Clinical Decision Support (CDS) Content and Health Level 7 (HL7)-Compliant Knowledge Artifacts (KNARTs)

Cardiology: Admission Orders - Heart Failure Clinical Content White Paper

Department of Veterans Affairs (*VA*)

Knowledge Based Systems (*KBS*)
Office of Informatics and Information Governance (*OIIG*)
Clinical Decision Support (*CDS*)

Clinical Decision Support (CDS) Content and Health Level 7 (HL7)-Compliant Knowledge Artifacts (KNARTs): Cardiology: Admission Orders - Heart Failure Clinical Content White Paper

by Department of Veterans Affairs (*VA*)

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Table 1. Relevant KNART Information: Cardiology: Admission Orders - Heart Failure

KNART Name	Associated CLIN
Admission Orders: Heart Failure - Order Set	CLIN0008DA

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1.1. Clinical Context Domains 1

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Introduction

The Department of Veterans Affairs (*VA*) is committed to improving the ability of clinicians to provide care for patients while increasing quality, safety, and efficiency. Recognizing the importance of standardizing clinical knowledge in support of this goal, *VA* is implementing the Health Level 7 (*HL7*) Knowledge Artifact Specification for a wide range of VA clinical use cases. Knowledge Artifacts, referred to as KNARTs, enable the structuring and encoding of clinical knowledge so the knowledge can be integrated with electronic health records to enable clinical decision support.

The purpose of this Clinical Content White Paper (*CCWP*) is to capture the clinical context and intent of *KNART* use cases in sufficient detail to provide the *KNART* authoring team with the clinical source material to construct the corresponding knowledge artifacts using the *HL7* Knowledge Artifact Specification. This paper has been developed using material from a variety of sources: *VA* artifacts, clinical practice guidelines, evidence in the body of medical literature, and clinical expertise. After reviewing these sources, the material has been synthesized and harmonized under the guidance of *VA* subject matter experts (*SMEs*) to reflect clinical intent for this use case.

Unless otherwise noted, items within this white paper (e.g., documentation template fields, orderable items, etc.) are chosen to reflect the clinical intent at the time of creation. To provide an exhaustive list of all possible items and their variations is beyond the scope of this work.

Conventions Used

Conventions used within the knowledge artifact descriptions include:

<*obtain*>: Indicates a prompt to obtain the information listed

- If possible, the requested information should be obtained from the underlying system(s). Otherwise, prompting the user for information may be required
- The technical and clinical notes associated with a section should be consulted for specific constraints on the information (e.g., time-frame, patient interview, etc.)
- Default Values: Unless otherwise noted, <obtain> indicates to obtain the most recent observation. It is recognized that this default time-frame value may be altered by future implementations

[...]: Square brackets enclose explanatory text that indicates some action on the part of the user, or general guidance to the clinical or technical teams. Examples include, but are not limited to:

[Begin ...] , *[End ...]*: Indicates the start and end of specific areas to clearly delineate them for technical purposes.

[Activate ...]: Initiates another knowledge artifact or knowledge artifact section.

[Section Prompt: ...]: If this section is applicable, then the following prompt should be displayed to the user.

[Section Selection Behavior: ...]: Indicates technical constraints or considerations for the selection of items within the section.

[Attach: ...]: Indicates that the specified item should be attached to the documentation template if available.

[Link: ...]: Indicates that rather than attaching an item, a link should be included in the documentation template.

[Clinical Comment: ...]: Indicates clinical rationale or guidance.

[Technical Note: ...]: Indicates technical considerations or notes.

[If ...]: Indicates the beginning of a conditional section.

[Else, ...]: Indicates the beginning of the alternative branch of a conditional section.

[End if ...]: Indicates the end of a conditional section.

☐*[Check boxes]*: Indicates items that should be selected based upon the section selection behavior.

Chapter 1. Cardiology: Admission Orders - Heart Failure

1.1. Clinical Context

[Begin Clinical Context.]

The Cardiology Admission Orders: Heart Failure *KNART* is intended for clinical providers caring for adult patients in a Clinic or an Emergency Department (*ED*) setting being admitted with a diagnosis of heart failure, initial or recurrent episode.

The context domains are summarized in the table below:

Table 1.1. Clinical Context Domains

Target User	Provider in an outpatient clinic, hospital and *ED* settings
Patient	Adult patient being admitted with a diagnosis suggestive of initial or recurrent heart failure
Priority	Routine
Specialty	Outpatient primary care or cardiology, Emergency Medicine, Hospitalist Medicine, or Intensive Care Unit (*ICU*) Medicine
Location	Outpatient or *ED*

[End Clinical Context.]

1.2. Knowledge Artifacts

[Begin Knowledge Artifacts.]

Heart failure is a highly prevalent condition that is associated with significant morbidity and mortality and with tens of billions of dollars of annual expense in the United States [(Yancy 2013)]. While clinical advances and authoritative guidelines have been developed, substantial practice variation still exists among caregivers, denying patients access to potentially life-extending treatment. Operationalizing evidence-based practice guidelines, therefore, has the potential to improve outcomes among a large number of patients while delivering more cost-effective care.

The clinical decision support (*CDS*) knowledge artifact for the heart failure admission order set use case is:

- Cardiology: Admission Orders - Heart Failure Order Set KNART
  - Orderable items
  - Includes logic for appropriate display of the order set

[End Knowledge Artifacts.]

Chapter 2. Cardiology: Admission Orders - Heart Failure Order Set

[Begin Cardiology: Admission Orders - Heart Failure Order Set.]

2.1. Knowledge Narrative

[Begin Knowledge Narrative.]

[See Clinical Context in Chapter 1.]

[Section Prompt: This order set should be used during the admission of patients presenting with a diagnosis of heart failure.]

