

GEVITY

Identifying high risk heart failure patients using semantic web technology.

Sitaramesh Emani, MD, The Ohio State University Wexner Medical Center

Shirin Haider Zaidi, MD, MHI, Gevity Consulting

Russell Buchanan, Gevity Consulting

June 8, 2016

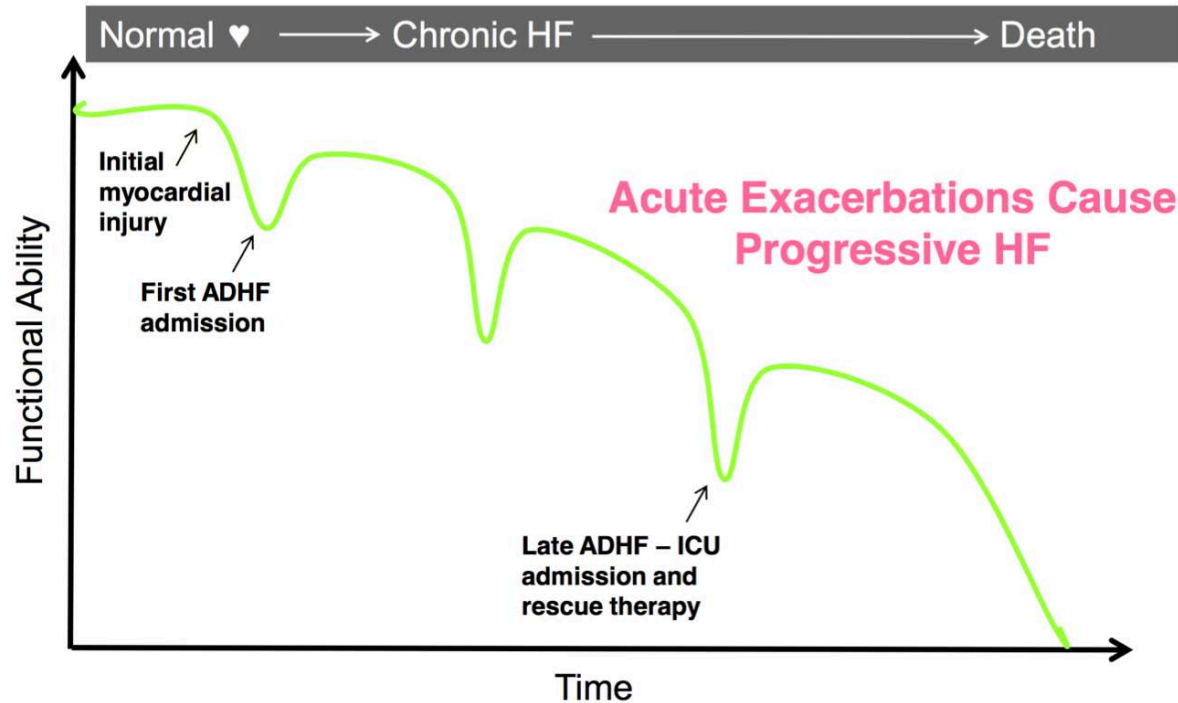
Clinical Problem

Therapies for advanced heart failure (HF) such as transplantation or left ventricular assist devices can improve quality of life and survival. However, many patients are often referred too late or not at all for these therapies.

