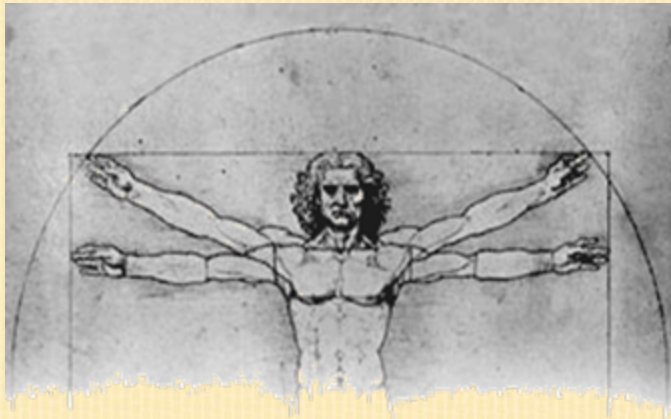


Triage of Acute Decompensated Congestive Heart Failure in the Emergency Department

Initial Results Using a Computer-Based Medical Decision-Support Tool



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*Christiana Hospital, Christiana Care Health System,
Newark, Delaware*

The National Predictive Modeling Summit

The Leading Forum on Predictive Analytics Applied to Key Health Care Functions, Settings, and Populations



**CHRISTIANA CARE
HEALTH SYSTEM**

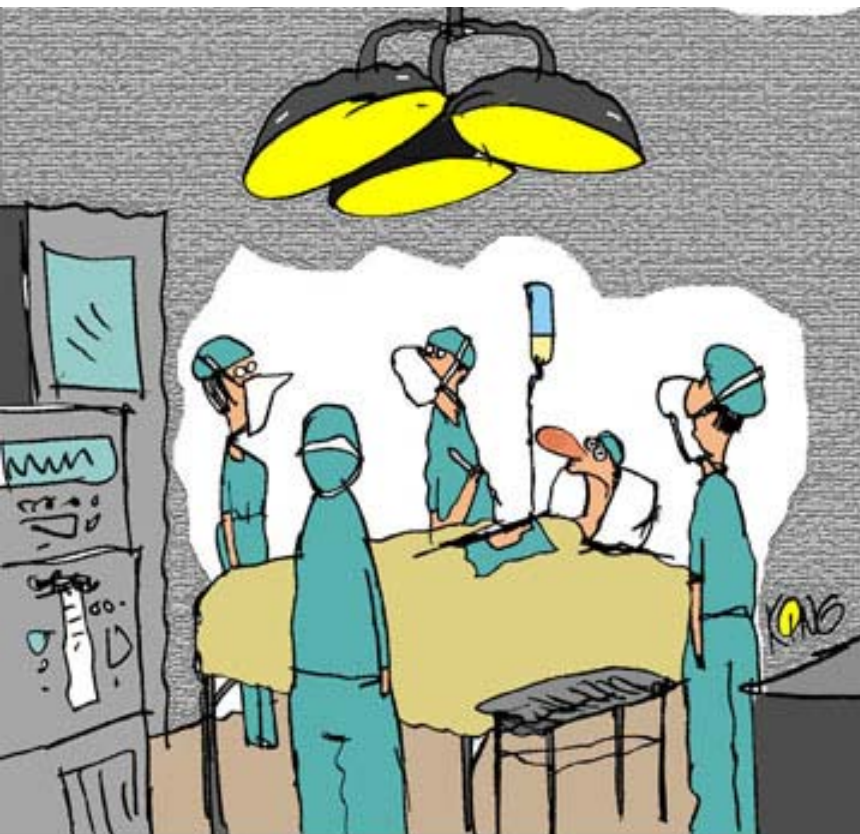
Disclosure Statement

**Ms. Debora J. Simmons, RN MSN CCRN CCNS
recuses herself from the presentation
due to conflict of interest**

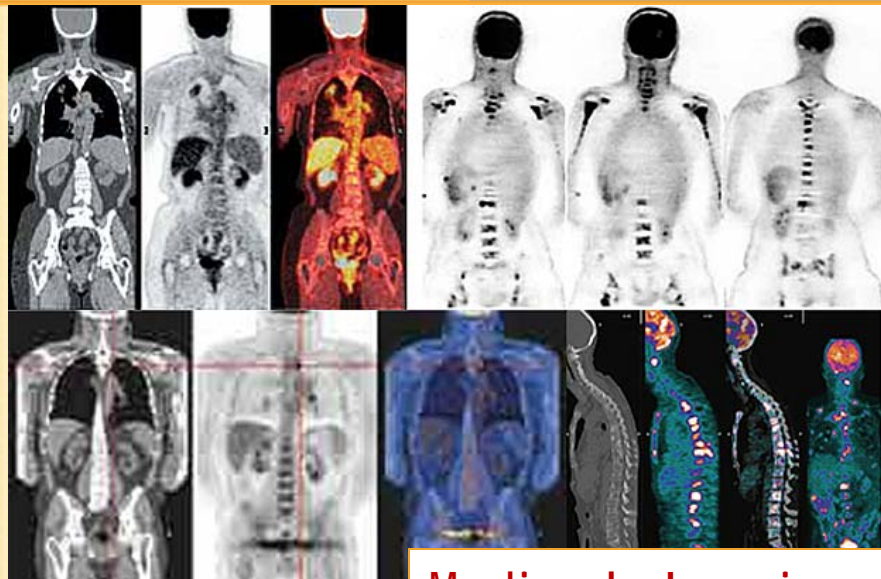
**All other co-investigators
have no conflict of interest**

Computer Applications in Medicine

Medical Information Look-up



"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."



Medical Imaging



Filing and Data Storage

Computer Applications in Medicine



Computer-aided diagnosis

The "Automated Doctor"



Audio: Courtesy of comedian Ms Kristin Lindner. Performance at the Houston Improv Comedy Club, 2005

Challenges and Limitations of Computer-based Diagnostics

Automated Medical Decision Making Systems

The Shortfalls:

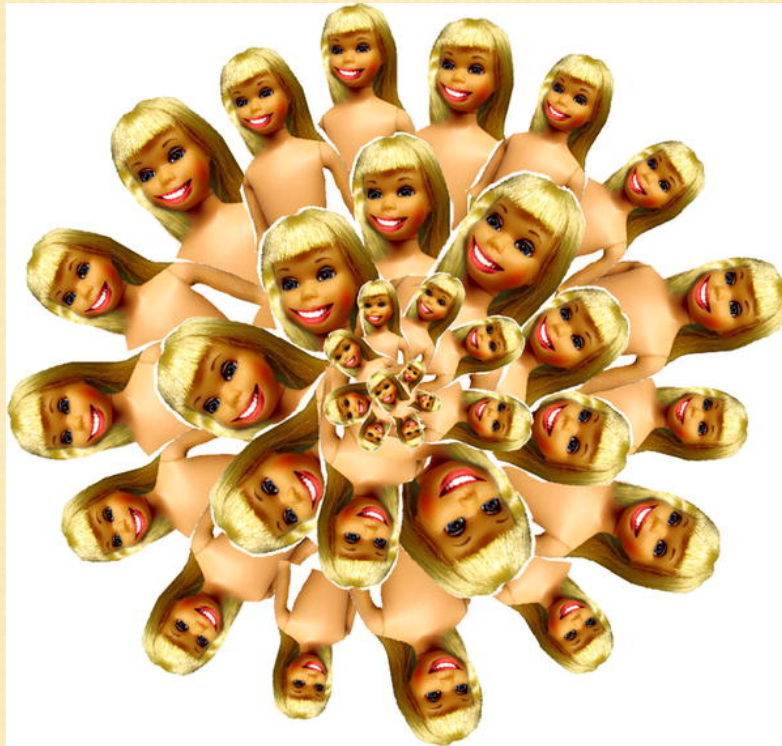
- Inadequate
- Imprecise
- Non-Reproducible