[End Knowledge Narrative.]

2.2. Admit To

[Begin Admit To.]

[Section Prompt: Admit To?]

[Section Selection Behavior: Required. Select only one.]

- ☐Medical ward
- ☐Telemetry
- ☐Stepdown unit
- ☐*ICU*
- ☐Other <obtain> Location

[End Admit To.]

2.3. Diagnosis

[Begin Diagnosis.]

[Section Prompt: Diagnosis?]

[Section Selection Behavior: Required. Select only one.]

- ☐Congestive heart failure (*CHF*)
- ☐Other <obtain> Diagnosis

[End Diagnosis.]

2.4. Allergies

[Begin Allergies.]

[Section Prompt: Medication allergies?]

[Section Selection Behavior: Required. Select only one.]

☐No known drug allergies

☐Other <obtain> List of allergies

[End Allergies.]

2.5. Code Status

[Begin Code Status.]

[Section Prompt: Code status?]

[Section Selection Behavior: Required. Select only one.]

☐Full code

☐Do Not Resuscitate (*DNR*)/Do Not Intubate (*DNI*)

[Technical Note: Link to Attending *DNR*/*DNI* order set]

☐Other <obtain> Code status

[End Code Status.]

2.6. Vital Signs and Monitoring

[Begin Vital Signs and Monitoring.]

[Section Prompt: Vital Signs and Monitoring]

[Section Selection Behavior: Optional. Select all that apply.]

☐Continuous telemetry

☐Vital signs

☐Routine

☐Every <obtain> Hours

☐With pulse oximetry

☐Weight daily (pounds)

☐Height (inches)

[Technical Note: If admitted to medical ward, then display the medical ward section.]

[Begin Medical Ward Section.]

[Section Prompt: Medical Ward Orders]

[Section Selection Behavior: Optional. Select all that apply.]

☐Oxygen saturation every 4 hours

☐Intake/output recording

☐Routine per local policy

☐Strict per local policy

☐Every <obtain> Hours

[End Medical Ward Section.]

[Technical Note: If admitted to *ICU*, then display the *ICU* section.]

[Begin *ICU* Section.]

[Section Prompt: *ICU* Orders]

[Section Selection Behavior: Optional. Select all that apply.]

☐Oxygen saturation continuous

☐Intake and output

☐Routine per local policy

☐Strict per local policy

☐Every 1 hour

☐Invasive hemodynamic monitoring

☐Arterial line

☐Pulmonary artery catheter

[End *ICU* Section.]

[End Vital Signs and Monitoring.]

2.7. Activity

[Begin Activity.]

[Section Prompt: Activity]

[Section Selection Behavior: Optional. Select all that apply.]

☐Bed rest

☐Bed rest with bedside commode

☐Bed rest with bathroom privileges

☐Ambulate with assistance <obtain> Frequency

☐Occupational/physical therapy assessment/assistance

☐Out of bed to chair <obtain> Frequency

☐Other specify <obtain> Other activity

☐May be off telemetry for <obtain> Reason

[End Activity.]

2.8. Nursing

[Begin Nursing.]

[Section Prompt: Urinary Catheter]

[Section Selection Behavior: Optional. Select all that apply.]

☐Insert Foley (indwelling urinary) catheter (note: routine urinary catheterization not recommended unless benefits outweigh risks)

☐Discontinue urinary catheter after 48hrs (reorder for continued use)

☐Condom catheter

[Section Prompt: Peripheral Intravenous (IV) Line]

[Section Selection Behavior: Optional. Select all that apply.]

☐Insert peripheral *IV* line

☐Saline lock

☐Heparin lock

☐Routine *IV* Care per local policy

[Section Prompt: Fluid Restriction]

[Section Selection Behavior: Optional. Select all that apply.]

☐Restrict fluids

<obtain> Maximum liters per 24 hours

[Section Prompt: Diet]

[Section Selection Behavior: Required. Select at least one.]

☐Regular

☐Nil per os (*NPO*)

☐*NPO* except meds

☐Cardiac diet

☐Low sodium

☐Low cholesterol

☐Low fat

☐2gm Na

☐No added salt

☐Diabetic diet <obtain> Calories

☐Other [tube feeding, Total Parenteral Nutrition (*TPN*), etc.] <obtain> Other diet

[End Nursing.]

2.9. Venous Thromboembolism (*VTE*) Prophylaxis

[Begin Venous Thromboembolism (*VTE*) Prophylaxis.]

[Section Selection Behavior: Optional.]

[Technical Note: The order below can be linked to the *VTE* prophylaxis *KNART*, if available.]

☐Conduct *VTE* prophylaxis risk screening and order appropriate protocol

[Section Prompt: Notify Clinician for:]

[Section Selection Behavior: Optional. Select all that apply.]

[Technical Note: Default values are specified in square brackets below. The user should be able to override the default values.]

☐Temperature greater than [38.5 degrees Celsius]

☐Systolic blood pressure (*BP*) greater than [170 mmHg]

☐Systolic *BP* lower than [90 mmHg]

☐Diastolic *BP* greater than [110 mmHg]

☐Diastolic *BP* less than [40 mmHg]

☐Heart rate greater than [130 bpm]

☐Heart rate less than [50 bpm]

☐Respiratory rate greater than [24 breaths per minute]

☐Respiratory rate less than [10 breaths per minute]

☐Urine output less than [0.5 mL/kg/hr]

[End Venous Thromboembolism (*VTE*) Prophylaxis.]

2.10. Immunizations

[Begin Immunizations.]

[Section Selection Behavior: Optional. Select all that apply.]

☐Pneumovax

☐Influenza vaccine

[End Immunizations.]

2.11. Laboratory Tests

[Begin Laboratory Tests.]

[Section Selection Behavior: Optional. Select all that apply.]