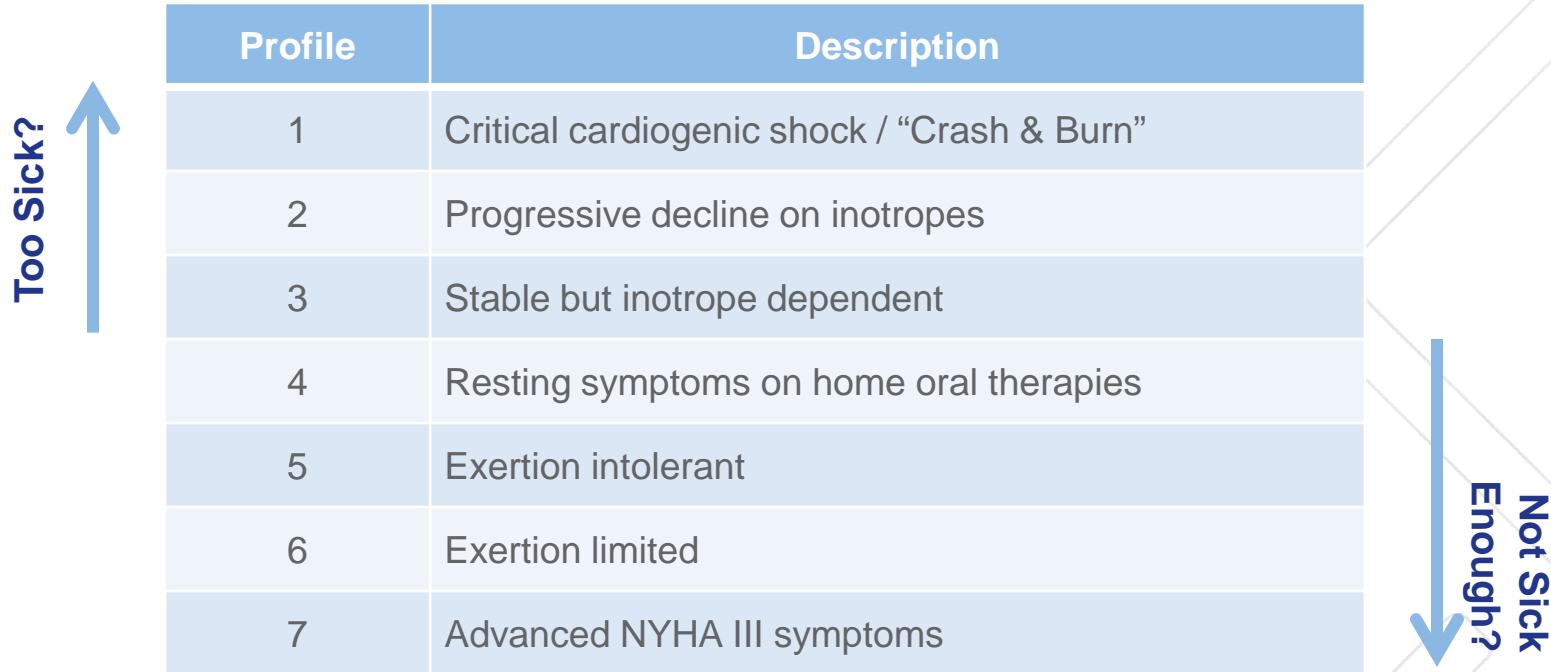
Barriers to appropriately timed referrals include difficulty recognizing patients at risk for poor outcomes prior to clinical deterioration, due in part to the complexities within the HF disease course.

Early identification of patients through analytics promises to be an avenue through which HF therapies may be offered to a greater number of patients to improve outcomes.

Natural History of Heart Failure



Dangers of Late Referrals



The diagram illustrates a spectrum of heart failure severity. On the left, a blue arrow points upwards, labeled 'Too Sick?'. On the right, a blue arrow points downwards, labeled 'Not Sick Enough?'. In the center is a table with 7 profiles, numbered 1 to 7, each with a corresponding description. The profiles are arranged from most severe (1) at the top to least severe (7) at the bottom.