Challenges and Limitations of Computer-based Diagnosis

I. Non-Uniformity of System Elements:

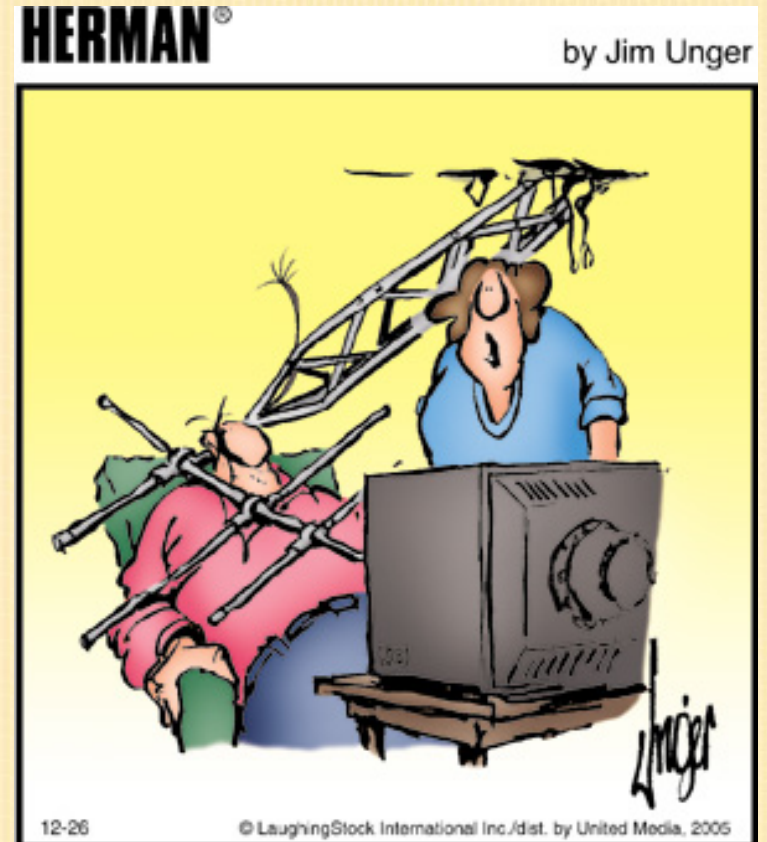
Variations of Human Patient Characteristics



II. Incomplete Understanding of the System's behavioral Patterns:

Such as:

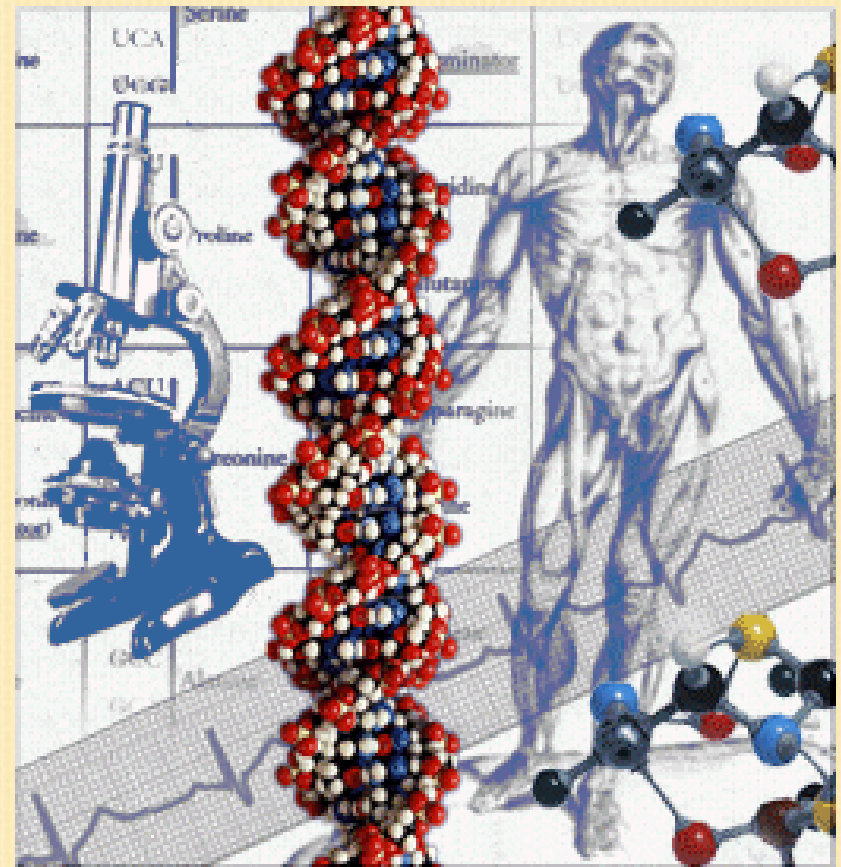
1. How diseases start and progress.....



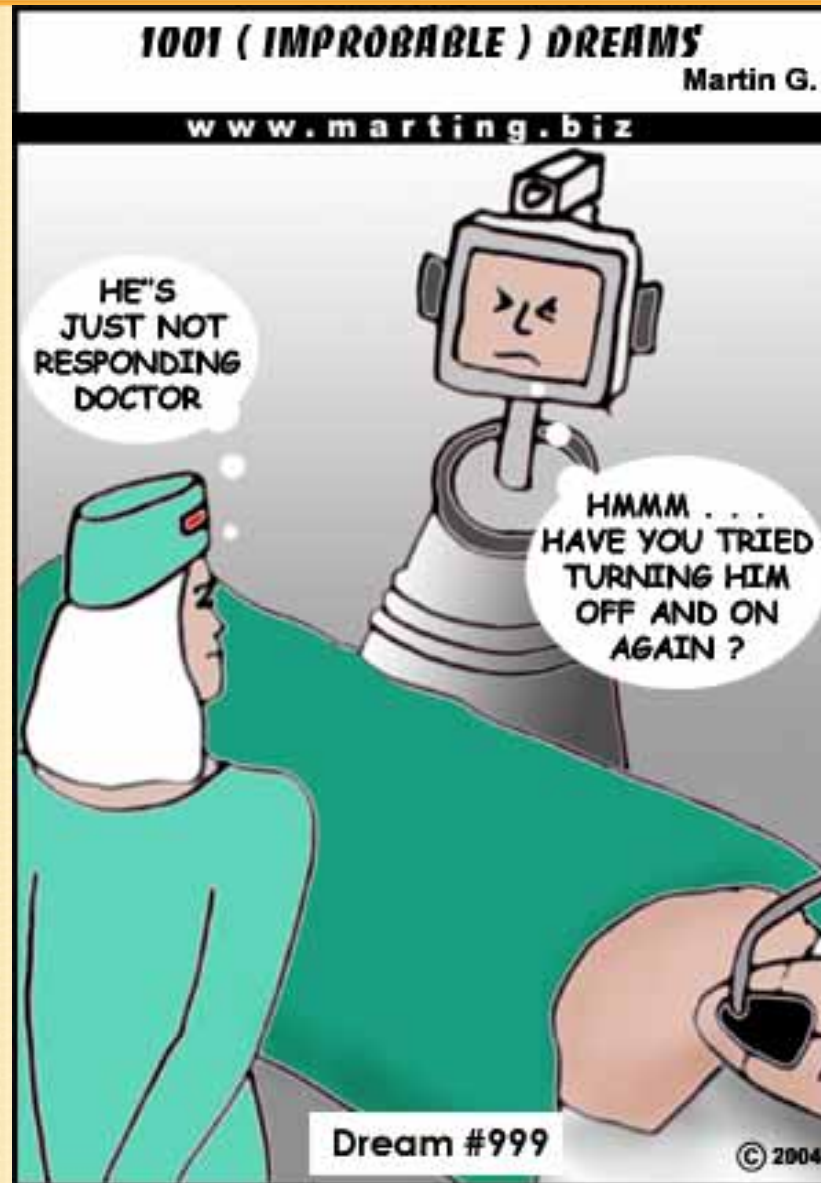
“What happened to the picture?”

Research about the causes, course, behavior and modification of different diseases is still on-going.

Our understanding of such processes and behavioral patterns remains incomplete.