☐Basic metabolic profile

☐Now

☐Daily

☐Complete metabolic panel

☐Now

☐In am

☐Brain natriuretic peptide

☐Now

☐In am

☐Complete blood count

☐Now

☐In am

☐Fasting lipid profile

☐In am

☐Partial Thromboplastin Time (*PTT*)

☐Now

☐In am

☐Prothrombin Time (*PT*)/International Normalized Ratio (*INR*)

☐Now

☐Daily

☐Liver function testing daily

☐Thyroid Stimulating Hormone (*TSH*)

☐Now

☐In am

☐Troponin I

☐Now

☐q 8 hours x 3

☐Magnesium

☐Now

☐In am

☐Digoxin level

☐Now

☐In am urinalysis

☐Arterial Blood Gas

☐Now

[Section Prompt: Point of Care Tests]

[Section Selection Behavior: Optional. Select all that apply.]

☐Blood glucose every 4 hours

☐Blood glucose now

[End Laboratory Tests.]

2.12. Diagnostic Testing

[Begin Diagnostic Testing.]

[Section Selection Behavior: Optional. Select all that apply.]

☐12-lead electrocardiogram (Dx: heart failure)

☐Now

☐In am

☐X-ray chest (Dx: heart failure)

☐Posterioranterior (*PA*)/Lateral

☐Now

☐In am

☐Portable Anteroposterior (*AP*)

☐Now

☐In am

☐Echocardiogram, transthoracic (*TTE*) (Dx: Heart failure)

☐Now

☐In am

☐Echocardiogram, transesophageal (*TEE*), (Dx: Heart failure)

☐Now

☐In am

☐Thallium Myocardial Perfusion Imaging (*MPI*) viability testing

☐MPI single-photon emission computed tomography (*SPECT*) for the etiology of cardiomyopathy

☐Cardiac magnetic resonance imaging (*MRI*) (with Gd delayed enhancement) for viability/etiology of cardiomyopathy

☐Multigated Acquisition Scan (*MUGA*) to define the Left Ventricular Ejection Fraction (*LVEF*) and/or Right Ventricular Ejection Fraction (*RVEF*)

[End Diagnostic Testing.]

2.13. Oxygen

[Begin Oxygen.]

[Section Selection Behavior: Optional. Select all that apply.]

☐Oxygen therapy per protocol

☐Nasal cannula 2 L/min or <obtain> L/min

☐Titrate to oxygen saturation > 90%

☐Face mask 40% fraction of inspired oxygen (*FiO2*) titrate to oxygen saturation > 90%

☐Nonrebreather face mask 15 L titrate to oxygen saturation > 90%

[End Oxygen.]

2.14. Consults and Referrals

[Begin Consults and Referrals.]

[Section Selection Behavior: Optional. Select all that apply.]

☐Consult cardiology

☐Advanced heart failure service for heart failure management

☐Consult electrophysiology service for consideration of device therapy [(Implantable Cardioverter-Defibrillator (*ICD*), Cardiac Resynchronization Therapy (*CRT*)]

[End Consults and Referrals.]

2.15. Medications

[Begin Medications.]

[Section Selection Behavior: Optional. Select all that apply.]

☐IV Fluid

☐Normal saline (*NS*)

☐Lactated Ringers (*LR*)

☐Dextrose 5%, ½ Normal Saline

☐Other <obtain> *IV* Fluids

☐Aspirin enteric coated, select one of the following:

☐81 mg daily

☐325 mg daily

[Section Prompt: Diuretics]

[Section Selection Behavior: Optional. Select all that apply.]

☐Furosemide specify: <obtain 20-120 mg> solution *IV* bolus

☐Now

☐Every <obtain> hours

☐Bumetanide specify: <obtain 0.5-2 mg> solution *IV* bolus

☐Now

☐Every <obtain> hours

☐Metolazone <obtain 2.5-5 mg> oral daily, 30 minutes prior to loop diuretic dose

[Section Prompt: Potassium Replacement]

[Section Selection Behavior: Optional. Select all that apply.]

☐Potassium replacement per protocol

☐Potassium chloride <obtain 10-20 meq> (max 60 meq) oral

☐Once

☐Daily

☐Bid

[Section Prompt: Angiotensin-Converting Enzyme (ACE-I) Inhibitors [if not on Angiotensin Receptor Blockers (ARBs)]

[Section Selection Behavior: Optional. Select all that apply.]

☐Captopril [initial 6.25-12.5, max 50] mg oral, three times daily (tid)

☐Lisinopril [initial 2.5-5, max 40] mg tablet oral daily hold for symptomatic systolic *BP* < 90

☐Enalapril [initial 2.5, max-20] mg tablet oral daily hold for symptomatic systolic *BP* < 90

[Section Prompt: Angiotensin II Receptor Blockers (ARBs) [if not on ACE-I]]

[Section Selection Behavior: Optional. Select all that apply.]

☐Losartan [initial 25-50, max 150] mg tablet oral daily hold for symptomatic systolic *BP* < 90

☐Valsartan [initial 20- 40, max 160] mg tablet oral two times daily hold for symptomatic systolic *BP* < 90

[Section Prompt: Angiotensin Receptor-Neprilysin Inhibitors (ARNIs)]

[Section Selection Behavior: Optional. Select all that apply.]

☐Valsartan 49 mg/sacubitril 51 mg 1 tablet oral two times daily hold for symptomatic systolic *BP* < 90

[Section Prompt: Beta-Blockers]

☐Metoprolol succinate [initial 12.5-25, max 200] mg tablet oral daily hold for symptomatic systolic *BP* < 90

☐Carvedilol [initial 3.125, max 25] mg tablet oral two times daily hold for symptomatic systolic *BP* < 90

[Section Prompt: Aldosterone Antagonists]

☐Spflironolactone [initial 12.5, max] 25 mg tablet oral daily

☐Eplerenone [initial 25, max 50] mg tablet oral daily

[Section Prompt: Hydralazine/Nitrates]

[Section Selection Behavior: Optional. Select all that apply.]