Profile	Description
1	Critical cardiogenic shock / “Crash & Burn”
2	Progressive decline on inotropes
3	Stable but inotrope dependent
4	Resting symptoms on home oral therapies
5	Exertion intolerant
6	Exertion limited
7	Advanced NYHA III symptoms

Left Ventricular Assist Device (LVAD) Therapy: Expenses and Gains



Heart Failure

HF Characteristics

- HF Sx that fail to respond to medical therapy
- Intolerance to HF meds (esp. new intolerance)
 - Hypotension
 - Renal dysfunction
 - Bradycardia
- Frequent hospitalizations
 - 2 in 3 months
 - 3 in 6 months
 - Need for inotropes during hospital stay

Simpler Referral Triggers

NYHA III-IV & ≥ 1 of the following:

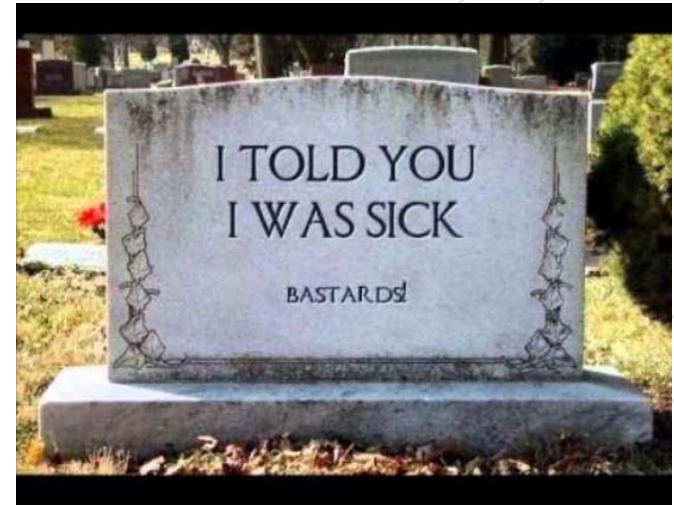
or

NYHA II & ≥ 2 of the following:

- $SBP \leq 90$ mmHg
- $Hgb \leq 12$ mg/dl
- $Cr \geq 1.6$
- Not on RAAS inhibition
- Not on β -blocker

Goal

- Identify patients who could benefit from advanced therapies early
- Try not to use advanced therapies as “salvage therapy”



Project Objective

Develop a screening tool for generalists:

- ✓ Implement an algorithm to identify patients who meet criteria for high-risk heart failure by querying the EMR for combinations of both discreet and non-discreet data elements.
- ❑ Test different combinations / permutations of the criteria to strengthen the positive-predictive value of the algorithm.
- ❑ Pilot the tool against different EMR systems at different provider sites.

Search Criteria

2 or more hospitalizations in a 60-day period with a HF diagnosis

Use of an inotrope during an inpatient stay

Reduction of β -blocker therapy $\geq 50\%$

Absence of β -blocker therapy

Systolic Blood Pressure ≤ 90 mmHg

Hemoglobin ≤ 12 g/dl

Serum Creatinine ≥ 1.6

Ejection Fraction $< 35\%$

Technical Challenge

1. Within a single EMR there are different ways to document information in a patient's chart and many values corresponding to search criteria.
2. We want the solution to be system independent.

Criteria	Location in Chart	Search Criteria (ICD9 only)
2 or more hospitalizations in a 60-day period with a heart failure diagnosis	Encounter Diagnosis	402.01, 402.11, 404.01, 402.91, 404.11, 404.91, 428, 428.1, 428.2, 428.21, 428.22, 428.23, 428.4, 428.41, 428.42, 428.43, 428.9
	Problem List	402.01, 402.11, 404.01, 402.91, 404.11, 404.91, 428, 428.1, 428.2, 428.21, 428.22, 428.23, 428.4, 428.41, 428.42, 428.43, 428.9
... many more criteria some with even more values.		

