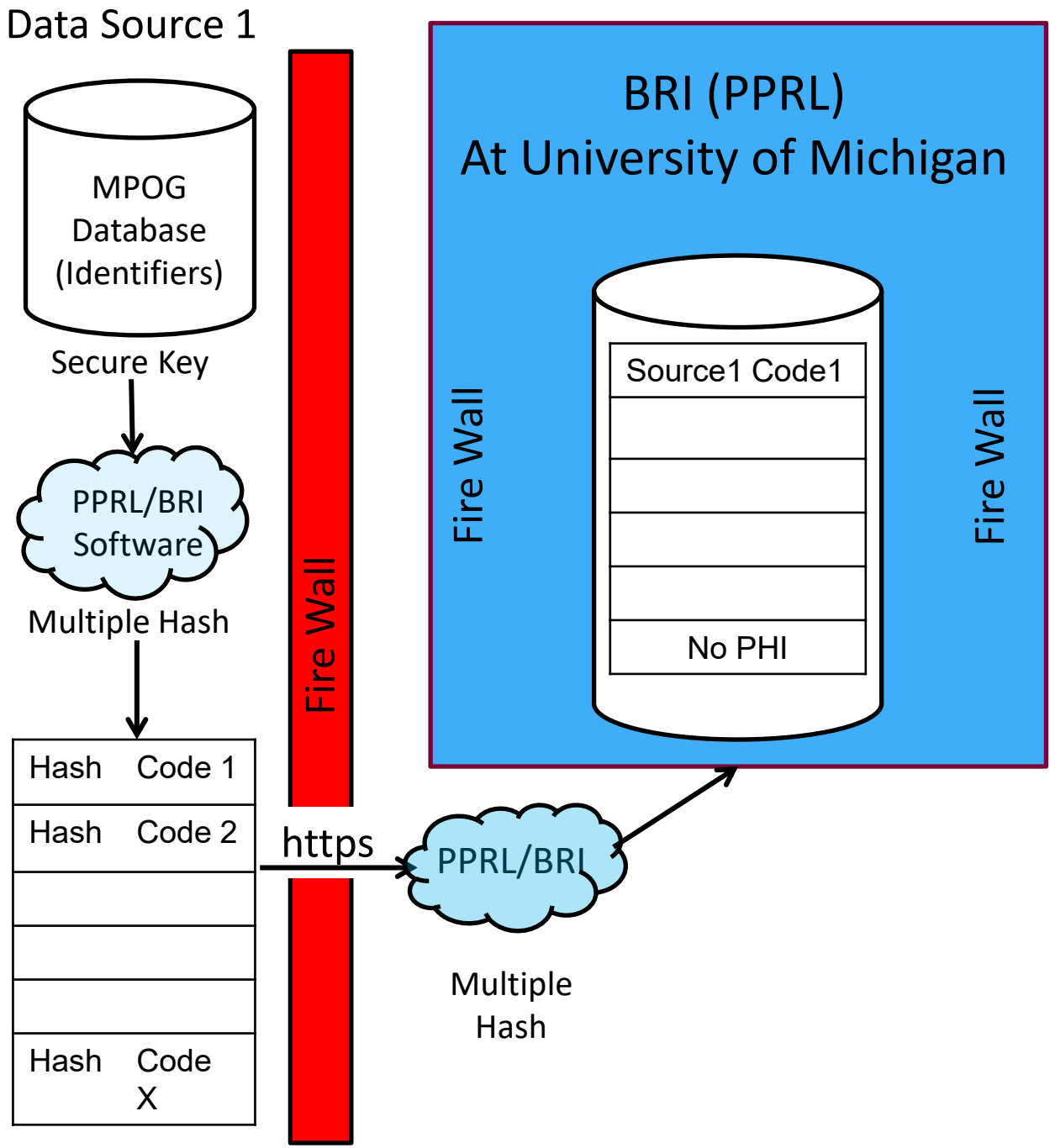
The Solution

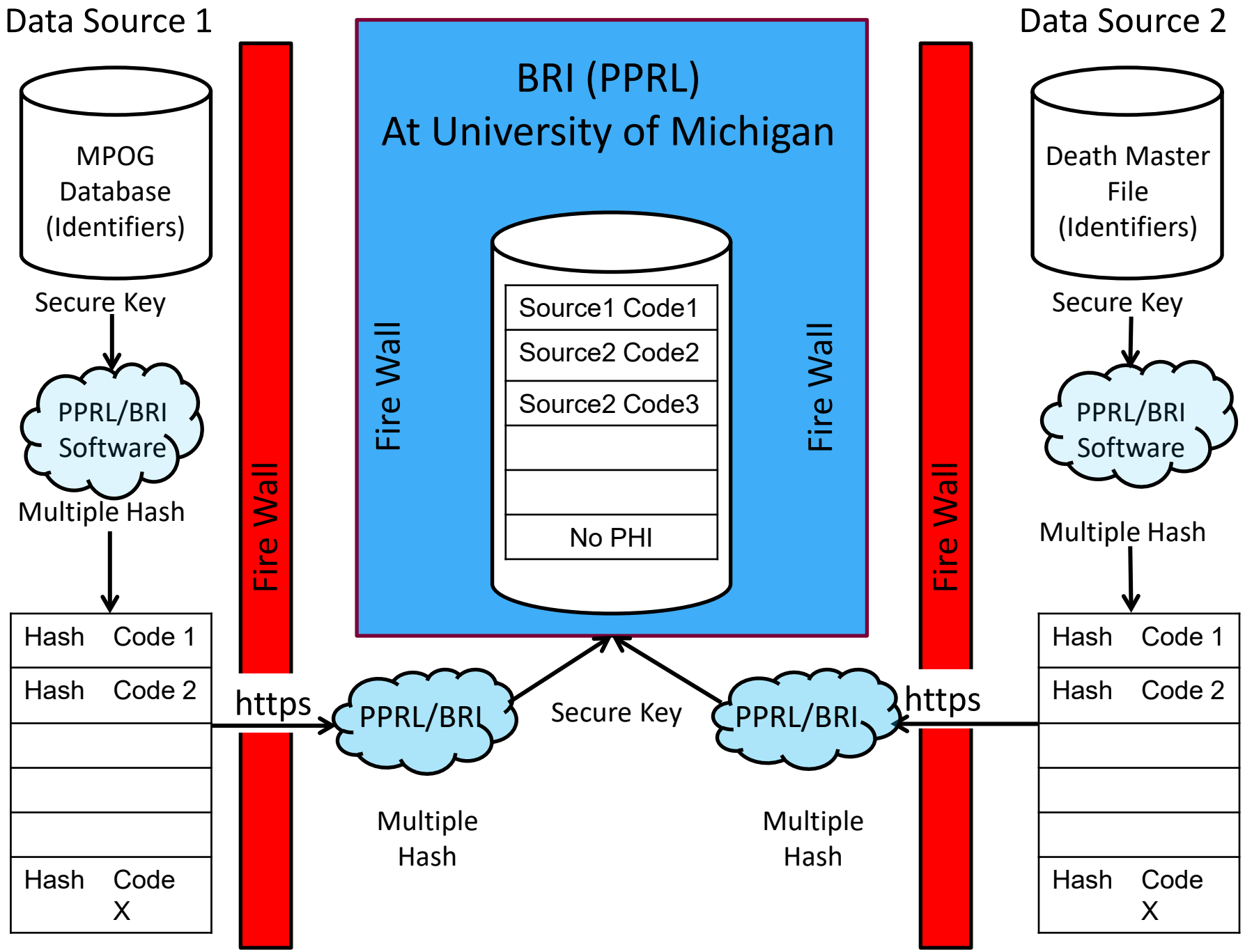
- Blinded Record Linking (aka Privacy Preserving Record Linkage)
  - For merging datasets across sites without PHI
  - Using US National Institutes of Standards and Technology Secure Hashing Algorithm
  - Incorporate RSA secure key
  - Keep the hashed codes centrally, no source identifiers
  - Hashed codes can be linked across data sources
- Established
  - Public domain hashing algorithm
  - “Blessed” by federal government in registries manual as non-PHI
  - Approved by IRBs, DUA at all MPOG institutions

What is Hashing?

- Publicly available one-way mathematical function
  - Input: a string (identifier)
  - Output: a really long alphanumeric code
- Cannot be “undone”
  - It is NOT encryption (which is meant to be decrypted)
- There are no “collisions”
  - No two strings result in the same hash code
  - Source uniqueness is maintained
  - Small changes in input string result in large changes in output code
- Example: Sachin →

964FA766292D50C62019ED7D33232559C0AF511CDDD5E55938AA845698F771B9


Data Source 1
MPOG
Database
(Identifiers)
Secure Key
PPRL/BRI
Software
Multiple Hash
Hash Code 1
Hash Code 2
Hash Code
X
Fire Wall
https
PPRL/BRI
Multiple
Hash
BRI (PPRL)
At University of Michigan
Fire Wall
Source1 Code1
No PHI
Fire Wall


Data Source 1
MPOG Database (Identifiers)
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PPRL/BRI Software
Multiple Hash
Hash Code 1
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BRI (PPRL)
At University of Michigan
Source1 Code1
Source2 Code2
Source2 Code3
No PHI
Fire Wall
Fire Wall
PPRL/BRI
PPRL/BRI
Secure Key
Multiple Hash
Multiple Hash
Fire Wall
https
Data Source 2
Death Master File (Identifiers)
Secure Key
PPRL/BRI Software
Multiple Hash
Hash Code 1
Hash Code 2
Hash Code X