☐Hydralazine 37.5 mg/ Isosorbide dinitrate 20 mg 1 tablet oral three times daily (tid)

[Section Prompt: Cardiac Glycosides]

[Section Selection Behavior: Optional. Select all that apply.]

☐Digoxin 0.125 micrograms tablet oral daily

[End Medications.]

[End Cardiology: Admission Orders - Heart Failure Order Set.]

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Appendix A. Existing Sample VA Artifacts

All of the figures illustrated below are referenced from the Portland *VAMC*.

Figure A.1. Inpatient Diet Menu

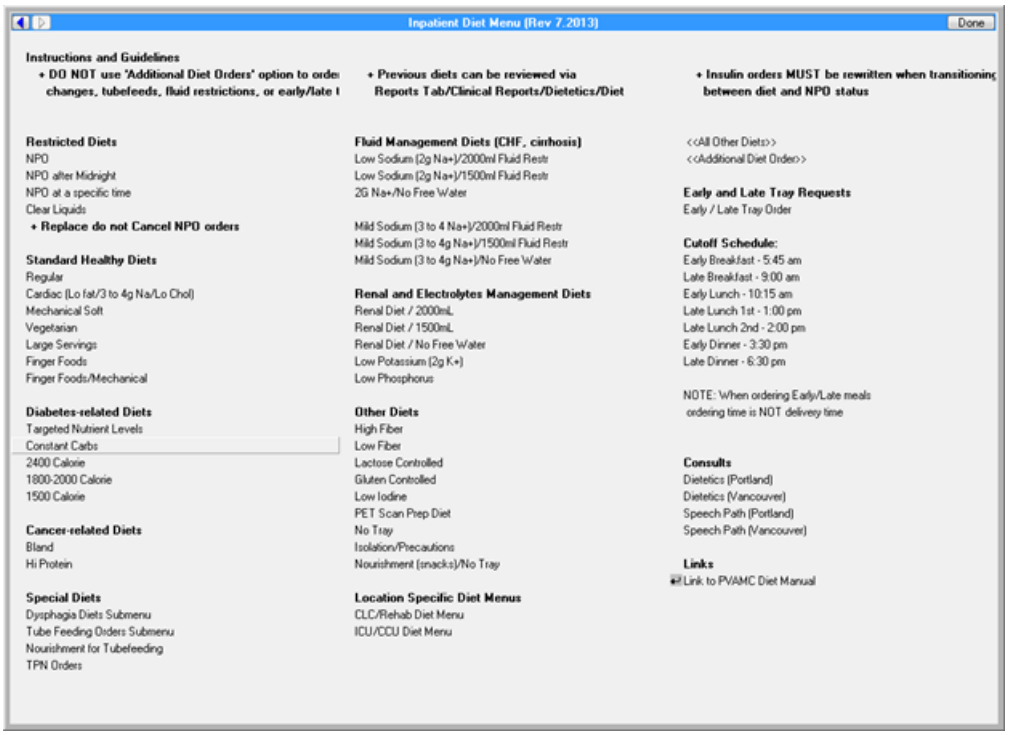


Figure A.2. Congestive Heart Failure (*CHF*) Medications

