ED Acute heart failure risk prediction and decision support in HealthConnect

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CREST Network

Fall 2023

Agenda

Explain **the why** behind KPNC ED HF risk tool and decision support

Explain **how to access** risk tool and use information (goal: help you out)

Share data from recent East Bay **pilot study**

Discuss study **timeline and goals**

HF Background and the role of the ED

- > 1 million ED visits / year for acute heart failure (HF), 80% admitted
  - 20% readmitted within 30-days
- HF hospitalizations, readmissions, age-adjusted mortality and costs going up
- Complex and high-risk population
  - 30-day mortality rates among discharged patients - 2.6% to 4%
- Approximately 10,000 ED visits / year for AHF in KPNC
  - Large variation in admission rates and patient outcomes across centers

The Why: Significant mis-match between risk category and admission decision for HF patients

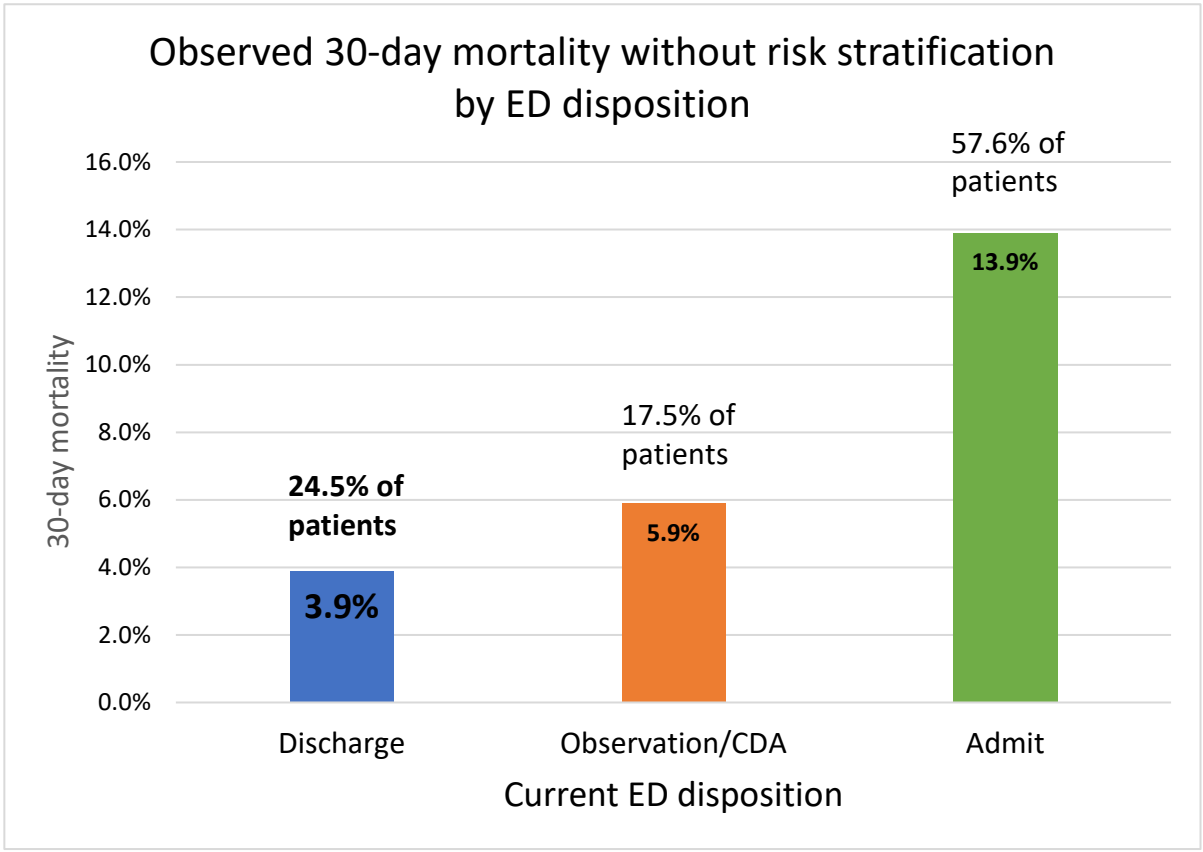
Risk strata	30-day risk of SAE in strata	N of study population (%)	Discharged home N= 6,424	Admit to CDA then dc home N= 4,592	Admitted to hospital N= 15,078
Very Low risk	<1%	33 (0.1%)	63.6%	12.1%	24.2%
Low risk	1% - 3%	2,893 (11.1%)	53.7%	18.3%	28.0%
Moderate risk	3.1% - 5%	3,809 (14.5%)	41.7%	20.6%	37.7%
High / moderate risk	5.1% - 10%	6,069 (23.2%)	29.8%	21.2%	49.0%
High risk	10.1% - 20%	5,541 (21.2%)	17.9%	19.2%	62.8%
Very high risk	>20%	7,844 (30.0%)	5.9%	11.8%	81.2%

Frequent admissions of low-risk patients

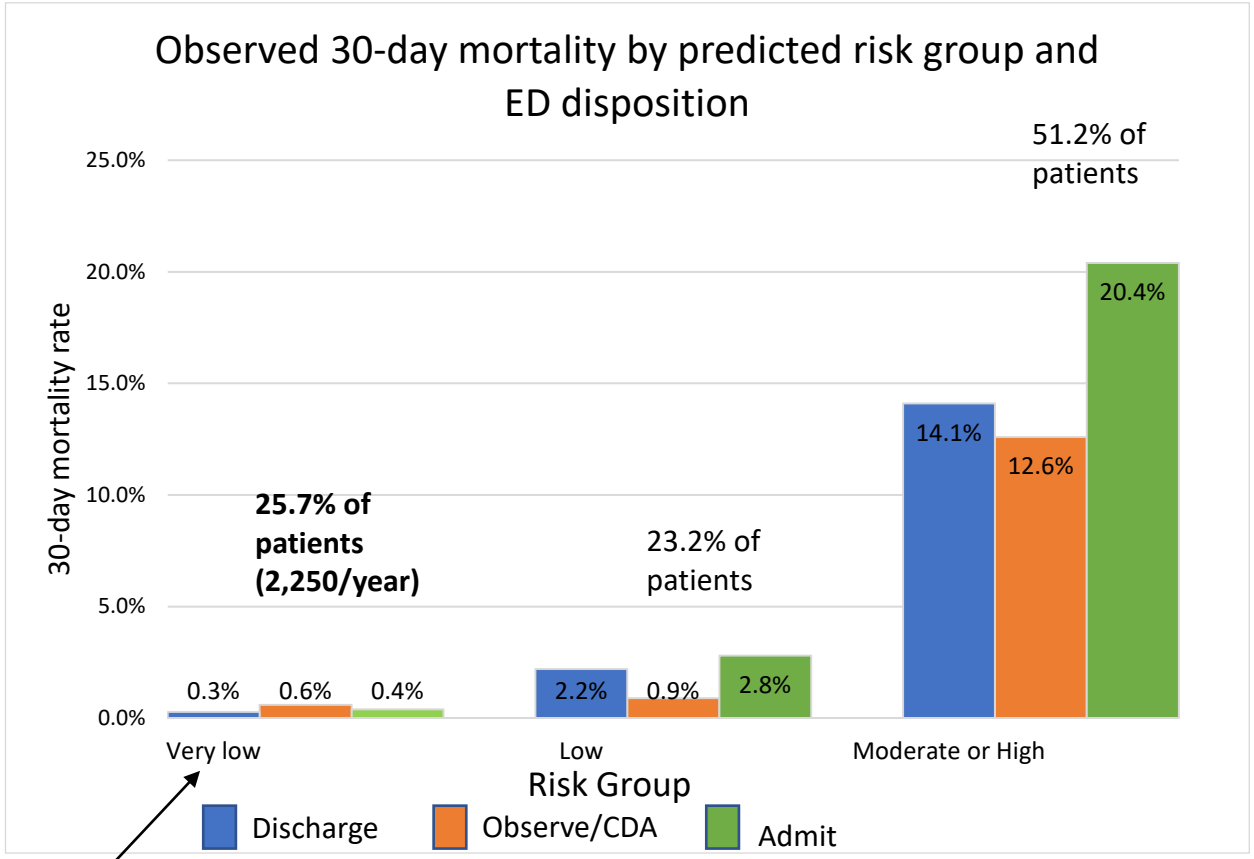
Frequent discharges of high-risk patients

