# A Physician Advisory System for Chronic Heart Failure management based on knowledge patterns

ZHUO CHEN, KYLE MARPLE, ELMER SALAZAR,
GOPAL GUPTA and LAKSHMAN TAMIL

University of Texas at Dallas, Texas, U.S.A

# Introduction

Management of chronic diseases such as chronic heart failure (CHF) is a major problem in health care. A standard approach followed by the medical community is to have a committee of experts develop guidelines that all physicians should follow. These guidelines typically consist of a series of complex rules that make recommendations based on a patient's information. Due to their complexity, often the guidelines are ignored or not complied with at all. It is not even clear whether it is humanly possible to follow these guidelines due to their length and complexity.

**Guidelines**

**Physician Advisory System**

**Image Credit:** Photographee.eu - Fotolia

# Objective

In this paper we describe a physician-advisory system for CHF management that codes the entire set of clinical practice guidelines for CHF using answer set programming (ASP). Our approach is based on developing reasoning templates, that we call knowledge patterns, and using them to systemically code the clinical guidelines for CHF as ASP rules.

**Guidelines**

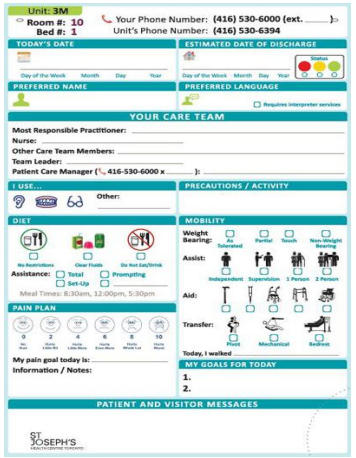
**ASP**

**Physician Advisory System**

**Image Credit:** Photographee.eu - Fotolia

# Objective

Given a patient's medical information, our system generates a recommendation for treatment just as a human physician would, using the guidelines.




**Patient Information**

# Physician Advisory System

**Recommendation**

**Image Credit:** Creator: Andrew Milligan

# Components of the Physician Advisory System

## Rule Database

**Guidelines**

"In all patients with a recent or remote history of MI or ACS and reduced EF, evidence-based beta blockers should be used to reduce mortality."

```
recommendation(beta_blockers, class_1):- accf_stage(b),
    history_of_mi_or_acs, measurement(lvef, Data),
    reduced_ef(Data), not contraindication(beta_blockers).
```

## Fact Table

```
%doctor's assessments
accf_stage(c).
nyha_class(3).
expectation_of_survival(3).

%demographics of the patient
gender(female).
age(78).
```

**Image Credit:** Creator: Andrew Milligan

# Components of the Physician Advisory System

## Rule Database

"In all patients with a recent or remote history of MI or ACS and reduced EF, evidence-based beta blockers should be used to reduce mortality."

**2013 ACCF/AHA Guideline Example**

```
recommendation(beta_blockers, class_1):- accf_stage(b),
    history_of_mi_or_acs, measurement(lvef, Data),
    reduced_ef(Data), not contraindication(beta_blockers).
```

**Guideline converted to rule in ASP**

## Fact Table

```
%doctor's assessments
accf_stage(c).
nyha_class(3).
expectation_of_survival(3).

%demographics of the patient
gender(female).
age(78).

%measurements from the lab
hf_with_reduced_ef.
measurement(creatinine, 1.8).
measurement(potassium, 4.9).
measurement(lvef, 0.35).
measurement(lbbb, 180).
measurement(sinus_rhythm).

%history of the patient
diagnosis(myocardial_ischemia).
diagnosis(atrial_fibrillation).
diagnosis(coronary_artery_disease).
diagnosis(hypertension).
evidence(ischemic_etiology_of_hf).
evidence(sleep_apnea).
evidence(fluid_retention).
history(mi, recent).
history(stroke).
history(cardiovascular_hospitalization).
post_mi(40).
```

**Patient Information Representation**

# Example

Table 1. *Input of the Physician-Advisory System for CHF Management*

| | |
|---|---|
| Demographics | Gender; age; race |
| Measurements | Weight; creatinine; potassium; sinus rhythm; left bundle branch block; non-left bundle branch block; QRS duration; ejection fraction NYHA class; ACCF/AHA stage; |
| Diseases and Symptoms | Sleep apnea, acute coronary syndrome; myocardial infarction; obesity; diabetes; stroke; fluid retention; angioedema; ischemic attack; thromboembolism; elevated plasma natriuretic peptide level; asymptomatic ischemic cardiomyopathy; lipid disorders; hypertension; atrial fibrillation; myocardial ischemia; coronary artery disease; dilated cardiomyopathy; acute profound hemodynamic compromise; threatened end organ dysfunction; ischemic heart disease;angina; structural cardiac abnormalities; atrioventricular block; volume overload |
| Miscellany | Expectation of survival;pregnancy; history of cardiovascular hospitalization; history of standard neurohumoral antagonist therapy; risk of cardioembolic stroke; eligibility of significant ventricular pacing; eligibility of mechanical circulatory support; dependence of continuous parenteral inotropic; ischemic etiology of HF; requirement of ventricular pacing |

Table 2. *Output of the Physician-Advisory System for CHF Management*

| | |
|---|---|
| Pharmaceutical Treatments | ACE inhibitors; ARBs; Beta blockers; statin; diuretics; aldosterone receptor antagonists; hydralazine and isosorbide dinitrate; digoxin; anticoagulations; Omege-3 fatty acids; inotropes; |
| Management Objectives | Systolic blood pressure control; diastolic blood pressure control; obesity control; diabetes control; tobacco avoidance; cardiotoxic agents avoidance; atrial fibrillation control; water restriction; sodium restriction; |
| Device/Surgery Therapies | Implantable cardioverter-defibrillator; cardiac resynchronization therapy; mechanical circulatory support; coronary revascularization |

# Plans to Implement

- **Obtain Rules from the 2013 ACCF/AHA Guidelines**

  There are some sixty odd rules in the 2013 ACCF/AHA Guideline for the Management of Heart Failure. All of these rules are coded in ASP to run on the s(ASP) system. *(MARPLE, K., SALAZAR, E. AND GUPTA, G. 2016)*

- **Test against various inputs**

  Obtain various patient records and pass it as input to the Physician Advisory System for CHF Management. Test the output obtained from the system.