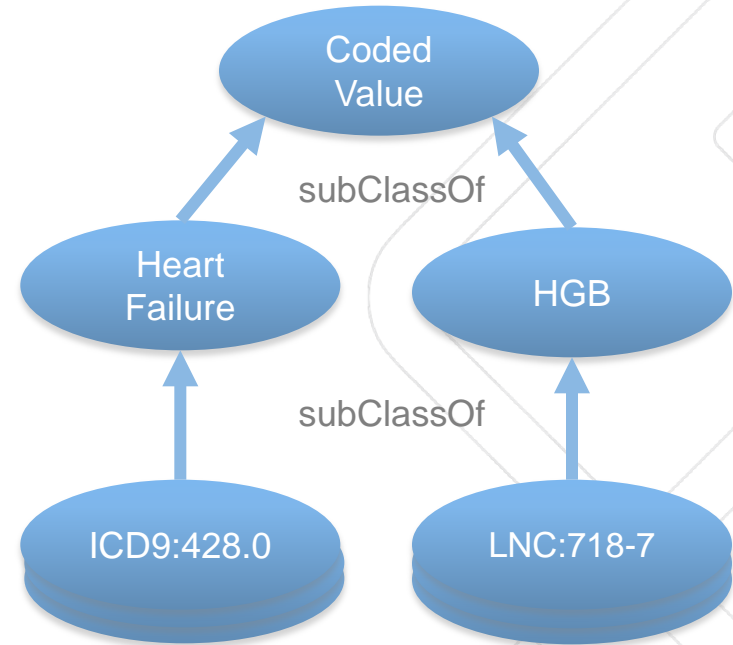
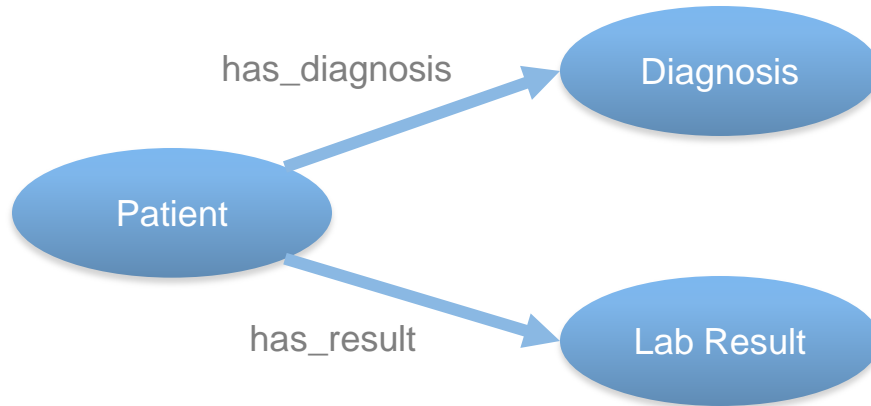
Our Approach

"The **Semantic Web** provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries."

... in an open-world framework that allows anyone to say anything about anything.

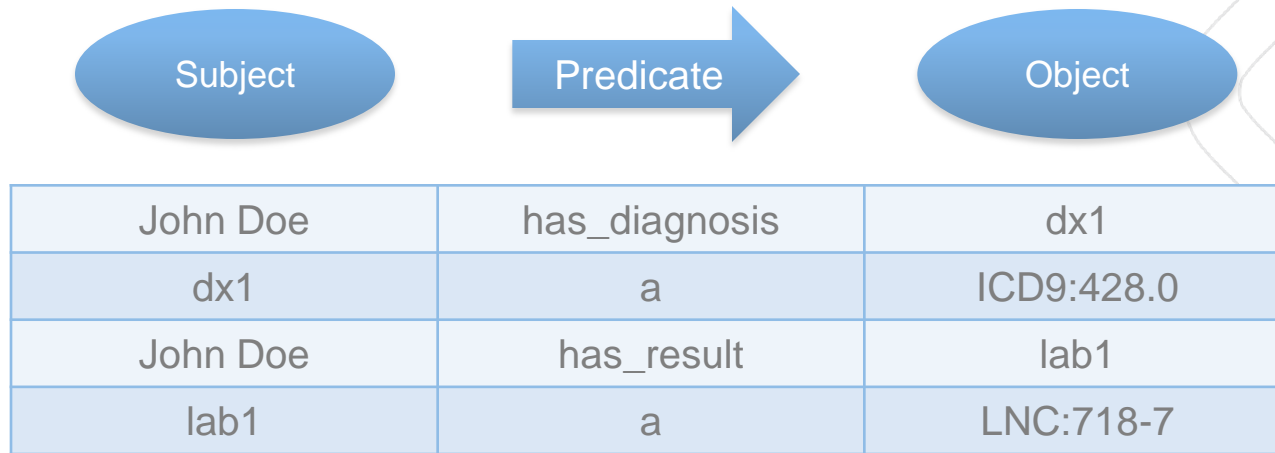
Ontology (OWL)

