Belief Revision in Coronary Artery Disease Risk Assessment

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Introduction

- Cognitive model of medical diagnosis process
- Belief revision in coronary heart disease risk assessment
- Our system models a doctor examining a potential coronary artery disease patient (expert system)
    - Considers the patients symptoms and test results to make a diagnosis
    - Considers a risk assessment.
- This system collects important information and changes its belief about the disease or the risk level of a patient.

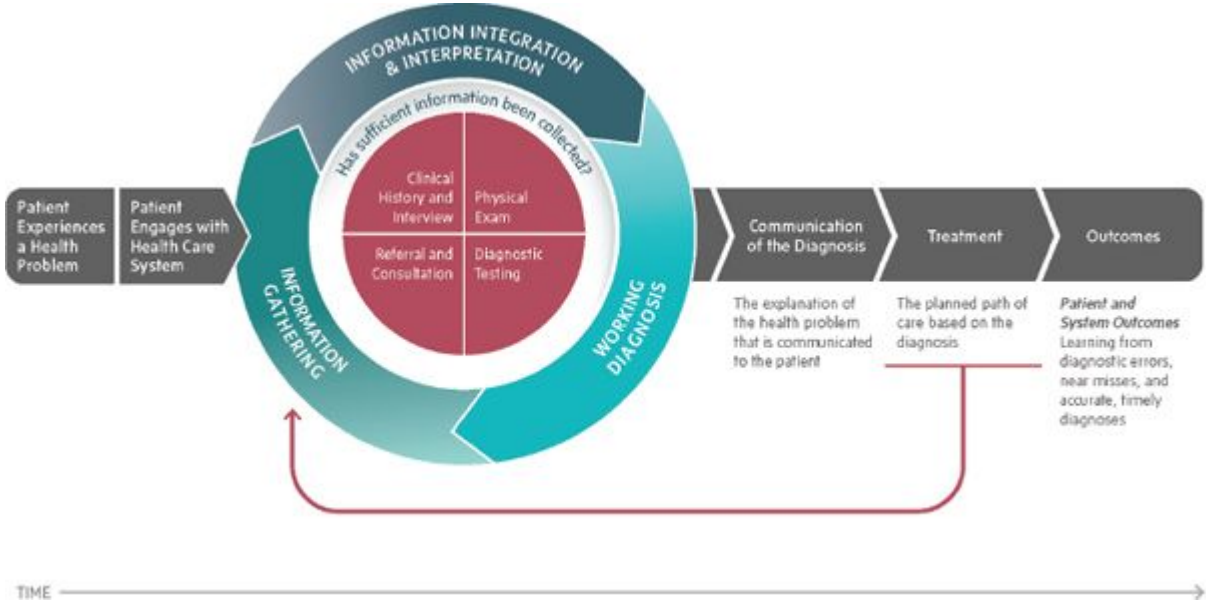
Background

- According to the National Academy of Medicine, the diagnosis process is a series of information gathering and integration with the goal of determining a patient's health problem.
- CAD is a multifactor disease - lifestyle, genetics, environment, etc.
- Information needed for the diagnosis is abundant - basic information, family history, symptoms, test results, etc.
- This belief constantly changes as more information is received, integrated and interpreted alongside previously formed beliefs.

CAD specific

- Symptoms: chest pain, family history, obesity, etc.
- Tests: cholesterol levels, blood pressure, etc.
- Risk assessment: if present, expressed or highly expressed.

Background


Patient Experiences a Health Problem
Patient Engages with Health Care System
INFORMATION GATHERING
INFORMATION INTEGRATION & INTERPRETATION
Has sufficient information been collected?
Clinical History and Interview
Physical Exam
Referral and Consultation
Diagnostic Testing
WORKING DIAGNOSIS
Communication of the Diagnosis
Treatment
Outcomes
The explanation of the health problem that is communicated to the patient
The planned path of care based on the diagnosis
Patient and System Outcomes
Learning from diagnostic errors, near misses, and accurate, timely diagnoses
TIME

Approach

- In order to model information gathering with belief revision, we divided our system into two main interactions: initial examination and further examination
- Initial examination:
  - Included yes/no questions about symptoms pertaining to CAD
  - (If enough symptoms) Results to certain tests relevant to CAD
  - Diagnosed
- Further examination:
  - Occurs when patient already had an initial diagnosis
  - Allows patient to add new symptoms or replace old test results
  - Rediagnosed

Approach

- In order to model the idea of information integration to reach to a final diagnosis, our system uses a “point system”
  - Each patient has a “diagnosis points”
  - Each relevant symptom and “positive test” adds 1 to the “diagnosis points”
- At the end of the examination, the “diagnosis points” is used to assess the patient’s CAD risk

Approach

Points:

1. Age:	**no** <50g.	**yes** 50g.>
2. smoking:	**no**	**yes**
3. family history of coronary artery disease:	no	**yes**
4. blood pressure	**no** < 139/40mmHg	**yes** >140/40mmHg
5. cholesterol:	**no** < 5,5 mmol/l	**yes** > 5,6 mmol/l
6. blood sugar:	**no** < 6,0 mmol/l	**yes** > 6,1 mmol/l
7. BMI :	**no** < 25 kg/m^2	**yes** >25 kg/m^2
8. the ratio of waist / hips:	m. **yes** >1,0 **no** < 0,9	w **yes** > 0,9 , **no** < 8, 9
9. physical activity:	**no** < 30 min. per day	**yes** > 30 min. per day

Assessment:

Risk present	Expressed risk	highly expressed risk
1 – 3 points	4 -6 points	7–9 points

Belief Revision Factors

Initial examination:

- Total points changes for every new symptom and positive test results

Further examination:

- New symptoms/new tests changes total points and has the chance of changing the patient's CAD risk assessment
- New tests replaces previous test results (system always assumes they're more reliable than previous ones)

Demo

https://cs.oswego.edu/~pokada/COG366WorkSite/project/demo.html

Limitations and Further Improvements

- No way to retract previous symptoms for now
- User interaction is fairly limited
  - Initial symptom retrieval is only done through yes/no questions
    - Interaction feels unnatural
    - Possible improvement: more integration of natural language processing to the system (feels more interactive)
  - Doesn’t accept test/symptoms that are not CAD related
    - Possible improvement: store all stated symptom and assess relevance to CAD

Limitations and Further Improvements

- Point system doesn't fully encompass CAD diagnosis (ex: all symptoms & tests are weighted equally)
    - Possible improvements: Add a weight system to each symptom + integrate a decision tree into CAD diagnosis
- No section for treatments based on risk assessment which would completely model a patient's visit to the doctor.