Sax DR, Rana JS, Mark DM et al. Use of machine learning to develop a risk-stratification tool for emergency department patients with acute heart failure. *Ann Emerg Med*. 2021 Feb.

Current state clinical outcomes by ED Disposition



Future state with risk tool guiding admission decisions

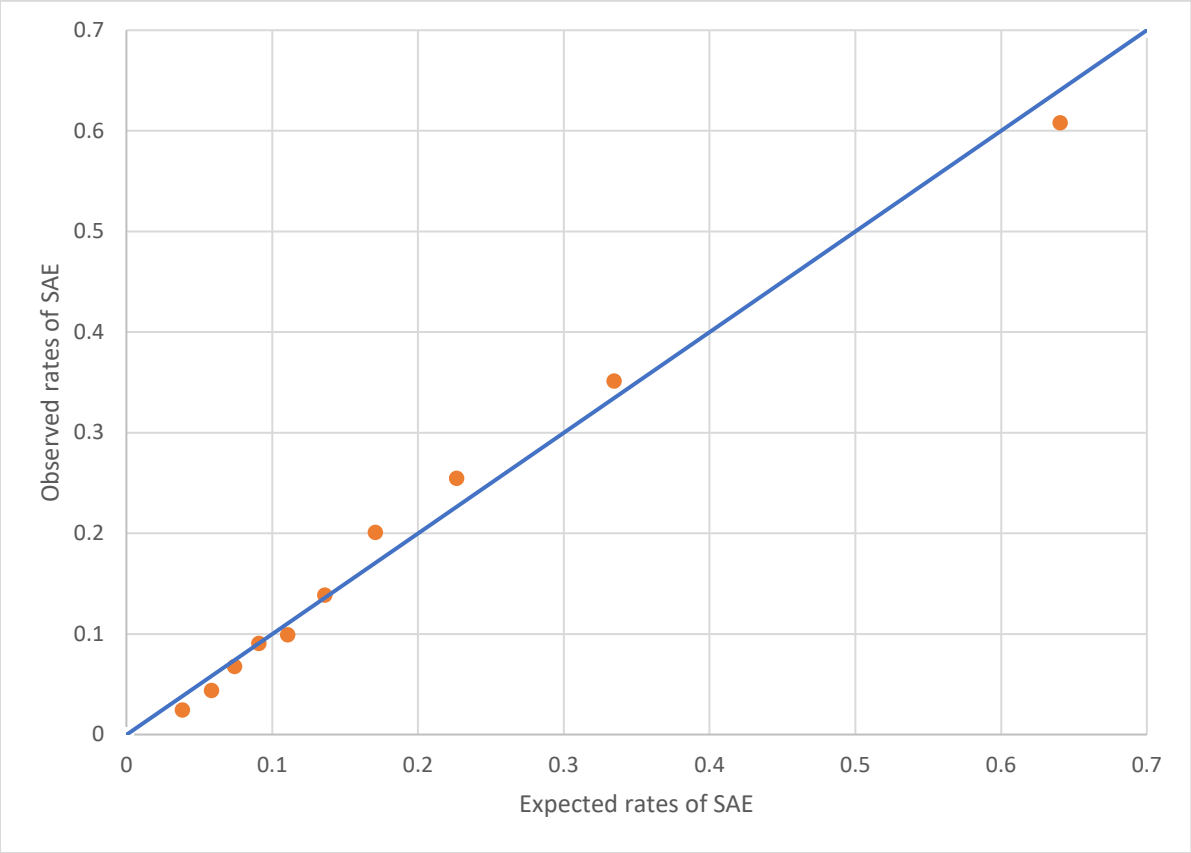


No mortality benefit of hospital admission in very low risk patients

1,135 patients per year who currently are admitted but *could be eligible for discharge*

Developed and validated KPNC ED AHF risk prediction tool using over 18,000 KPNC ED patient encounters

Calibration curve: Observed vs expected rates of SAE



- Sax DR et al, Annals of Emergency Medicine, 2021
- Model uses 60+ variables to predict risk of serious adverse event at 30 days