Develop models of meaning ...



Linked Data (RDF)

Express source data using the model ...



Semantic Queries (SPARQL)

Develop queries using the model ...

Example: “Patient has a diagnosis of Heart Failure”

```
SELECT ?patient
WHERE {
  ?patient :has_diagnosis ?dx .
  ?dx a :Heart_Failure .
}
```

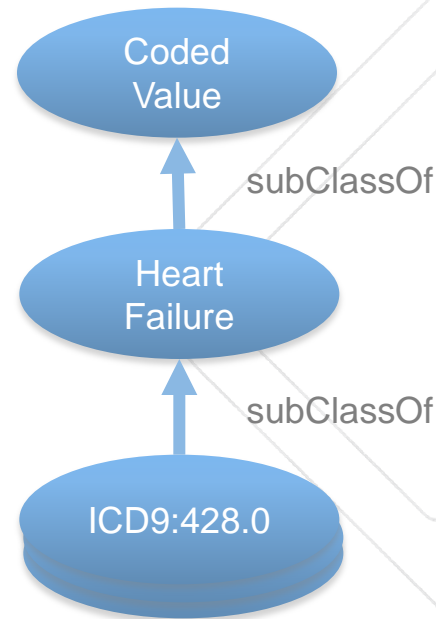


John Doe	has_diagnosis	dx1
dx1	a	ICD9:428.0

Inference

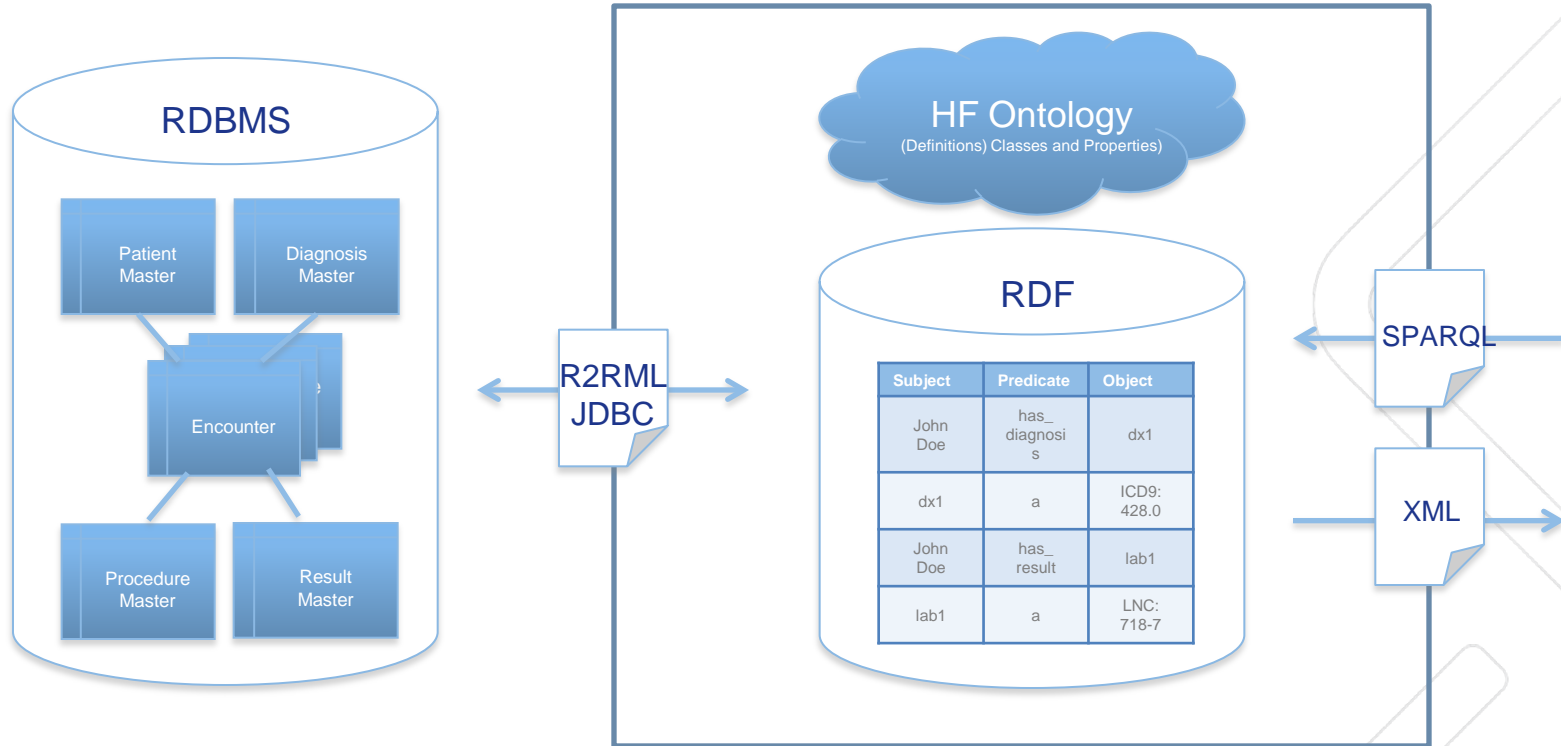
Leverage relationships in the model to infer others ...

```
SELECT ?patient
WHERE {
    ?patient :has_diagnosis ?dx .
    ?dx a :Heart_Failure .
}
```



John Doe	has_diagnosis	dx1
dx1	a	ICD9:428.0

Relational data as RDF



Results to Date

- Technical Solution
 - Solution is bound to the relational source data, maps and queries are working.
 - Query performance is similar to SQL using query time transformation.
- Clinical validation and refinement in progress ...



Future Directions

- Refine and validate existing algorithm
- Test against additional data sources
- Extend solution to additional use cases
- Leverage SNOMED CT content
- Suggestions?

Take Home Messages

- Medical data is complex both clinically and structurally.
- Emerging technologies provide standards based ways to:
 - Represent clinical problems and algorithms semantically
 - Link existing solutions and data to semantic models
- This technology can be leveraged to build tools that use data within existing systems to make the practice of health care more proactive and evidence based.

Questions?



Thank you!



**THE OHIO STATE
UNIVERSITY**
WEXNER MEDICAL CENTER

Sitaramesh Emani, MD

Assistant Professor of Medicine
Advanced Heart Failure & Cardiac
Transplant

The Ohio State University Wexner
Medical Center

473 W. 12th Ave, Suite 200 DHLRI
Columbus, OH 43210

P: [614-293-4967](tel:614-293-4967) | F: [614-293-5614](tel:614-293-5614)

Sitaramesh.emani@osumc.edu

GEVITY

Informatics for a
healthier world

RUSSELL BUCHANAN

Senior Consultant, Terminology
Information Technology Services

M 416.907.4880

E rbuchanan@gevityinc.com |
gevityinc.com

© 2016 Gevity Consulting Inc. All Rights Reserved.

Any trademarks or service marks used are the property of their respective owners.