2. The effects of different therapeutic modalities....



3. The effects of interaction between different System Elements and/or therapeutic modalities

- Population cohort factors
- Individual factors
- Compliance
- Socio-economic factors
- Historical evidence
- Prospective evidence
- Off-Label evidence
- Therapeutic variability
- Therapeutic/Medication interactions
- Side effects
- Complications
- Unexpected effects/Idiosyncracies
- Co-existing conditions
- Unknown/Undiagnosed conditions



For example, rules and behavioral patterns in the Aviation Industry Systems have been well understood for over a century,

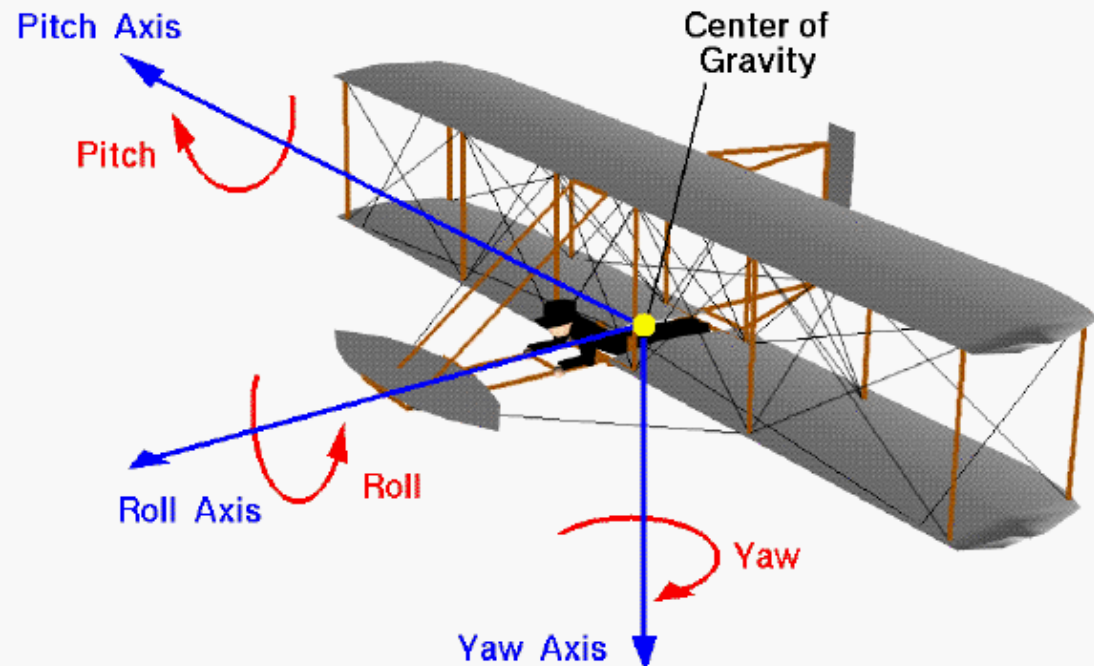
= Feasible and easy to achieve optimal control over the system's components



Aircraft Control

Wright 1902 Glider

Glenn
Research
Center



4. Unpredictability of the Consequences or Results of Intended /Planned Actions:

Unpredictability of the Effectiveness of Therapeutic Modality...



5. The Diagnostic Software I.Q.

A Computer Program

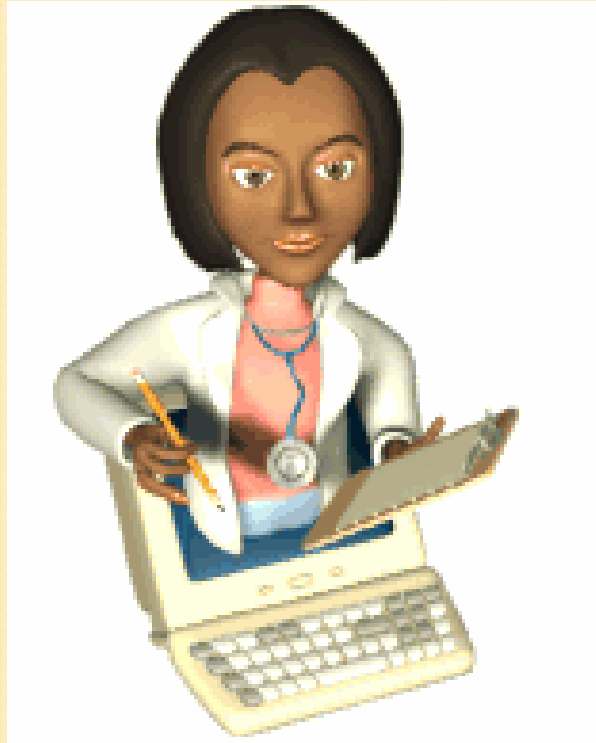
will **ALWAYS** do what you **TELL** it to do,

But rarely

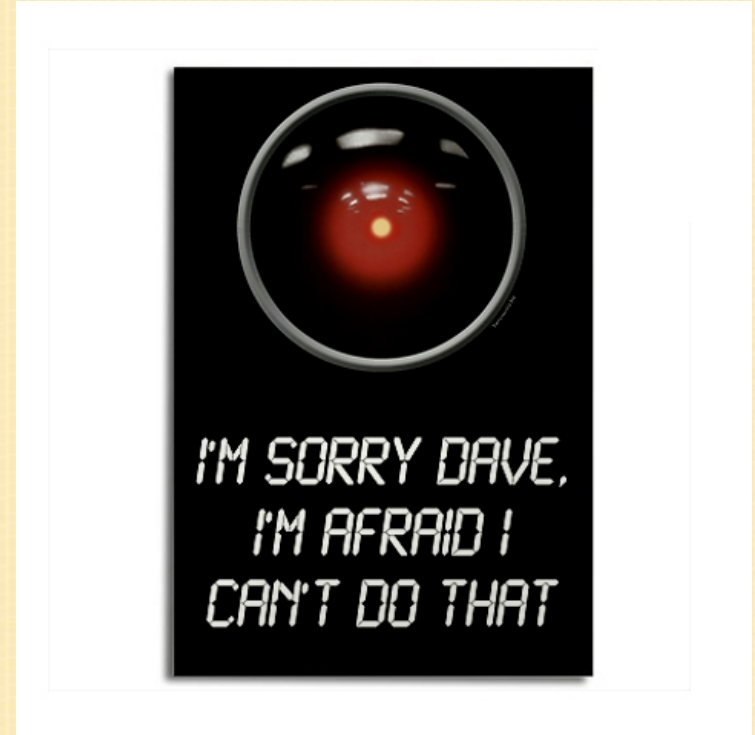
what you **WANT** it to do



Can We Teach the Computer ?



vs.



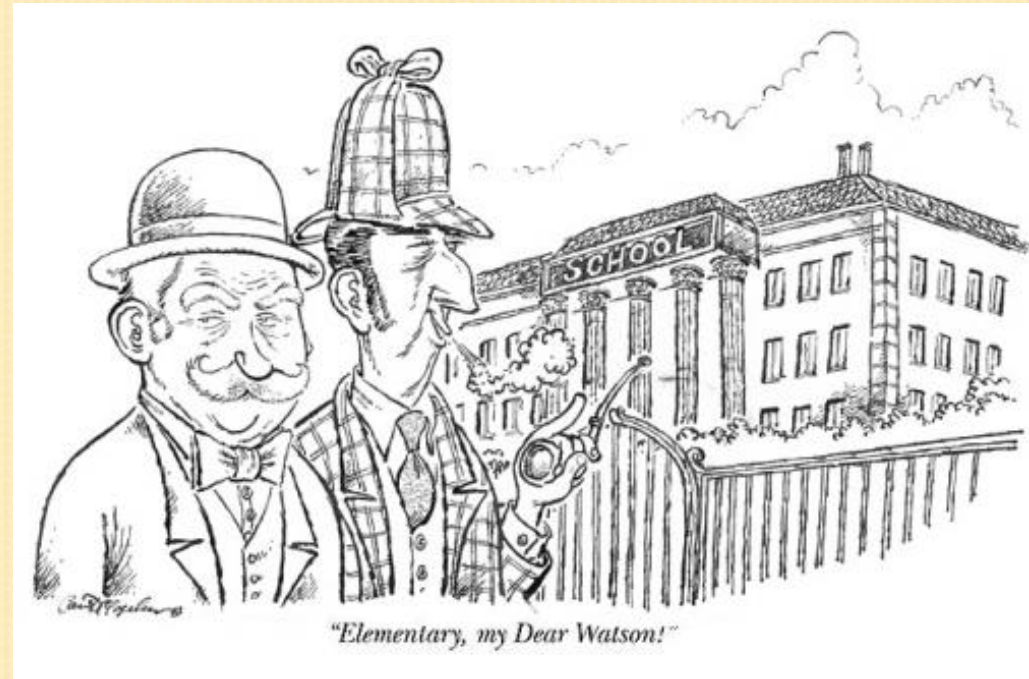
Basics of Medical Triage

- Quick Establishment of Diagnosis
- Assigning a Severity Score
- Establishing the Predicted Outcome
- Disposition (according to the predicted outcome)