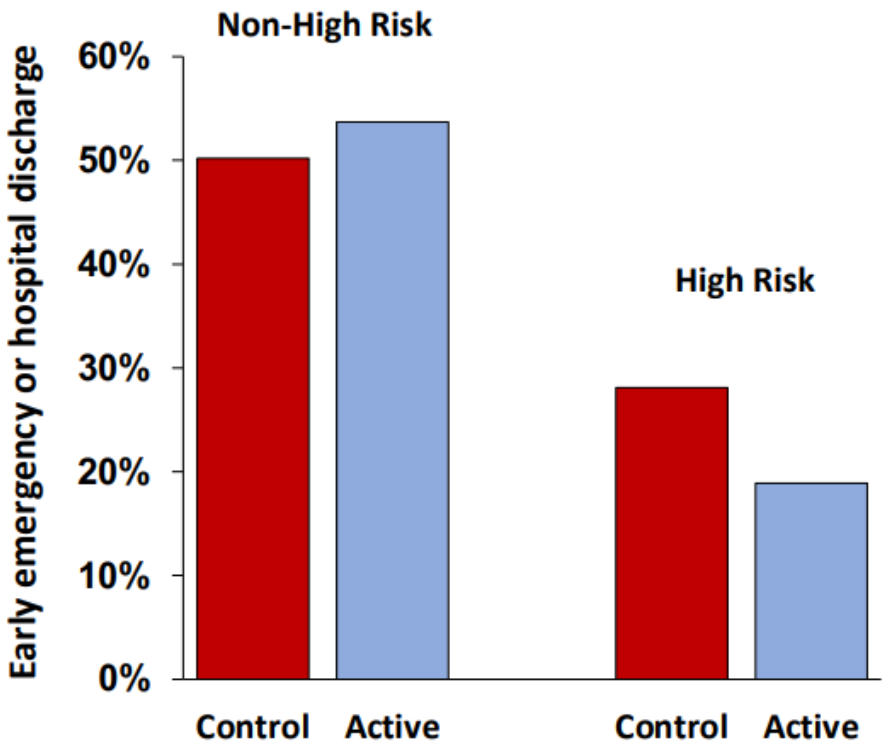
AUC for various models

Model	AUC (95% confidence interval)
Logistic regression	0.80 (0.79 – 0.82)
LASSO	0.80 (0.79 – 0.82)
Decision Tree	0.65 (0.64 – 0.67)
Random forest	0.83 (0.82 – 0.85)
XGBoost	**0.85 (0.83 – 0.86)**

Risk model has very good accuracy

Recent NEJM Article: Use of point of care HF risk tool to guide admission decision across 10 Canadian EDs lowered admissions, saved lives

Early discharge by risk group



Outcome	Intervention (N=2480)	Control (N=2972)	Adjusted Hazard Ratio (95% CI)	P Value
Primary outcome				
Composite of death from any cause or hospitalization for cardiovascular causes — no. (%)	301 (12.1)	430 (14.5)	0.88 (0.78–0.99)	0.04
Secondary outcomes				
Hospitalization for cardiovascular causes — no./total no. (%)	190/2343 (8.1)	294/2775 (10.6)	0.85 (0.74–0.98)	—
Hospitalization for heart failure — no./total no. (%)	142/2343 (6.1)	222/2775 (8.0)	0.81 (0.69–0.95)	—
Death from any cause — no. (%)	147 (5.9)	196 (6.6)	0.94 (0.74–1.19)	—
Composite of emergency department visit, death from any cause, or hospitalization for cardiovascular causes — no. (%)	687 (27.7)	851 (28.6)	0.97 (0.85–1.11)	—

Decrease admission of lower risk patients, increase admission of higher risk patients → 12% lower rate 30day mortality or hospitalization

East Bay ED physician pre-implementation survey: What would be most helpful for HF decision support?

Figure 1: Areas where clinical decision support requested:

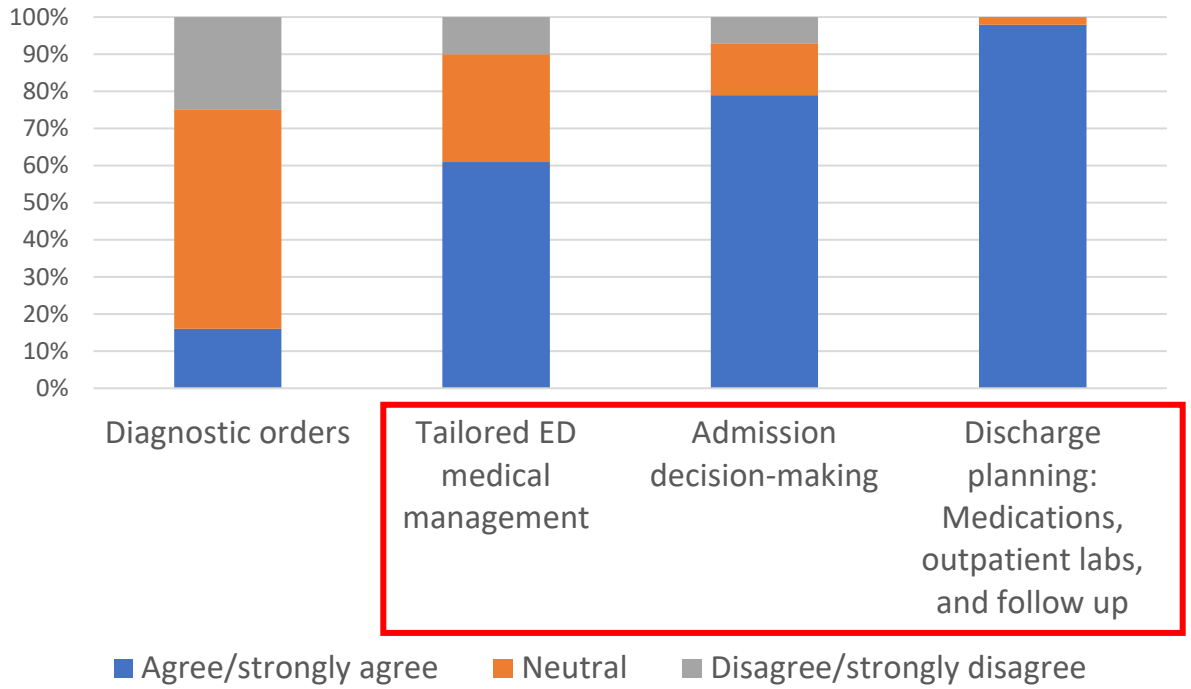
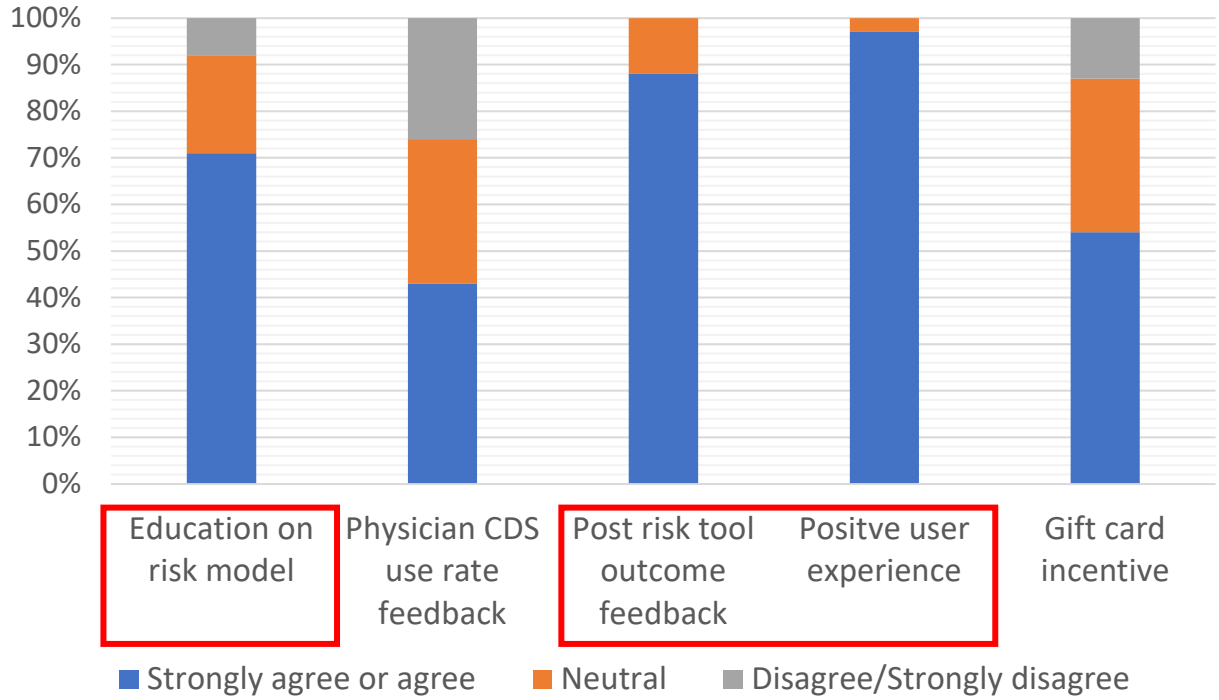