Example: Mortality Ascertainment

- Using Social Security Death Master File (DMF) (No longer available)
  - Treated DMF as a ‘data source”
  - Hashed each patient record in DMF since 2003
  - Kept Date of Death as plain text
    - Date of Death is publicly available
    - Need to keep unhashed for research purposes
- Each MPOG site’s patient records are also hashed
- Centralized Privacy Preserving Record Linkage (PPRL)
  - Previously referred to as Blinded Record Index (BRI)
  - Match clinical patient records against DMF patient records
  - Apply “Last Known Alive” check step to improve specificity

Study Goals

- Establish that Privacy Preserving Record Linking (PPRL) was
  - Feasible (computationally)
  - Economical (server quality / speed)
  - Accurate: acceptable match rates
- Evaluate the impact of
  - Varying ‘stringency’ levels on matching algorithm
    - Exact match of all (SSN, DOB, name)
    - Exact match of one and close match of others
    - Somewhere in between
  - Value of “Last Known Alive date” to improve specificity
  - Value of SSN

Methods

- 2400 patients across 2 distinct sites
  - University of Michigan
    - Suburban / rural patient population
    - 90% SSN fill rate
  - Thomas Jefferson University
    - Urban / metropolis patient population
    - 70% SSN fill rate
- Established “gold standard” dead and alive status
  - Manual review of patient records
  - Prospective patient registry
  - 30 day and 1 year mortality

Contact: support@mpog.zendesk.com

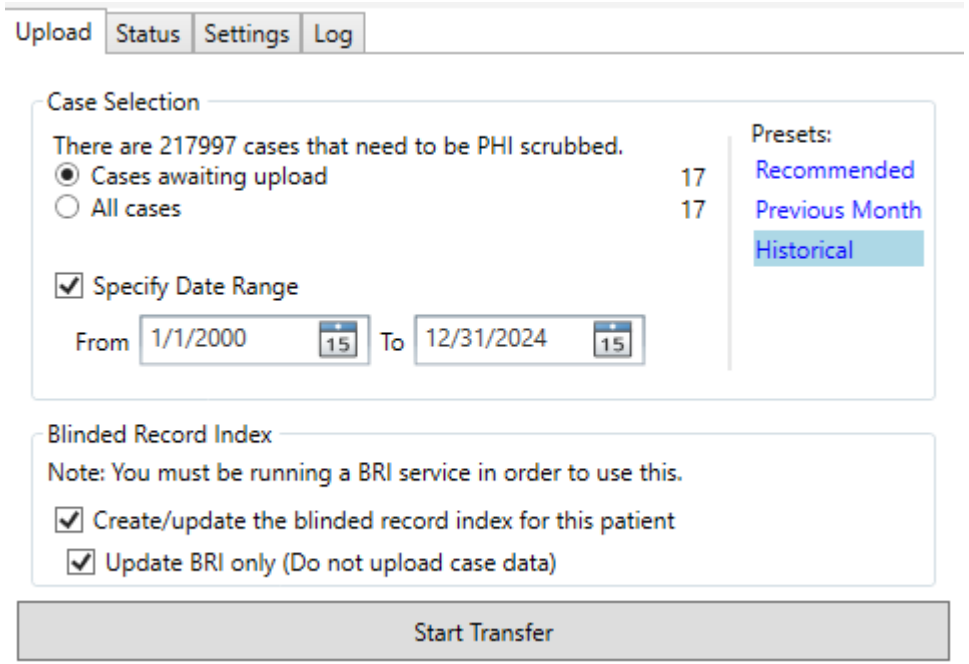
Results

- Achievable
  - IRB approved each center's work
  - Standard commercially available servers
  - Commercially available software from 3rd party vendors
- 30 day mortality
  - Very Strict matching: Sens: 89.7% Spec:100%
  - Expanded matching: Sens: 93.3% Spec: 99.3%
- Impact of last known alive:
  - Worsens sensitivity
  - Improves specificity
- SSN is NOT necessary for high quality matching

What Next?

- Coordinating center
  - Signed contract with State of Michigan for Death Data
  - We will eventually apply Privacy Preserving Record Linkage to the state death data
- Each MPOG site
  - Work by your technical staff: < 1 minute
  - Work by your ACQR: < 5 minute
  - All software already installed and ready to go
- What we've learned
    - Do it in 2 phases: It takes a while 1 hour for 8,000 patients
      - Historical data first, then monthly data
    - It works

Historical Load



Monthly Load