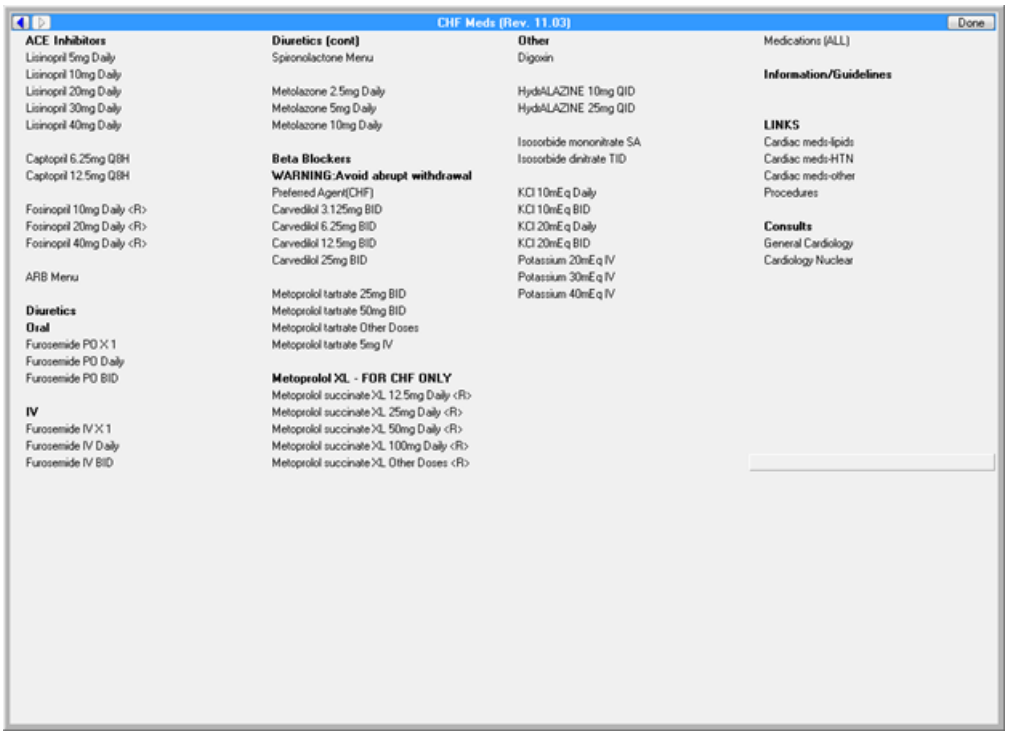


Figure A.3. Angiotensin Receptor Blockers (*ARBs*) Menu

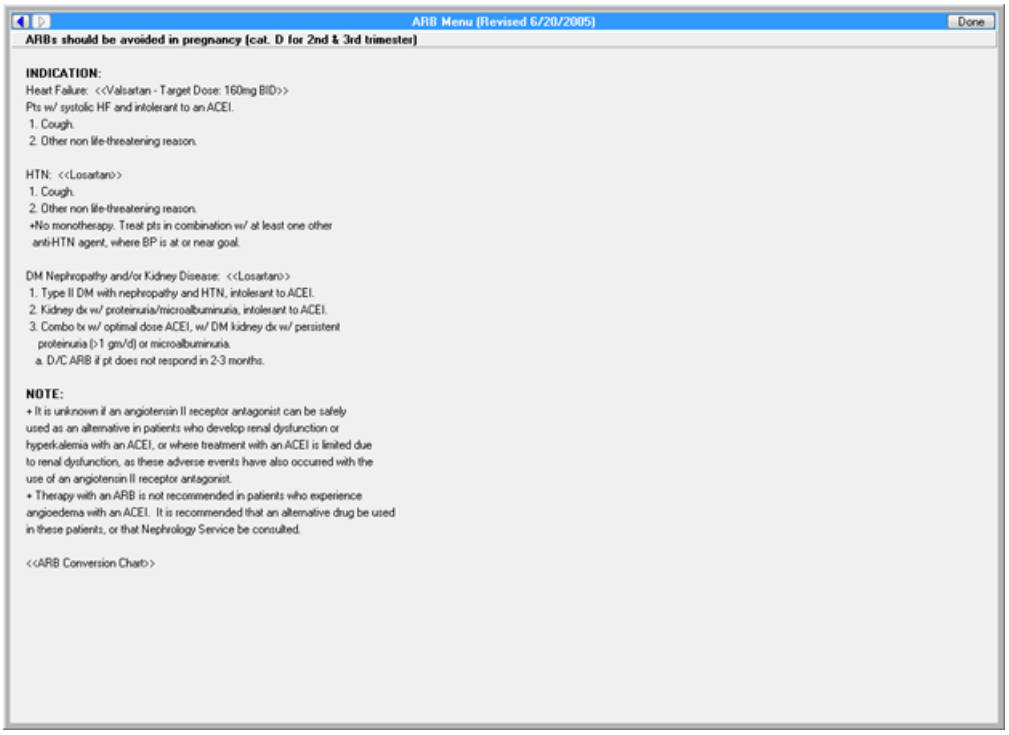


Figure A.4. Angiotensin Receptor Blockers (*ARBs*) Conversion

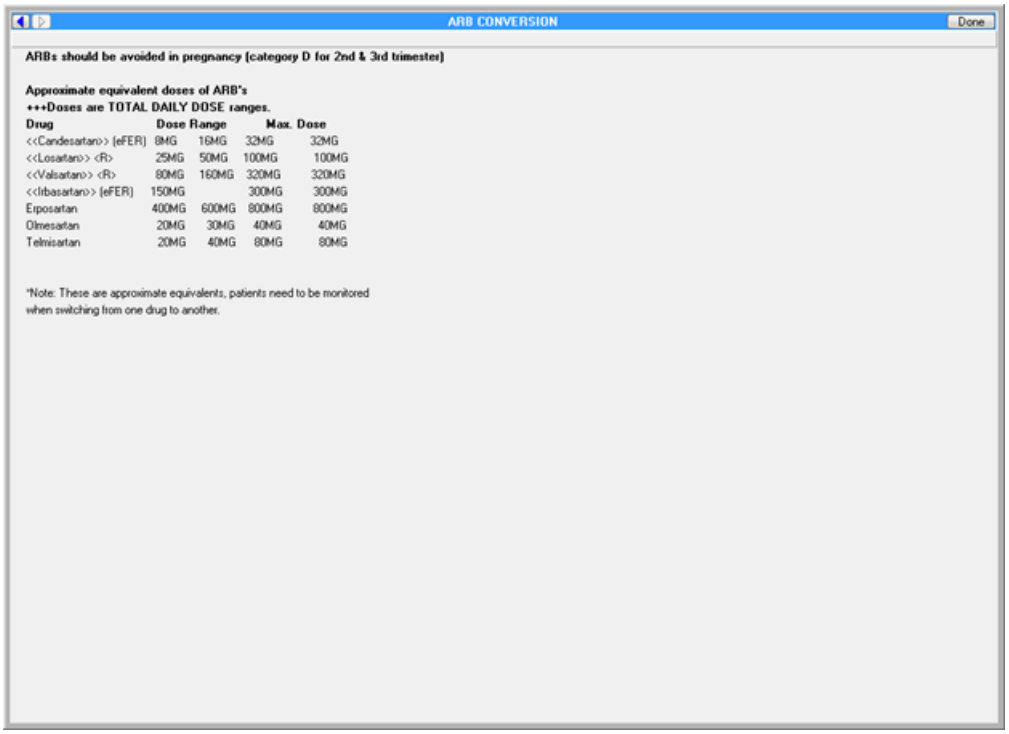


Figure A.5. Digoxin Menu

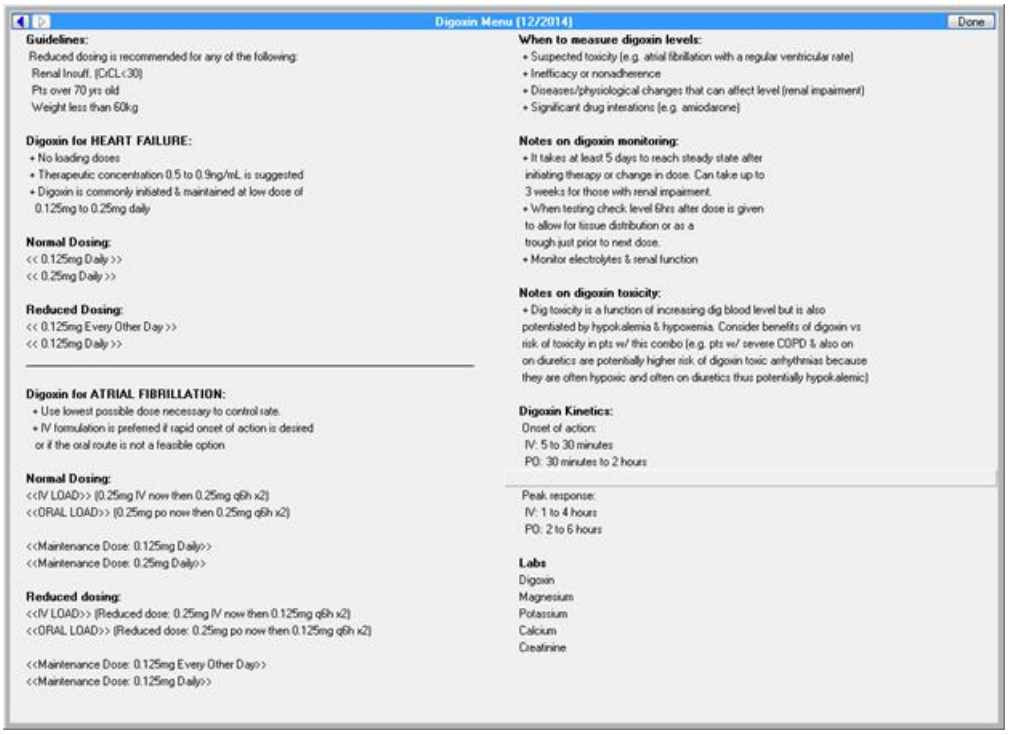