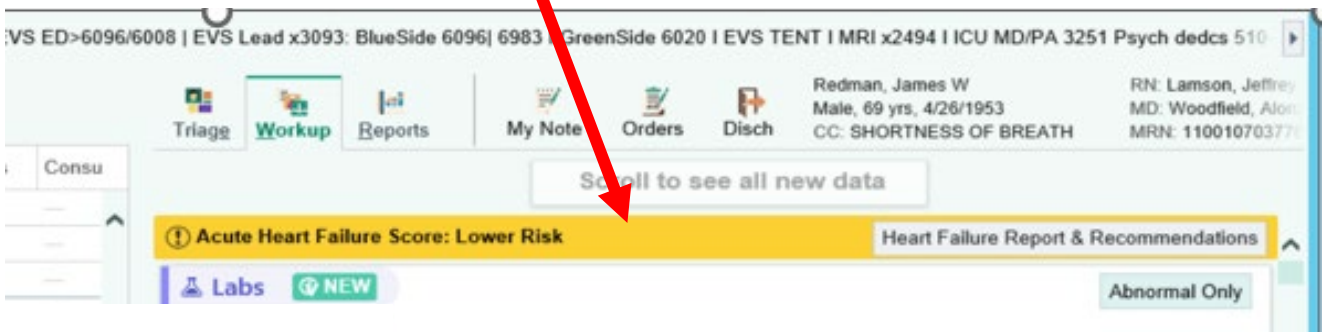
Figure 2: Opportunities to increase use of risk tool and decision support



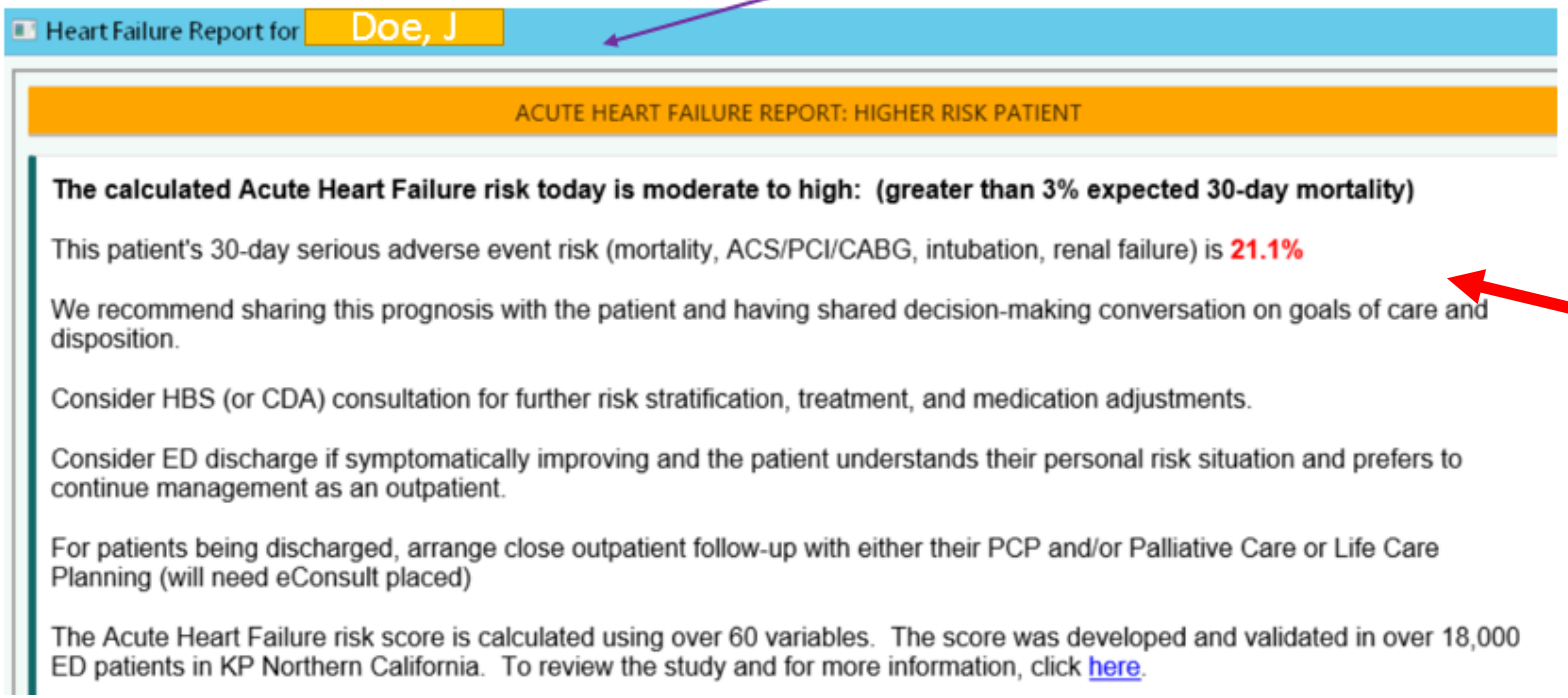
AHF Banner: Flags patients in ED with likely decompensated heart failure – cues ED doc to use risk tool and decision support