Basics of Medical Diagnosis

- Information Gathering:
 - Medical history
 - Symptoms
 - Physical Examination
 - Laboratory Data
 - Imaging Data



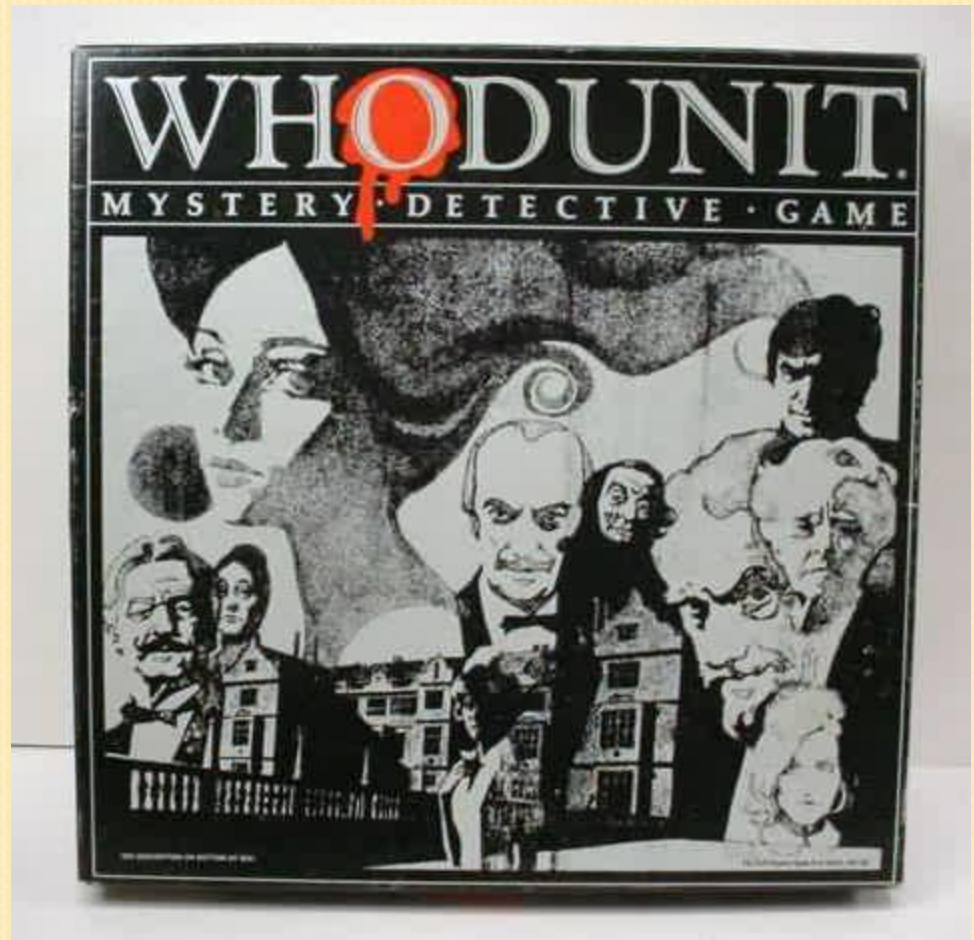
- Differential Diagnosis List
- Assignment of a Probability Hierarchy

Medical Triage

"Guess Who?"
(Diagnosis)

"Drop that knife!"
(Predicted Outcome)

"Book 'em, Danno!"
(Disposition)