Figure A.6. Spironolactone Information and Orders

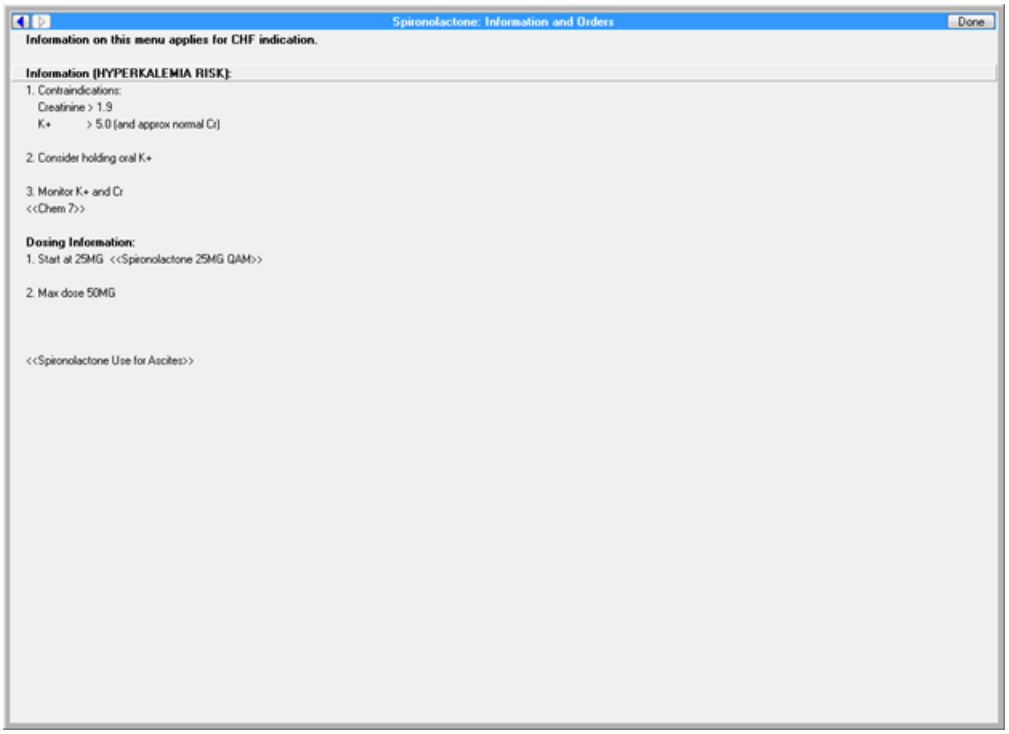


Figure A.7. Inpatient Antilipid Medications

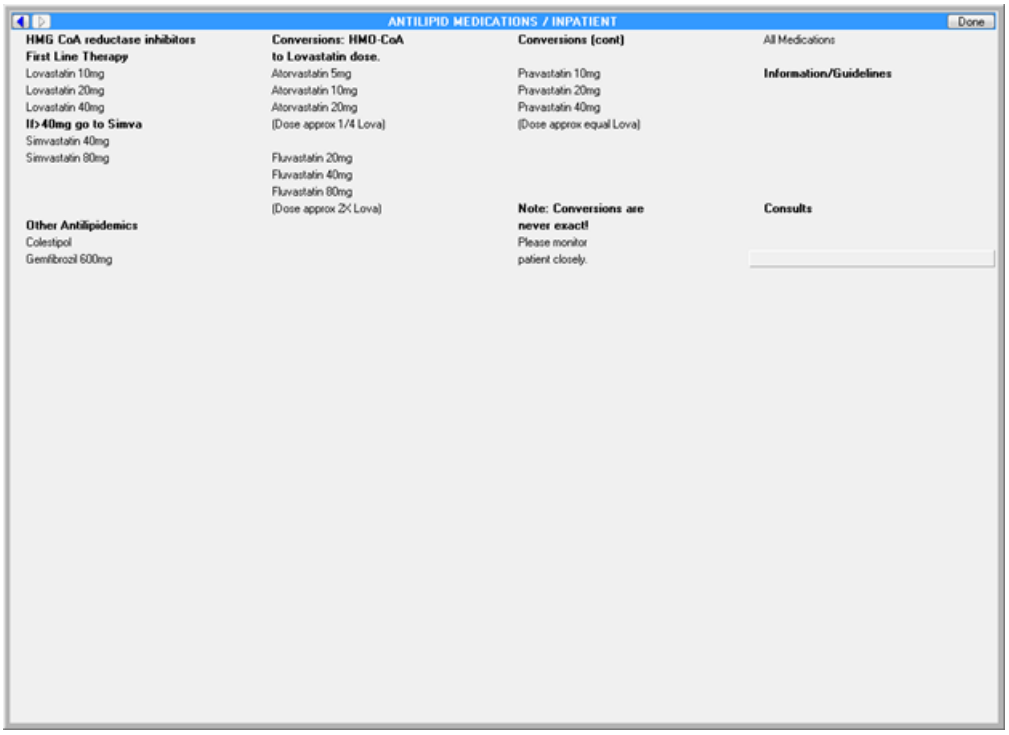


Figure A.8. JNC 7 Heart Failure Recommendations

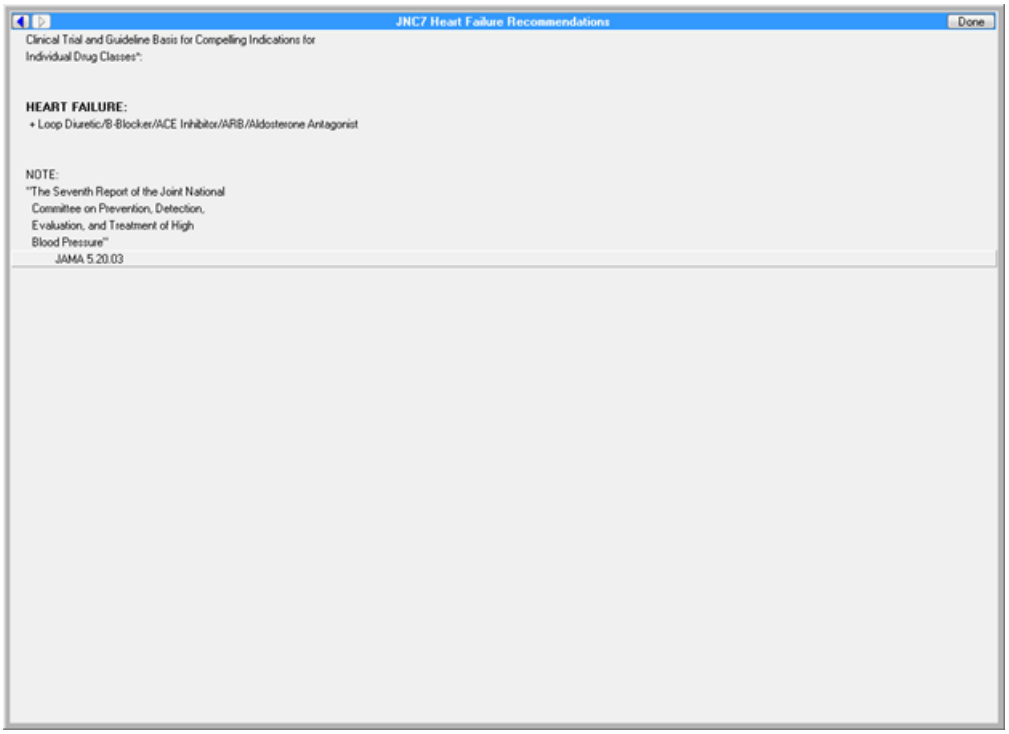
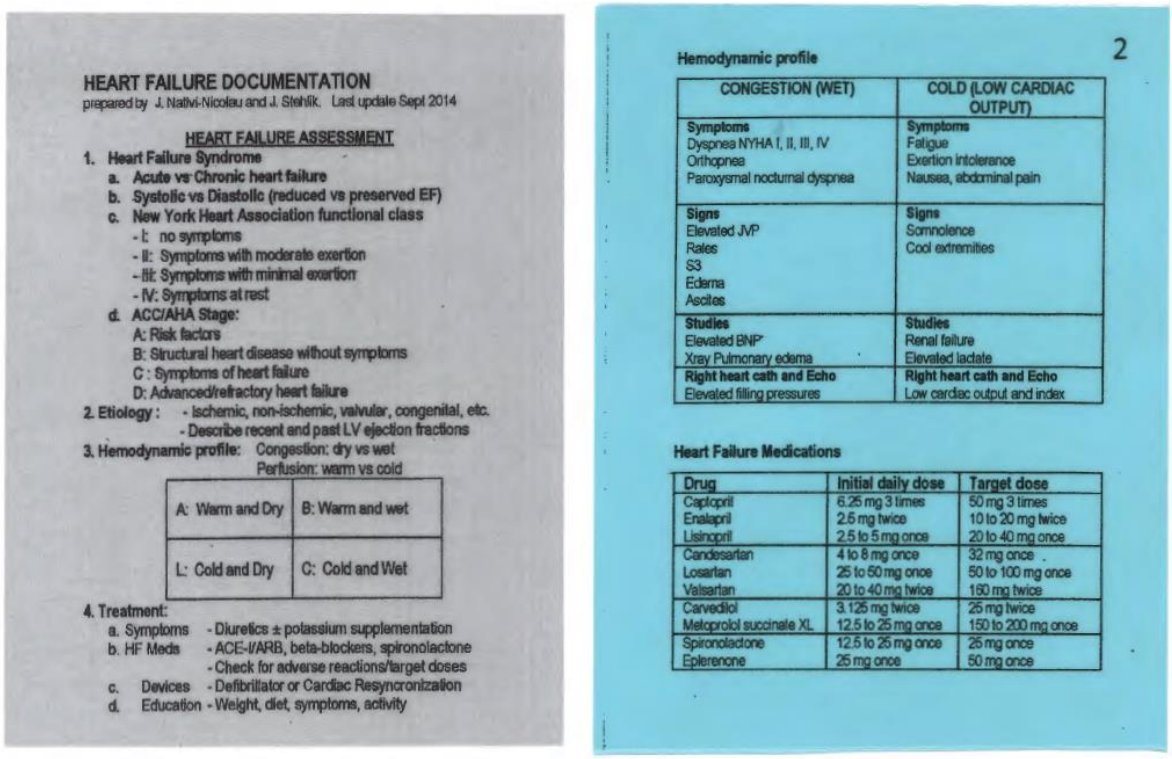