AHF Report: Useful, collated clinical history and personalized recommendations in one place

AHF Banner

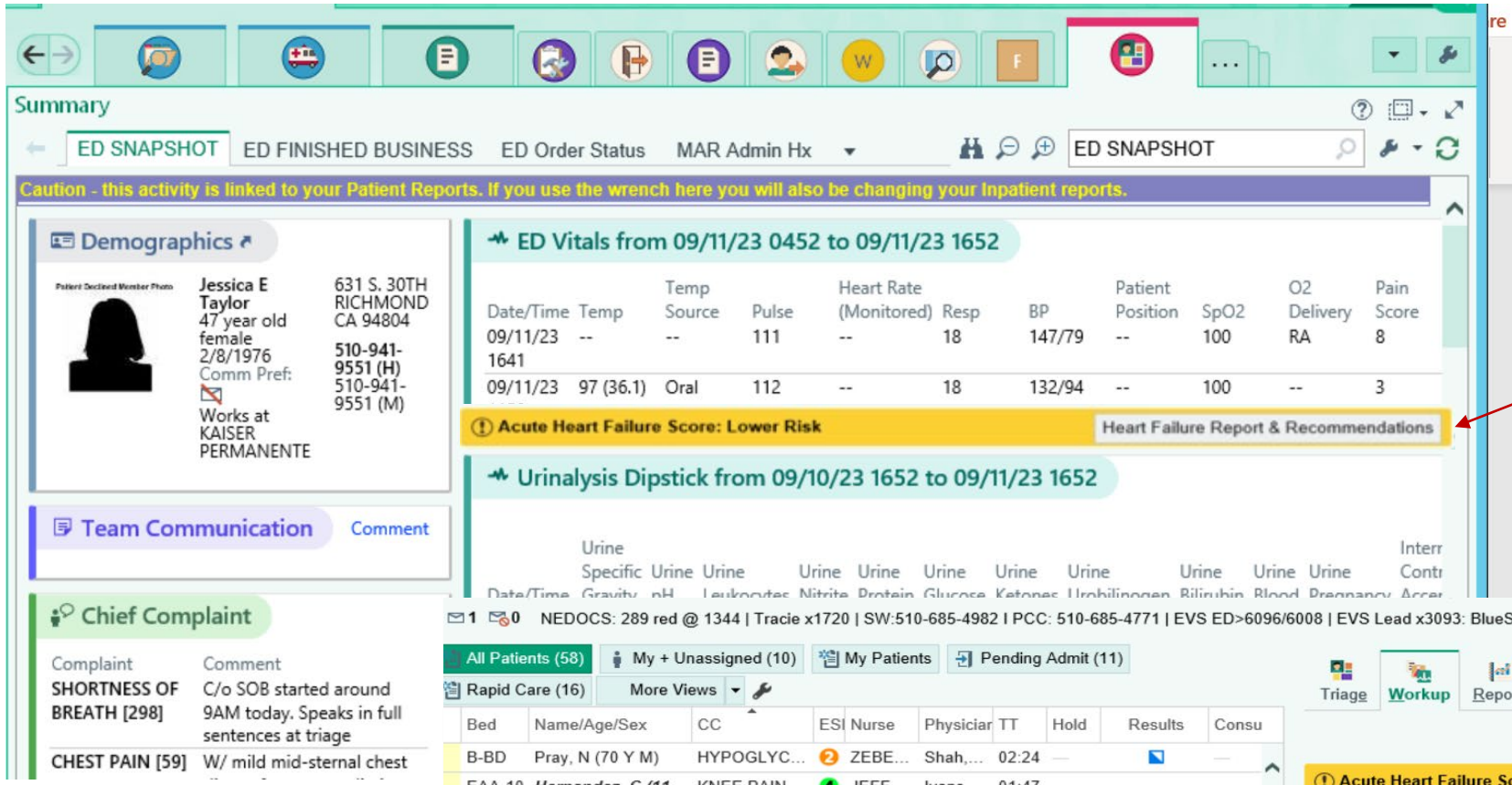


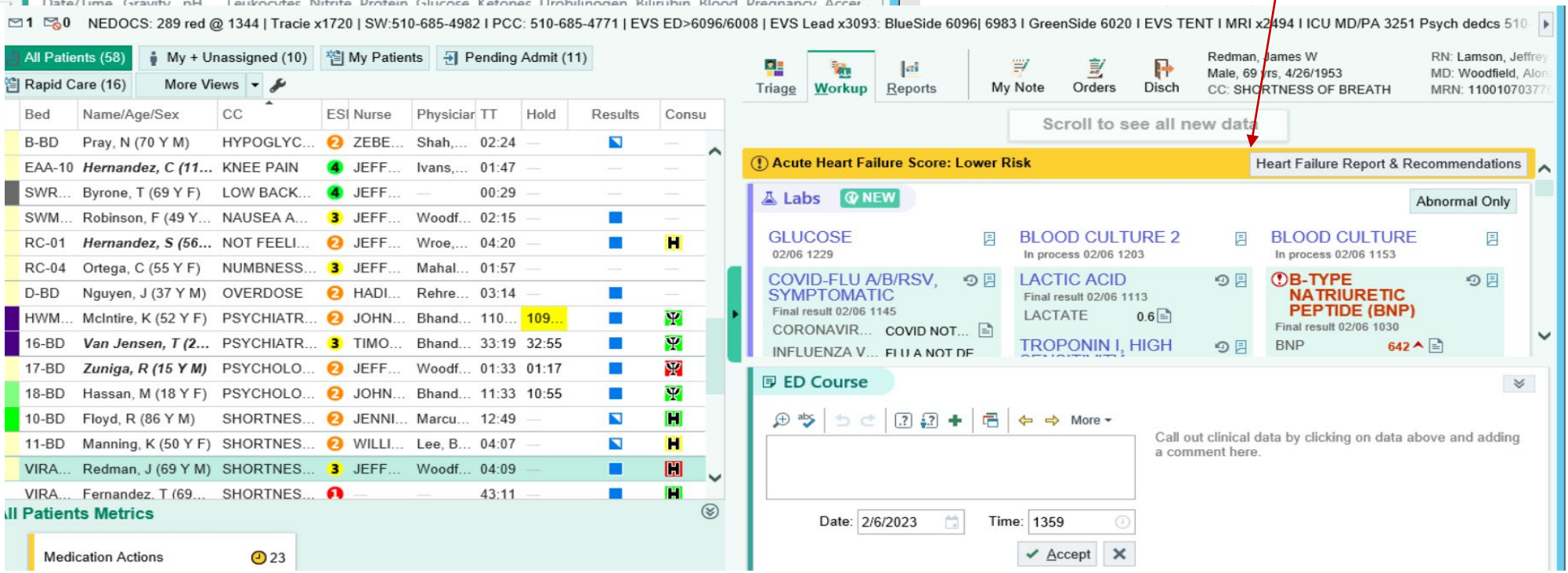
Heart Failure **Report** (access by clicking on HF Banner)