Establishing a Diagnosis

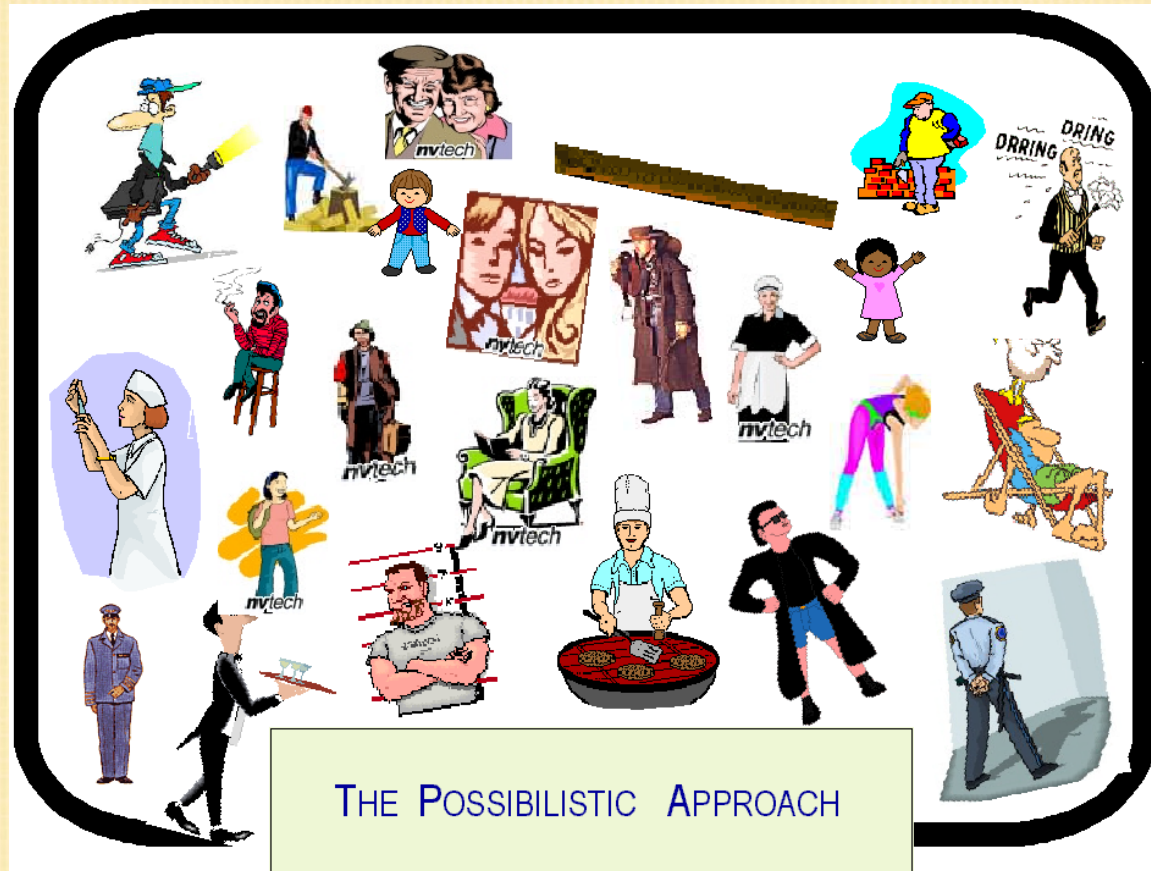
A -- Differential Diagnosis

B-- Sorting out the Suspect List



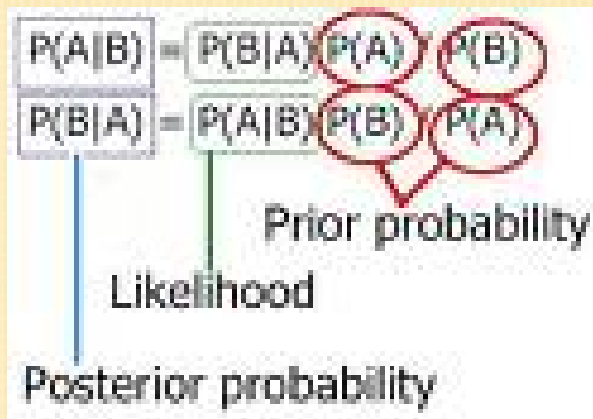
1. The Possibilistic Approach

a. k. a, DRAGNET

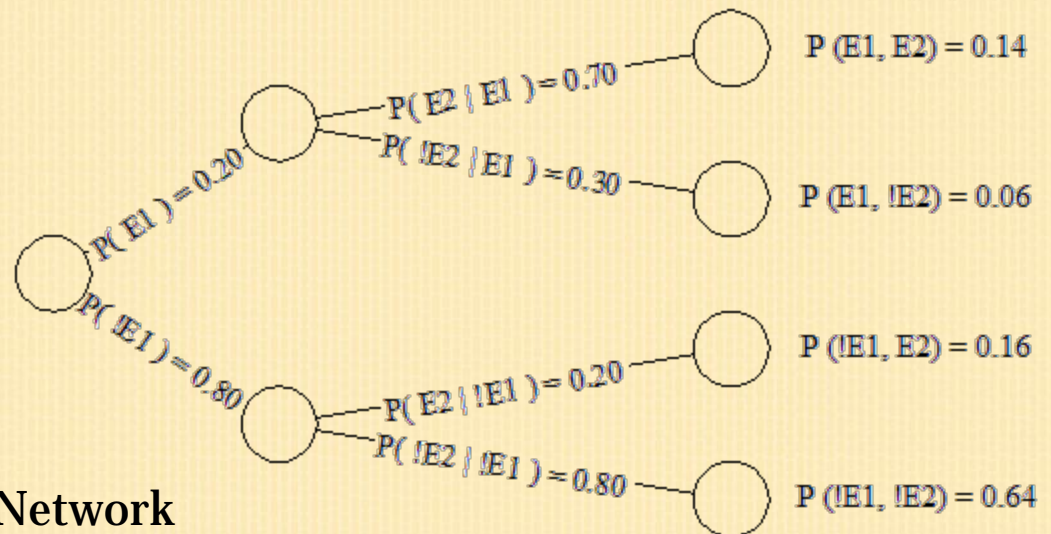


2. The Probabilistic Approach

a. k. a. , What Are the Odds?!



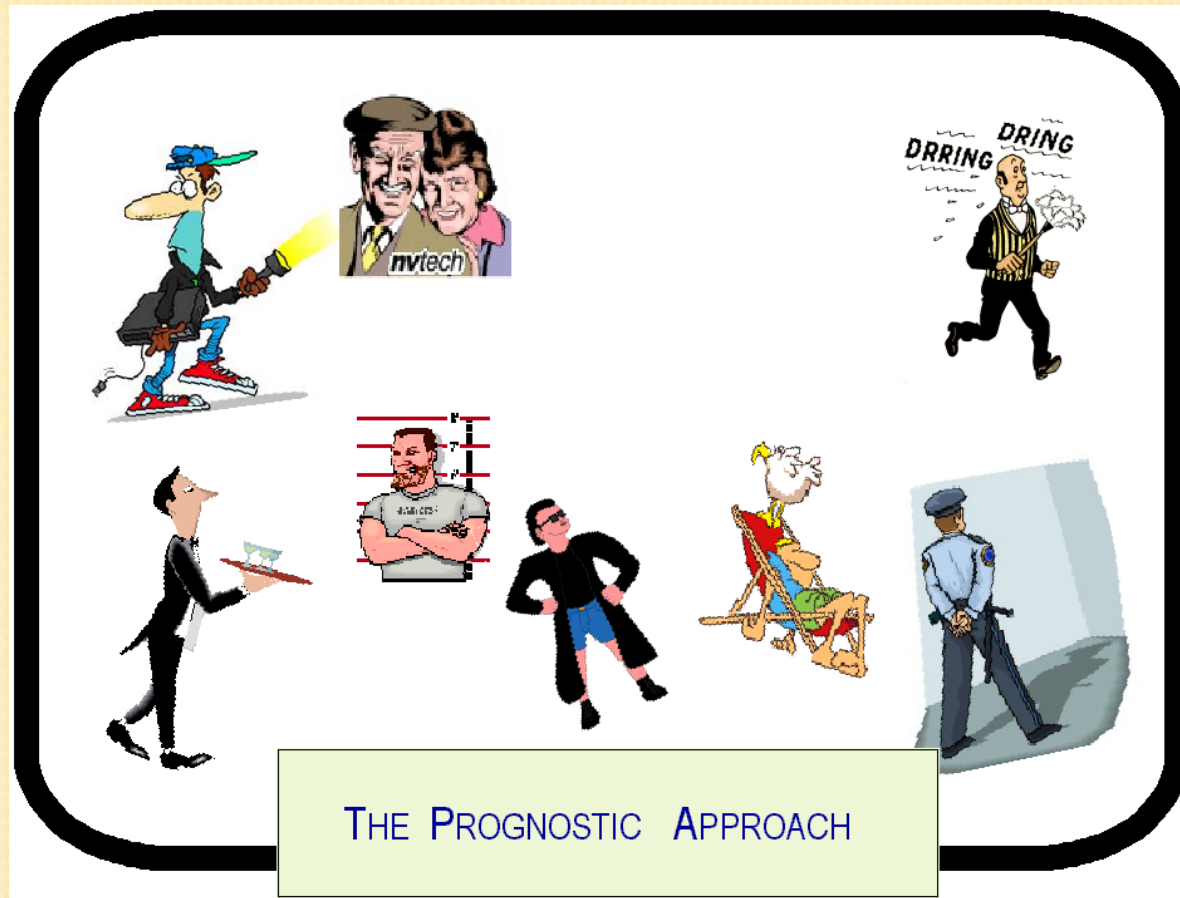
Bayes Theorem



Bayesian Network

3. The Prognostic Approach

a. k. a, Voted Most Likely to Succeed?



Computer-Based Diagnostic/Predictive Systems: Principles and Correlation

Identify:

- Problem
- Objective

-Identify Data Sub-sets:

- Determinants
- Modifiers
- Associated Data Variables

-Determine Data Flow

-Assign Probability Values

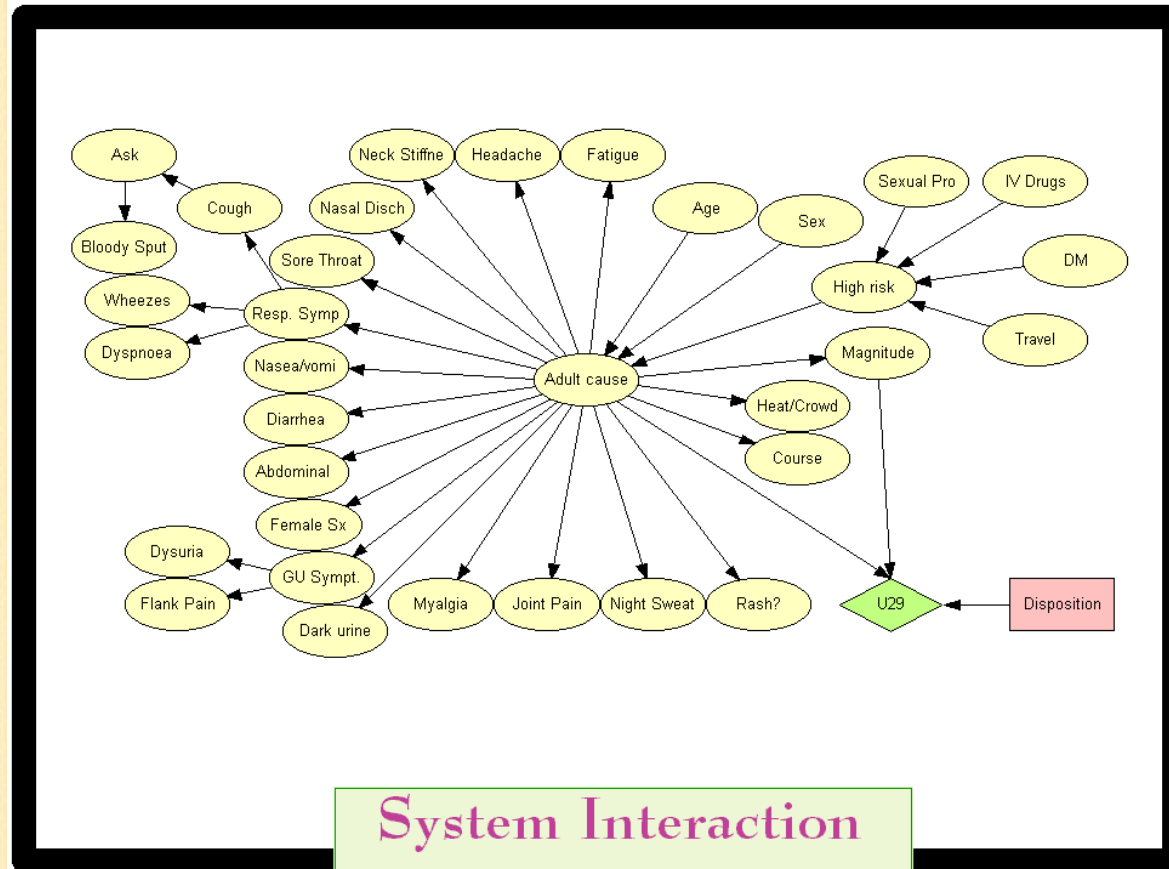
-Develop a Hierarchy

SYSTEM CORRELATION

Our Tool



Example

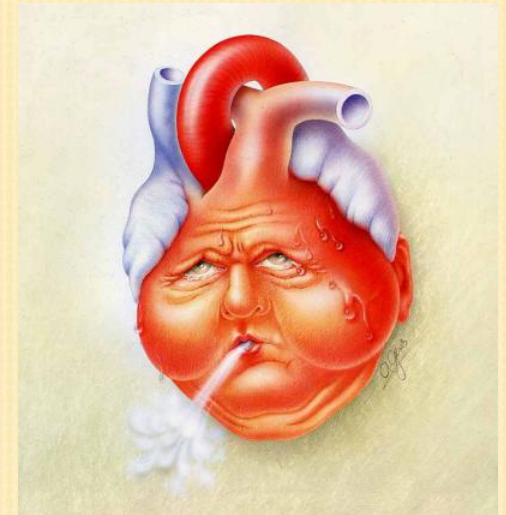


Triage of Acute Decompensated Congestive Heart Failure

Background:

Congestive Heart Failure :

- About 2-4 million cases in the US
- 15 million cases worldwide.
- 550,000 new cases per year



Triage of Acute Decompensated Congestive Heart Failure

Outcomes:

-Congestive Heart Failure :

- 287,000 deaths per Year
- < 50% expected to live more than 5 years
- Class IV survival :
 - At 1 Yr : 43%
 - At 3 Yr : 18%



•M Gheorghide and P Pang. Acute Heart Failure Syndromes. J Am Coll Cardiol 2009 53: 557-573

•M Gheorghide, F Zannad, G Sopko, et al.

Acute Heart Failure Syndromes: Current State and Framework for Future Research. Circulation. 2005;112:3958-3968

Triage of Acute Decompensated Congestive Heart Failure

Cost:

- In-Patient care: 23.1 Billion \$
- 300% increase in readmission rates from 1970-1994 (Patients >65 years)
- Readmission Cost up to 17.4 Billion \$ per year (Medicare)

Sources:

The American Medical Association
American Medical Directors Association
Agency for Health Care Research and Quality



Some others' work...

D Lombardo, T Bridgmean, N De Michelis, M Nunez.

An academic medical centre's programme to develop clinical pathways to manage health care: Focus on acute decompensated heart failure.

J Integrated Care Pathways. (2008);12:45-55

D Lee, P Austin, J Rouleau, P Liu, D Naimark, J Tu.

Predicting mortality among patients hospitalized for heart failure. Derivation and validation of a clinical model.

JAMA.2003;290:2581-2587.

W Levy, D Mozaffarian, D Linker, S Sutradhar, S Anker, A Cropp, I Anand, A Maggioni, P Burton, M Sullivan, B Pitt, P Poole-Wilson, D Mann, and M Packer.

The Seattle Heart Failure Model: Prediction of Survival in Heart Failure.

Circulation. 2006;113:1424-1433



Study Objective

To develop a custom-built, computer-based clinical decision-support tool to:

- a) Help determine the underlying cause of the patient's clinical presentation

- b) Help the emergency department physician predict the likelihood of readmission for ADHF syndrome.



Acute Decompensated Congestive Heart Failure: Emergency Department Parameters

Patient Factors:

- Age
- Gender
- Documented History of Congestive Heart Failure
- Prior Admission for Acute Decompensated CHF

Symptomatology:

- Shortness of Breath
- Orthopnea/Paroxysmal Nocturnal Dyspnea
- Palpitations
- Chills

Physical Examination:

- Heart Rate
- Systolic Blood Pressure
- Fever
- Presence of a Third Heart Sound
- Jugular Venous Distension
- Dependent Edema

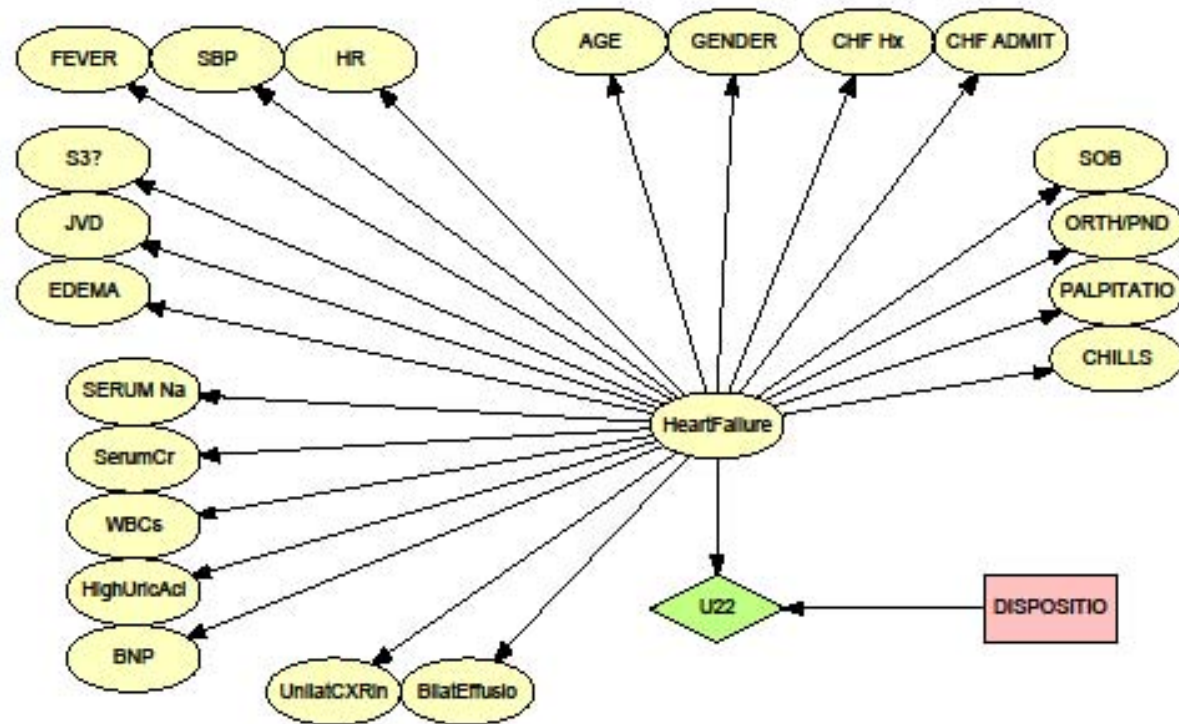
Laboratory Data:

- Serum Sodium
- Serum Creatinine
- White Blood Cell Count
- Serum Uric Acid
- Serum BNP

Findings on Chest Radiograph:

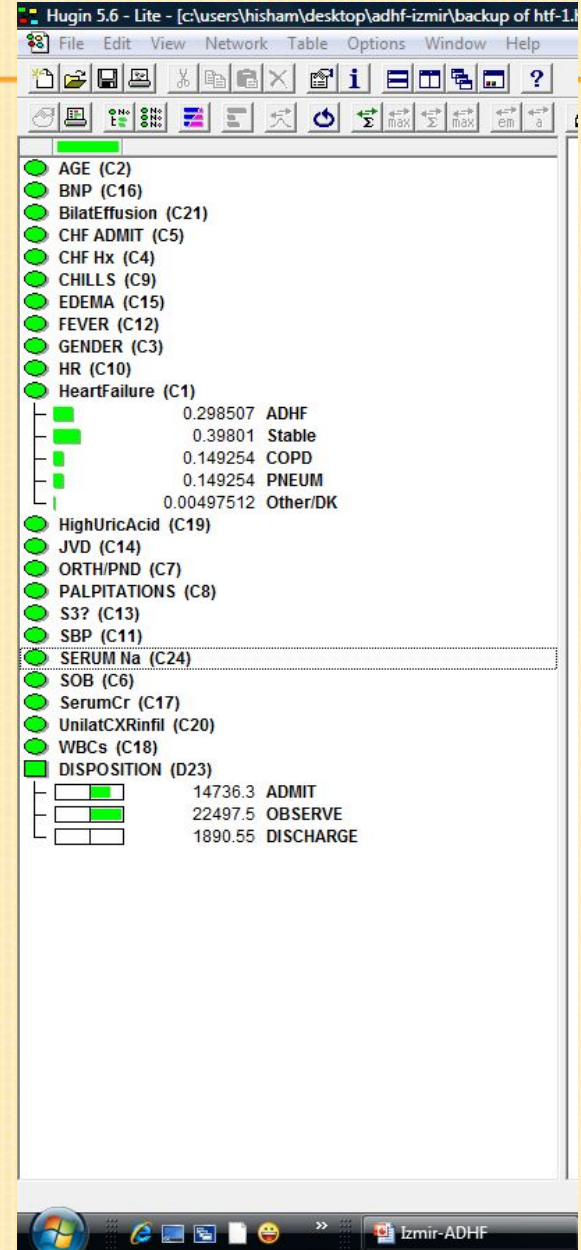
- Unilateral Lung Infiltrates
- Bilateral Pleural Effusions

Acute Decompensated Congestive Heart Failure: The Predictive Program Basic Layout

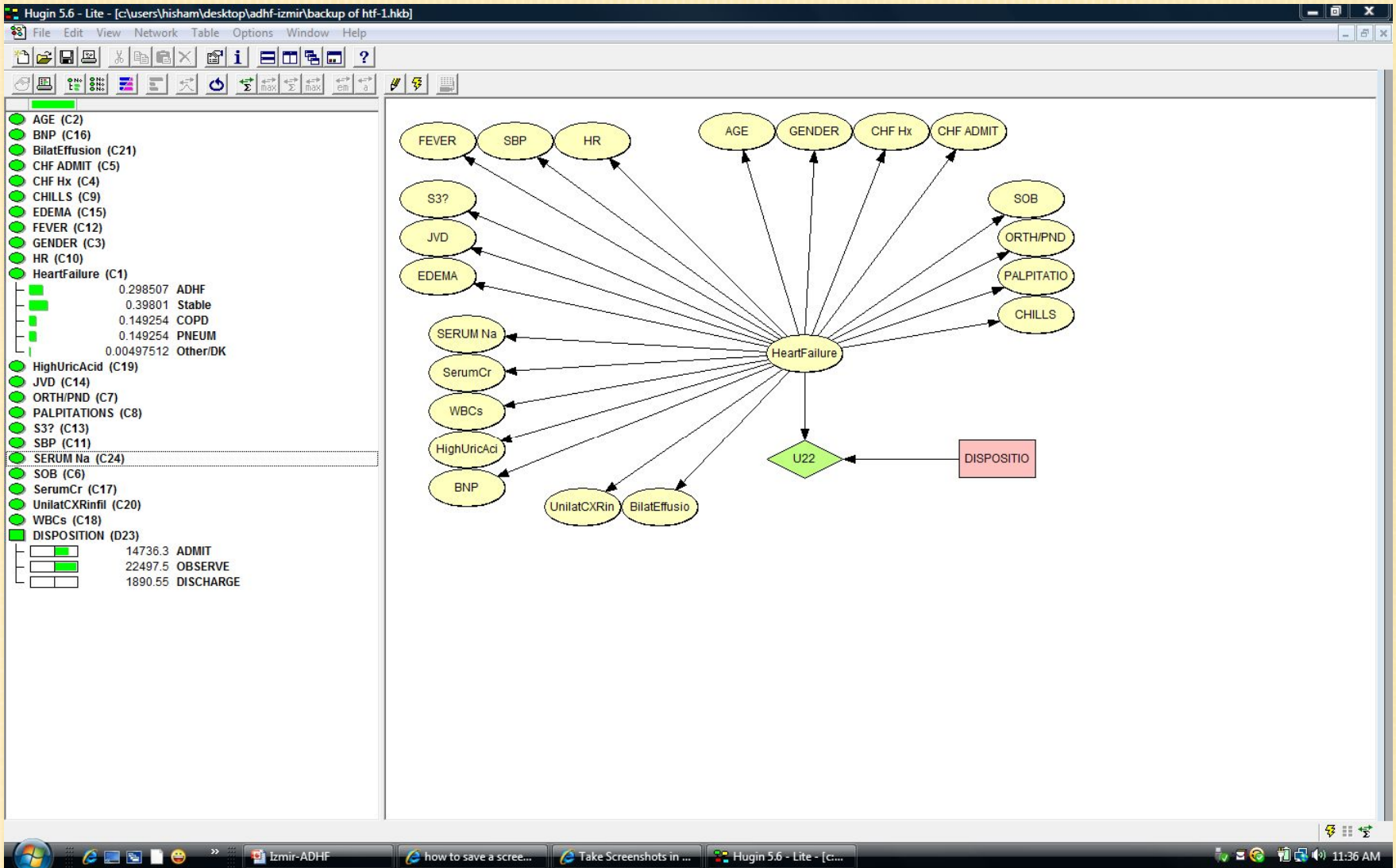


Acute Decompensated Congestive Heart Failure:

Di agnosti c and Di sposi ti on Ti ers



Acute Decompensated Congestive Heart Failure: The Predictive Program "Run Mode"



Initial Results

Phase I:

“Proof-of-Concept”

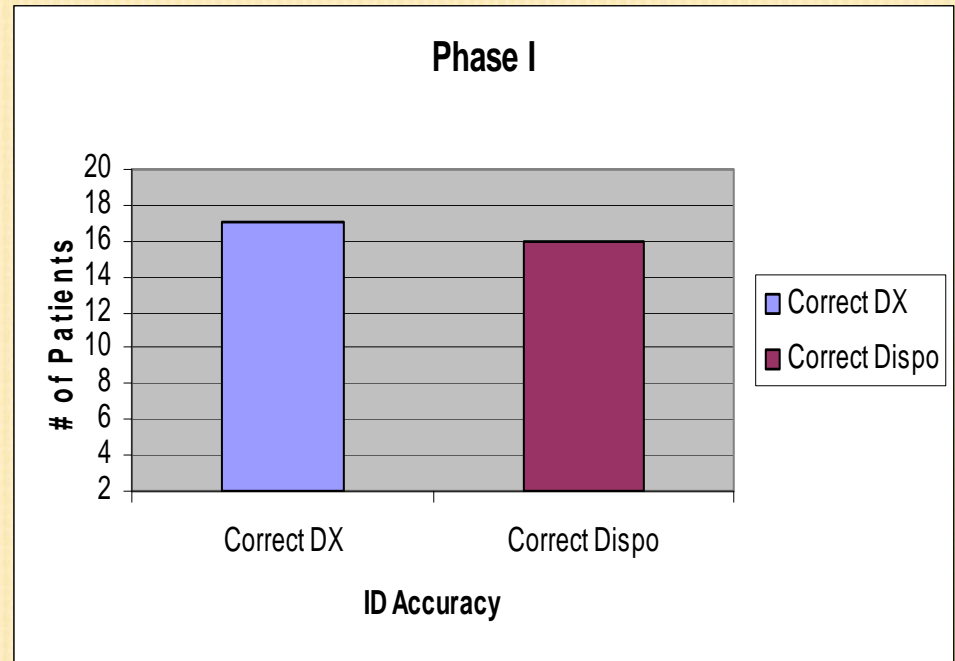
- 20 cases
- Hypothetical, Randomly Generated Parameters

