Ontology-based Integration of Consumer Data and EHR Systems to Fill Gaps in Social Determinants of Health Data

S. Clint Dowland\textsuperscript{1}, Melody L. Greer\textsuperscript{1}, Sudeepa Bhattacharyya\textsuperscript{1,2}, and Mathias Brochhausen\textsuperscript{1}

\textsuperscript{1} University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA
\textsuperscript{2} Arkansas State University, Jonesboro, Arkansas, USA
Social Determinants of Health (SDOH)

- Income level
- Employment status
- Access to job opportunities
- Access to health care
- Adequacy of housing
- Language and literacy skills
- Level of education
- Access to transportation
- Food security
- Access to healthy foods
Simple Causal Loop Diagram of SDOH
Social Risk Factor Ontology (SRFON)

• From 19 SDOH literature summaries, I extracted 809 assertions about causal relations or correlations between (a) pairs of social conditions, or (b) a social condition and a health condition
Social Risk Factor Ontology (SRFON)

• From 19 SDOH literature summaries, I extracted 809 assertions about causal relations or correlations between (a) pairs of social conditions, or (b) a social condition and a health condition

• Identified common elements and made the phrasing uniform
Social Risk Factor Ontology (SRFON)

- From 19 SDOH literature summaries, I extracted 809 assertions about causal relations or correlations between (a) pairs of social conditions, or (b) a social condition and a health condition.
- Identified common elements and made the phrasing uniform.
- Those that are scenarios featuring multiple entities were analyzed and modeled, yielding additional entity types.
Social Risk Factor Ontology (SRFON)

• From 19 SDOH literature summaries, I extracted 809 assertions about causal relations or correlations between (a) pairs of social conditions, or (b) a social condition and a health condition
• Identified common elements and made the phrasing uniform
• Those that are scenarios featuring multiple entities were analyzed and modeled, yielding additional entity types
• Matching terms from other ontologies were used if available
Social Risk Factor Ontology (SRFON)

• From 19 SDOH literature summaries, I extracted 809 assertions about causal relations or correlations between (a) pairs of social conditions, or (b) a social condition and a health condition
• Identified common elements and made the phrasing uniform
• Those that are scenarios featuring multiple entities were analyzed and modeled, yielding additional entity types
• Matching terms from other ontologies were used if available
• Terms were arranged into a BFO-based hierarchy
Commercial Consumer Data

• Gathered for predicting spending habits
• Some elements are informative about SDOH
• We are reviewing 6,260 data elements from a commercial database marketing company
Goals

• Pipeline from consumer data about SDOH to EHR systems
  • Gives providers a more robust picture of a patient’s social conditions without additional questioning

• More broadly: identify SDOH-relevant consumer data and enable the integration of SDOH data from disparate sources
SDOH-related Consumer Data: Examples

• Employment status
• Occupation
• Education level
• Primary language
• Household size
• Number of vehicles

• Bedroom count
• Room count
• Home square footage
• Home lacks heating
• Home lacks cooling
Language Barriers & Limited Linguistic Skills

• Can be obstacles to:
  • understanding health care providers’ questions and conveying problems to them
  • understanding health-related information from:
    • health care providers
    • public sources
Primary Language from Consumer Data

Diagram:
- Person P2
  - primary language data item for P2
    - is about
- P2's competence for Spanish
  - is about
- the Spanish language
  - member part of
  - instance of

OMRSE:
- language
Combined Language Data

- **Person P2**
  - Primary language data item for P2
  - Bearer of P2's competence for Spanish

- **OMRSE: language**
  - Member part of the Spanish language
  - Instance of the Spanish language

- **EHR preferred language data item for P2**
  - Participates in a health care encounter
  - Is about the English language

- **OMRSE: language**
  - Instance of the English language
  - Unintelligible with the Spanish language
Combined Language Data

- **Person P2**
  - primary language data item for P2
  - is about
  - bearer of

- **P2's competence for Spanish**
  - is about

- **the Spanish language**
  - member part of
  - instance of

- **OMRSE: language**

- **Person P2**
  - participates in
  - a health care encounter
  - is about

- **OMRSE: language**

- **EHR preferred language data item for P2**
  - is about

- **the English language**
  - instance of
  - unintelligible with
  - instance of
Combined Language Data
Combined Language Data
Combined Language Data

- **Primary Language Data Item for P2**
- **Person P2**
- **EHR Preferred Language Data Item for P2**
- **P2's Competence for Spanish**
- **A Health Care Encounter**
- **OMRSE: Language**
- **Spanish Language**
- **English Language**

Relationships:
- **is about**
- **bearer of**
- **participates in**
- **unintelligible with**
Combined Language Data

- **Person P2**
  - preferred language data item for P2
  - participates in a health care encounter
  - bearer of Spanish

- **P2's competence for Spanish**
  - is about

- **OMRSE: language**
  - instance of English
  - unintelligible with

- **the English language**
  - is about

- **the Spanish language**
  - member part of

- **primary language data item for P2**
  - is about
Household Overcrowding

• Too many people sharing insufficient space

• Researchers have measured it different ways, for example:
  • Persons per bedroom (above some threshold)
  • Persons per room (above some threshold)
  • Square feet per person (below some threshold)

• Associated with stress, infectious diseases, and food insecurity
Overcrowding-related Consumer Data

- Household: number of people
- Home: room count
- Home: bedroom count
- Home: square footage
Simple Example of Overcrowding

2 has specified numeric value

P1's home

home bedroom count data item

is about

P1's home resides in

6 has specified numeric value

P1's household

size data item

is about

P1's household member part of

Person P1
Simple Example of Overcrowding

2

has specified numeric value

P1's home bedroom count data item

is about

P1's home

is about

resides in

P1's household

is about

persons per bedroom data item

has specified numeric value

6

has specified numeric value

P1's household size data item

is about

P1's household

is about

member part of

Person P1

3
Using 2-persons-per-bedroom threshold

- 2 persons per bedroom threshold
- Overcrowded in house
- Inadequate housing

Diagram:

- 2 has specified numeric value
- P1's home bedroom count data item
- P1's home is about
- P1's home resides in
- P1's household
- P1's household is about
- P1's household has specified numeric value
- 6 has specified numeric value
- P1's household size data item
- P1's household is about
- P1's household member part of
- “Inadequate housing”
- Person P1
- SNOMED-CT 105532006
- Characterized by
- ICD-10 CM Z59.1
- Characterized by
- 3
Continuing and Future Work

• Further developing SRFON and making it accessible

• Developing the pipeline of SDOH data to EHR systems

• Using SRFON as the basis for an additional ontological representation featuring causal interrelations among SDOH, similar to those in the causal loop diagram but more fine-grained and with more specific relations
Thank you!

S. Clint Dowland
clintdowland@gmail.com