Click on Banner to access **Heart Failure Report**, includes:

- 30-day risk estimate
- Admission guidance
- Relevant cardiac history
- Medication recommendations

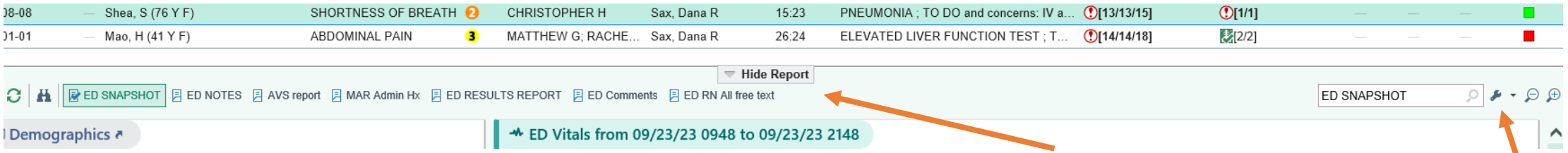


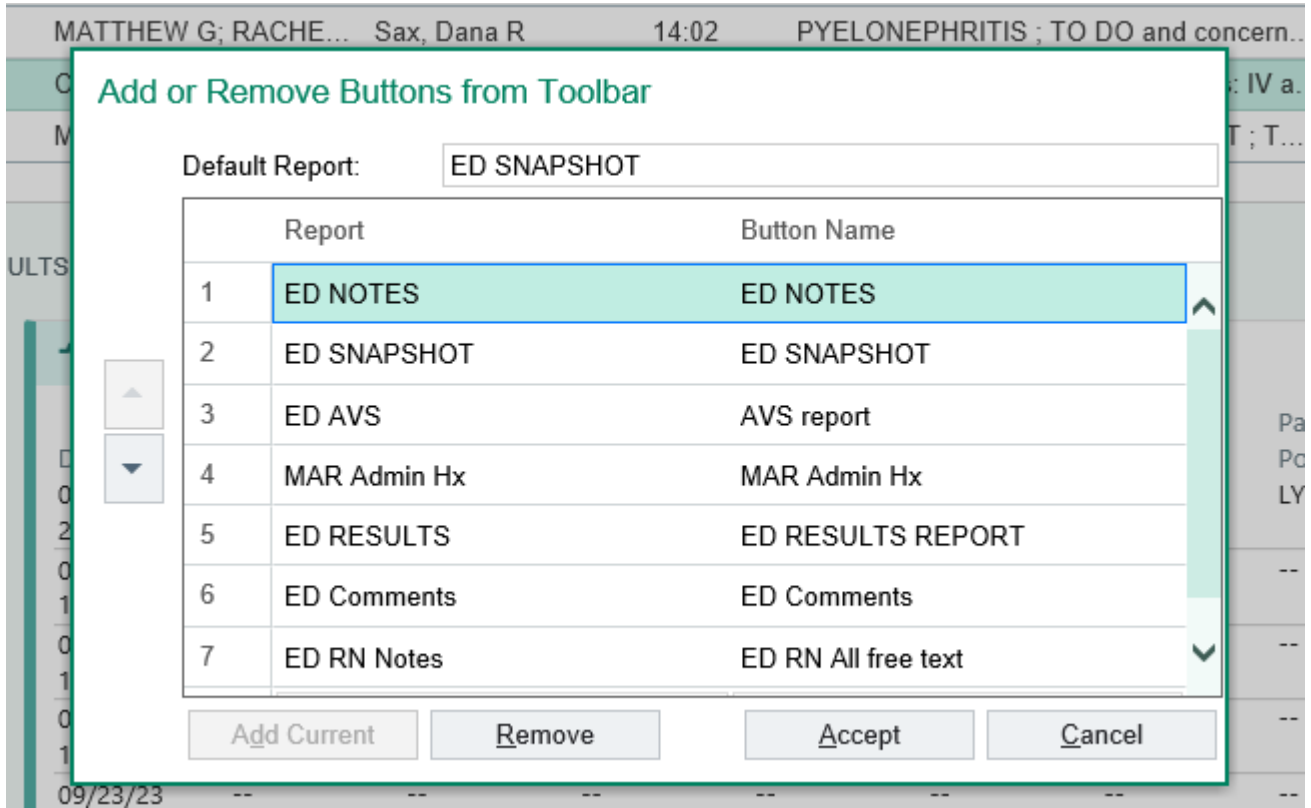


For eligible patients, you will see “HF Banner” in Workup Tab and in ED Snapshot

Banner appears if patient has h/o HF *and* presents with relevant chief complaint (SOB or edema)

Accessing Report for patients without a Banner





"Wrench" in the Acute Heart Failure Report

Heart Failure Report for Bolton,Roberta

ACUTE HEART FAILURE REPORT: HIGHER RISK PATIENT

Click on Banner to Access "Heart Failure Report"

Tailored risk information:

Patient's risk class: Medium/High

Patient's 30-day severe adverse event risk estimate: 28%

Click here for more information on risk score (developed on 18,000+ KPNC ED patients)

Consider HBS consult for further risk stratification, medication management

Tailored medication recommendations based on EF and allergy list:

Most recent Ejection fraction: 38%

OUTPATIENT LOOP DIURETIC MEDICATIONS

Diuretic - Loop	Disp	Start	End
Furosemide (LASIX) 20 mg Oral Tab Sig - Route: Take 20 mg by mouth daily - Oral Class: Historical Med		4/11/2023	4/10/2024

Recommended initial Diuretic Dose: 40mg IV

If initial diuretic dose does not produce diuretic response in 1-2 hours, consider repeating with higher dose.