Figure A.9. Heart Failure Documentation



HEART FAILURE DOCUMENTATION

prepared by J. Nativi-Nicolau and J. Stehlik. Last update Sept 2014

HEART FAILURE ASSESSMENT

1. Heart Failure Syndrome
   a. Acute vs Chronic heart failure
   b. Systolic vs Diastolic (reduced vs preserved EF)
   c. New York Heart Association functional class
      - I: no symptoms
      - II: Symptoms with moderate exertion
      - III: Symptoms with minimal exertion
      - IV: Symptoms at rest
   d. ACC/AHA Stage:
      A: Risk factors
      B: Structural heart disease without symptoms
      C : Symptoms of heart failure
      D: Advanced/refractory heart failure
2. Etiology : - Ischemic, non-ischemic, valvular, congenital, etc.
   - Describe recent and past LV ejection fractions
3. Hemodynamic profile: Congestion: dry vs wet
   Perfusion: warm vs cold

A: Warm and Dry	B: Warm and wet
L: Cold and Dry	C: Cold and Wet

4. Treatment:
   a. Symptoms - Diuretics ± potassium supplementation
   b. HF Meds - ACE-I/ARB, beta-blockers, spironolactone
      - Check for adverse reactions/target doses
   c. Devices - Defibrillator or Cardiac Resynchronization
   d. Education - Weight, diet, symptoms, activity

2

Hemodynamic profile

CONGESTION (WET)	COLD (LOW CARDIAC OUTPUT)
Symptoms Dyspnea NYHA I, II, III, IV Orthopnea Paroxysmal nocturnal dyspnea	**Symptoms** Fatigue Exertion intolerance Nausea, abdominal pain
Signs Elevated JVP Rales S3 Edema Ascites	**Signs** Somnolence Cool extremities
Studies Elevated BNP Xray Pulmonary edema	**Studies** Renal failure Elevated lactate
Right heart cath and Echo Elevated filling pressures	**Right heart cath and Echo** Low cardiac output and index

Heart Failure Medications

Drug	Initial daily dose	Target dose
Captopril	6.25 mg 3 times	50 mg 3 times
Enalapril	2.5 mg twice	10 to 20 mg twice
Lisinopril	2.5 to 5 mg once	20 to 40 mg once
Candesartan	4 to 8 mg once	32 mg once
Losartan	25 to 50 mg once	50 to 100 mg once
Valsartan	20 to 40 mg twice	160 mg twice
Carvedilol	3.125 mg twice	25 mg twice
Metoprolol succinate XL	12.5 to 25 mg once	150 to 200 mg once
Spironolactone	12.5 to 25 mg once	25 mg once
Eplerenone	25 mg once	50 mg once

Appendix B. Basic Laboratory Panel Definition

- Blood urea nitrogen
- Calcium
- Chloride
- *CO2* (Carbon dioxide, bicarbonate)
- Creatinine
- Glucose
- Potassium
- Sodium

Acronyms

ACC	American College of Cardiology
ACCF	United States Preventive Task Force
ACE-I	Angiotensin-Converting Enzyme
AHA	American Heart Association
AP	Anteroposterior
ARBs	Angiotensin Receptor Blockers
ARNIs	Angiotensin Receptor-Neprilysin Inhibitors
BP	Blood Pressure
CCWP	Clinical Content White Paper
CDS	Clinical Decision Support
CHF	Congestive Heart Failure
CO2	Carbon Dioxide
CRT	Cardiac Resynchronization Therapy
DNI	Do Not Intubate
DNR	Do Not Resuscitate
ED	Emergency Department
HFSA	Heart Failure Society of America
HL7	Health Level 7
ICD	Implantable Cardioverter-Defibrillator
ICU	Intensive Care Unit
INR	International Normalized Ratio
IV	Intravenous
KBS	Knowledge Based Systems
KNART	Knowledge Artifact
LVEF	Left ventricular ejection fraction
MPI	Myocardial perfusion
MRI	Magnetic Resonance Imaging
MUGA	Multigated acquisition scan
NPO	Nothing by mouth
OIIG	Office of Informatics and Information Governance
PA	Posterioranterior

PT	Prothrombin Time
PTT	Partial Thromboplastin Time
RVEF	Right ventricular ejection fraction
SPECT	Single-photon emission computed tomography
TEE	Transesophageal
TO	Task Order
TSH	Thyroid Stimulating Hormones
TTE	Transthoracic
VA	Department of Veteran Affairs
VAMC	VA Medical Center
VTE	Venous Thromboembolism