Initial Results

Phase I:

Successful Prediction:

- **Diagnosis** 17/20 (85%)
- **Disposition** 16/20 (80%)



I n i t i a l R e s u l t s

Phase II:

Clinical-based, Real-World Retrospective Study

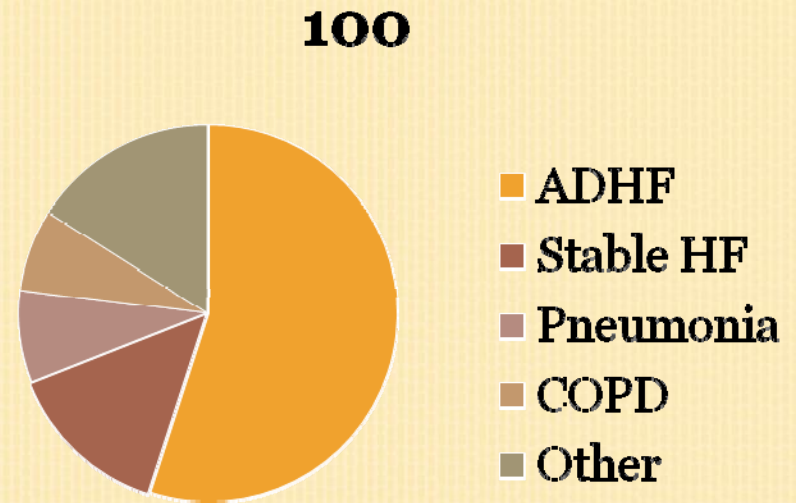
- Retrospective chart review
- Records-based parameters
- 100 Emergency Department case records
- Documented final diagnosis:
 - 55 cases of Acute Decompensated Heart Failure
 - 45 cases of Other Diagnoses

Initial Results

Phase II:

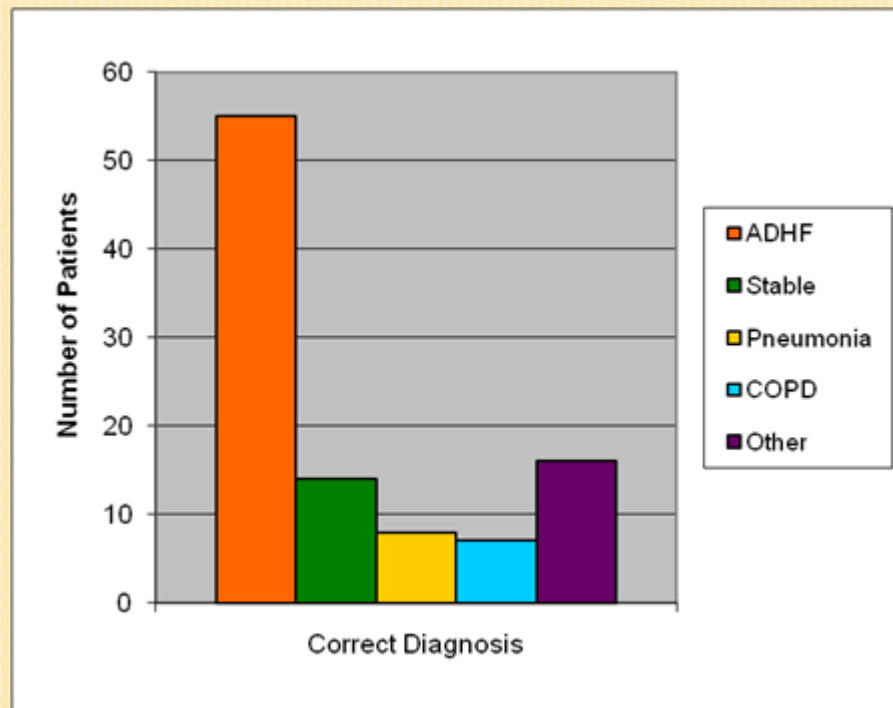
Case number by Diagnosis:

ADHF	55
Stable HF	14
Pneumonia	8
COPD	7
“Other”	16
Total	100



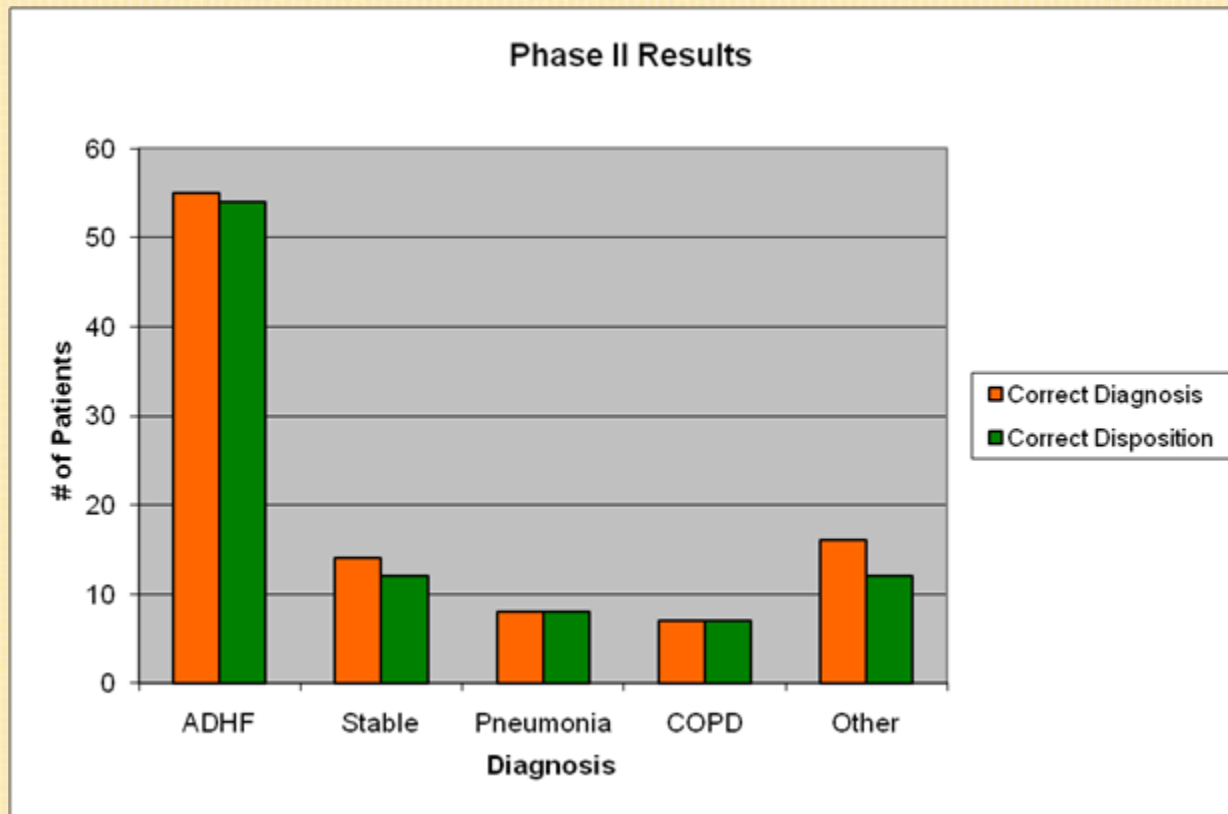
Initial Results

Phase II:



Initial Results

Phase II:



Study Limitations

- Pilot study design
- Retrospective
- Chart Review
- Small Sample Size

Conclusion

A Custom-built, Computer based predictive model,
Using Evidence-based, population-wide real-life clinical
data and trends
can be a useful adjunct tool in clinical decision making



Conclusion

... especially in high-paced, high risk clinical environments



THANK YOU !