Diuretic Conversion Table

	Furosemide	Torsemide	Bumetanide
Relative intravenous potency (mg)	40	20	1
Oral : intravenous dosing	1 : 2	1 : 1	1 : 1
Bioavailability (%)	10–100	80–100	80–100
Drug half-life (h)	1.5–2.0	3–4	1.0–1.5
Duration of effect (h)	6–8	6–16	4–6

- HF Report provides:
  - Risk class
  - Dispo recs
  - Personalized medication recs
  - Other useful clinical data for "one stop shopping"

Guideline directed medical therapy (Level 1a AHA/ACC Recommendations) if Ejection Fraction < 45%

This patient's current outpatient medications:

OUTPATIENT CARDIAC MEDICATIONS

ACE Inhibitors	Disp	Start	End
Lisinopril (PRINIVIL/ZESTRIL) 20 mg Oral Tab Sig - Route: Take 20 mg by mouth daily - Oral Class: Historical Med			

Beta Blockers Cardiac Selective	Disp	Start	End
Metoprolol Succinate (TOPROL XL) 100 mg Oral 24hr SR Tab Sig - Route: Take 100 mg by mouth daily - Oral Class: Historical Med		4/11/2023	4/10/2024

Optimal medical therapy based on patient's EF

Patient's listed allergies:

ALLERGIES
Amoxicillin, Penicillins Class

This patient is not yet on:

- Mineralocorticoid receptor agonist (e.g. Spironolactone)
- Sodium-Glucose Co-transporter 2 inhibitor medication (SGLT2i; e.g. Jardiance)

Medication recommendations (Level 1A) to reduce mortality and re-hospitalizations in your patient:

- Jardiance; Starting dose is ½ tab of 25mg (12.5mg qd)
- Spironolactone; Starting dose is 12.5mg qd (order outpatient Cr and K in 3-5 days)

Guideline directed medical therapy (Level 1a AHA/ACC Recommendations) if Ejection Fraction > 45%

Current medications:

Beta Blockers Cardiac Selective	Disp	Start	End
Metoprolol Succinate (TOPROL XL) 100 mg Oral 24hr SR Tab		4/11/2023	4/10/2024
Sig - Route: Take 100 mg by mouth daily - Oral			
Class: Historical Med			

Diuretic - Thiazides and Related	Disp	Start	End
hydroCHLOROthiazide (ESIDRIX/HYDRODIURIL) 25 mg Oral Tab	100 tablet	3/6/2023	3/5/2025
Sig - Route: Take 1 tablet by mouth daily - Oral			
Class: zRefill-Pharmacy Use Only			

ALLERGIES
Dye

This patient is not yet on and has no allergies to:

- Sodium-Glucose Co-transporter 2 inhibitor medication (SGLT2i; e.g. Jardiance)
- Mineralocorticoid receptor agonist (MRA; e.g. Spironolactone)
- Angiotensin receptor blocker (ARB, e.g. Losartan).

Level 2 AHA / ACC and Level 1 ESC recommendations for your patient (consider starting in step-wise fashion):

- Optimize blood pressure and heart rate control (if a fib) – Level 2a
- Jardiance - Starting dose is ½ tab of 25mg (12.5mg qd) – Level 1a (ESC Guideline)
- Losartan – Starting dose is 25mg daily - Level 2b
- Spironolactone - Starting dose is 12.5mg qd (order outpatient Cr and K in 3-5 days) - Level 2b

Report also has a lot of other useful clinical info for you to access in one place:

Weight Readings

	1/18/2023 1047	1/25/2023 1024	1/27/2023 1217
Weight:	50 kg (110 lb 3.7 oz)	47.2 kg (104 lb)	51.8 kg (114 lb 3.2 oz)
Scale Type:	STANDING	—	STANDING

Weights from prior 12 months

Brief Vitals (last day)

Date/Time	Temp	Pulse	Resp	BP	FiO2 (%)	O2 Delivery	O2 (LPM)	SpO2	Weight	Who
01/27/23 1218	97.4 °F (36.3 °C)	89	25	123/67	—	—	—	100 %	—	JS
01/27/23 1217	—	—	—	—	—	—	—	—	51.8 kg (114 lb 3.2 oz)	JS

Today's VS

Cardiac Rhythm (last day)

None

Cardiac Studies (Last 5 Years)

Date	Order Name	Status	Specimen ID
12/16/2022 5:47 PM	TRANSTHORACIC ECHO (TTE) COMPLETE CARD, CV	Final	11804293121

EKG Results

Date	Order Name	Sensitivity	Status	Description	Specimen ID	Source
1/27/2023 12:25 PM	EKG 12 OR MORE LEADS W INT & RPT		Preliminary		MUSENCA14228249	
1/18/2023	EKG 12 OR MORE LEADS W		Final		MUSENCA14201623	

5 most recent EKGs

Recent Lab Studies

	1/25/2023 12:27 PM	1/18/2023 11:42 AM	1/18/2023 11:33 AM	1/17/2023 10:41 AM	1/9/2023 11:18 AM	1/5/2023 10:23 AM	12/29/2022 2:02 PM	12/22/2022 10:37 AM	12/20/2022 12:18 PM	12/18/2022 11:25 AM	12/18/2022 6:13 AM	12/17/2022 3:44 AM	12/16/2022 3:49 PM	12/16/2022 10:22 AM	10 12
TROP	—	—	—	—	—	—	—	—	—	20 ^	—	—	25 ^	—	—
BNP	—	—	—	—	—	—	—	—	—	—	—	1,582 ^	—	1,399 ^	—
K	5.3	4.9	4.6	6.3 !!	4.6	5.5 ^	5.4 ^	5.1	5.5 ^	—	4.1	3.4 v	3.8	4.5	—
CR	0.90	—	0.80	1.25 ^	0.85	0.96	0.93	0.82	1.18 ^	—	0.93	0.62	0.67	0.86	0.7

Recent ED/IP Visits

2 days ago	RCHLAB	HEART FAILURE W REDUCED LVEF 41-49%, UNSPECIFIED ACUITY ..., Lab
1 week ago	Misa, Nana Yaa Yeboah (M.D.); Vah..., RCHED	ABNL LABORATORY FINDING ..., ED (Discharge)
1 week ago	RCHLAB	HEART FAILURE W REDUCED LVEF 41-49%, UNSPECIFIED ACUITY ..., Lab
2 weeks ago	RCHLAB	HEART FAILURE W REDUCED LVEF 41-49%, UNSPECIFIED ACUITY ..., Lab

Discharge Recommendations

- Please ensure all patients with EF < 45% enrolled in **CCM HF program** (eConsult)
- If patient not back to dry weight, consider adding a note in their diuretic discharge order to double their usual diuretic dose for 3 days, then go back to their baseline dose.
- AVS: Please include (copy and paste) the "Stoplight" or "Heart Failure Zone Tool" into the AVS for home care.
- Please route your note to the patient's cardiologist and/or PCP as applicable. When applicable also include their Heart Failure Transitions Nurse.

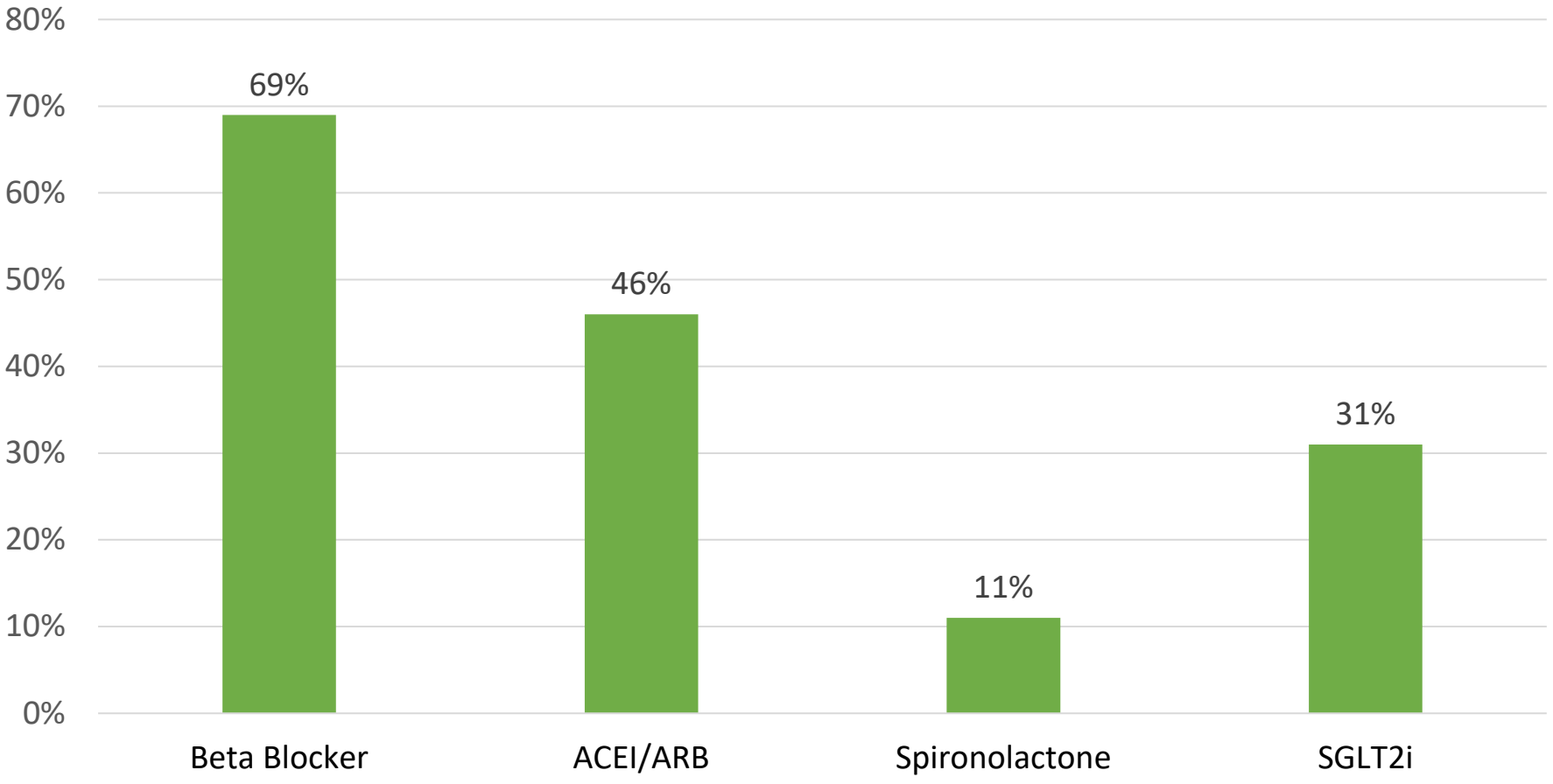
East Bay Pilot study: Jan-Mar 2023

- Trained all East Bay ED and CDA physicians prior to launch
- 297 eligible patients in 11 weeks (3-4 patients/day)
- Disposition: 25% Discharged, 7% observed, 68% admitted

East Bay pilot study goals

- Technical feasibility ✓
  - Scores calculated at right time for right patients, presented in timely manner
- Safety of low-risk discharges ✓
  - Among patients identified as low risk and discharged home:
    - No adverse events, 7-day ED visits, or hospitalizations
- Usability and acceptability of risk tool and HF report
  - >90% agreed 30-day risk estimate easy to understand, clinical info presented in report is practical/actionable
  - > 90% agreed use of report has potential to save time, improve patient outcomes, improve cross-specialty communication, and standardize care
- Guideline concordant medical care

Adherence to Guideline Directed Medical Therapy among East Bay ED patients with HFrEF in East Bay pilot study



- Room for improvement
- 70% of surveyed docs open to starting meds based on report's recommendations
- Many providers who viewed report added these recommendations to their note; some started medications among low-risk patients going home.

SGLT2 inhibitors- Empagliflozin (Jardiance)

- We are familiar with BB and ACEI… what about SGLT2i and Spironolactone???
- Mechanism: Inhibit SGLT-2 in the proximal renal tubules → excrete more glucose, sodium, and water
- Recommended for HF patients across EF spectrum
- Notable Adverse Drug reactions: euglycemic DKA, increased GU infections
  - Generally very safe and well tolerated
- When to avoid:
  - Anyone with eGFR <20 ml/min/1.73m^2
  - Anyone with recurrent UTIs
  - Type I DM
- Start with ½ tab 25mg (12.5mg)

MRAs- Spironolactone

- Mechanism: Compete with aldosterone in distal renal tubules → excrete more NaCl and water
- Notable adverse reactions: hyperkalemia, hypotension
- When to avoid:
  - Men with serum creatinine >2.5 mg/dL
  - Women with serum creatinine >2 mg/dL
  - Anyone with eGFR <30 ml/min/1.73m^2
  - Anyone with K >5.0 mEq/L

Why do these two drugs matter?

- Both spironolactone and empagliflozin reduce risk of hospitalization and death
- Both are recommended by AHA guidelines
- Optimizing the 4 pillars of HFrEF therapy adds years of life compared to ACEi/BB dual therapy:
  - 55-year-old: +6.3 years
  - 65-year-old: +4.4 years
  - 80-year-old: +1.4 years

Vaduganathan M, et al. Estimating lifetime benefits of comprehensive disease-modifying pharmacological therapies in patients with heart failure with reduced ejection fraction: a comparative analysis of three randomised controlled trials. Lancet. 2020 Jul 11;396(10244):121-128.

Next steps

September – November 2023: Education sessions for all KPNC ED and HBS groups on risk tool and HF Report

Late 2023: All ED and HBS physicians will have access to risk tool and HF Report

Early 2024: Further upgrades to HF Report: more personalized med recommendations, place directly orders from HF Report

Plan **18-month study** to evaluate impact of risk tool and HF Report on admission decision-making and 30-day patient outcomes

Thank you

Follow up questions – dana.r.sax@kp.org

Collaborators and study team:

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