

The **Surg-e-Screener HF** Tool: *Improving Heart Failure Recognition using Electronic Health Records*

e-Learning Module

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MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN



The Problem



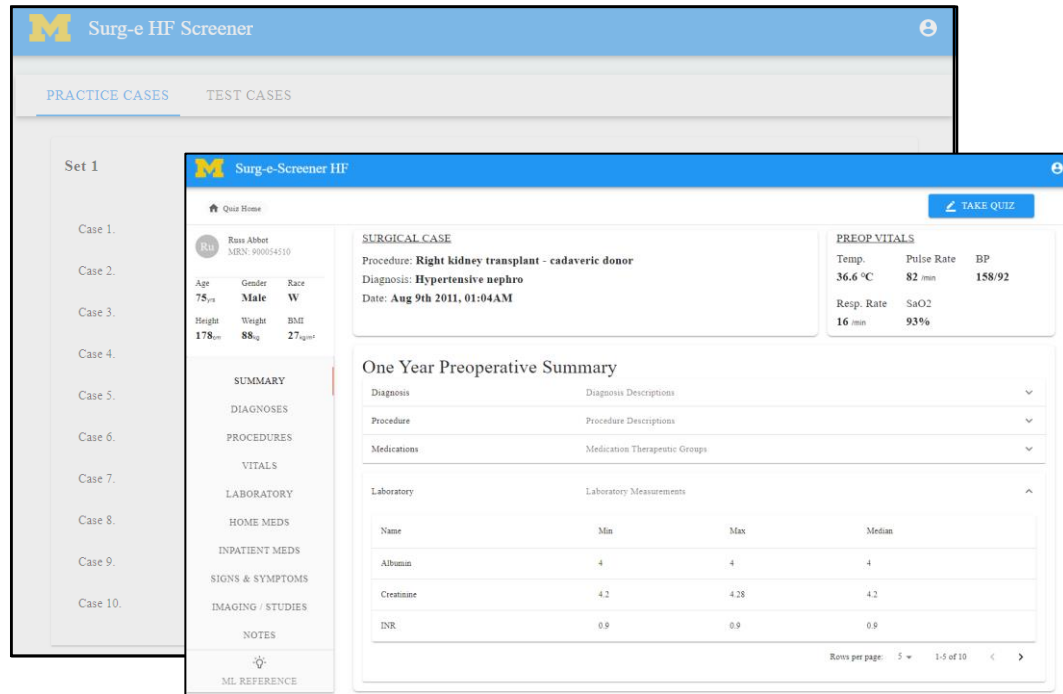
Treatments for **heart failure** (HF) proven to extend & improve quality of life are limited by clinicians' ability to diagnose the disease in **early stages**.

The Problem



Unrecognized or untreated heart failure is the single greatest risk factor for cardiovascular complications and mortality after *major surgery*.

The Solution: Surg-e-Screener HF

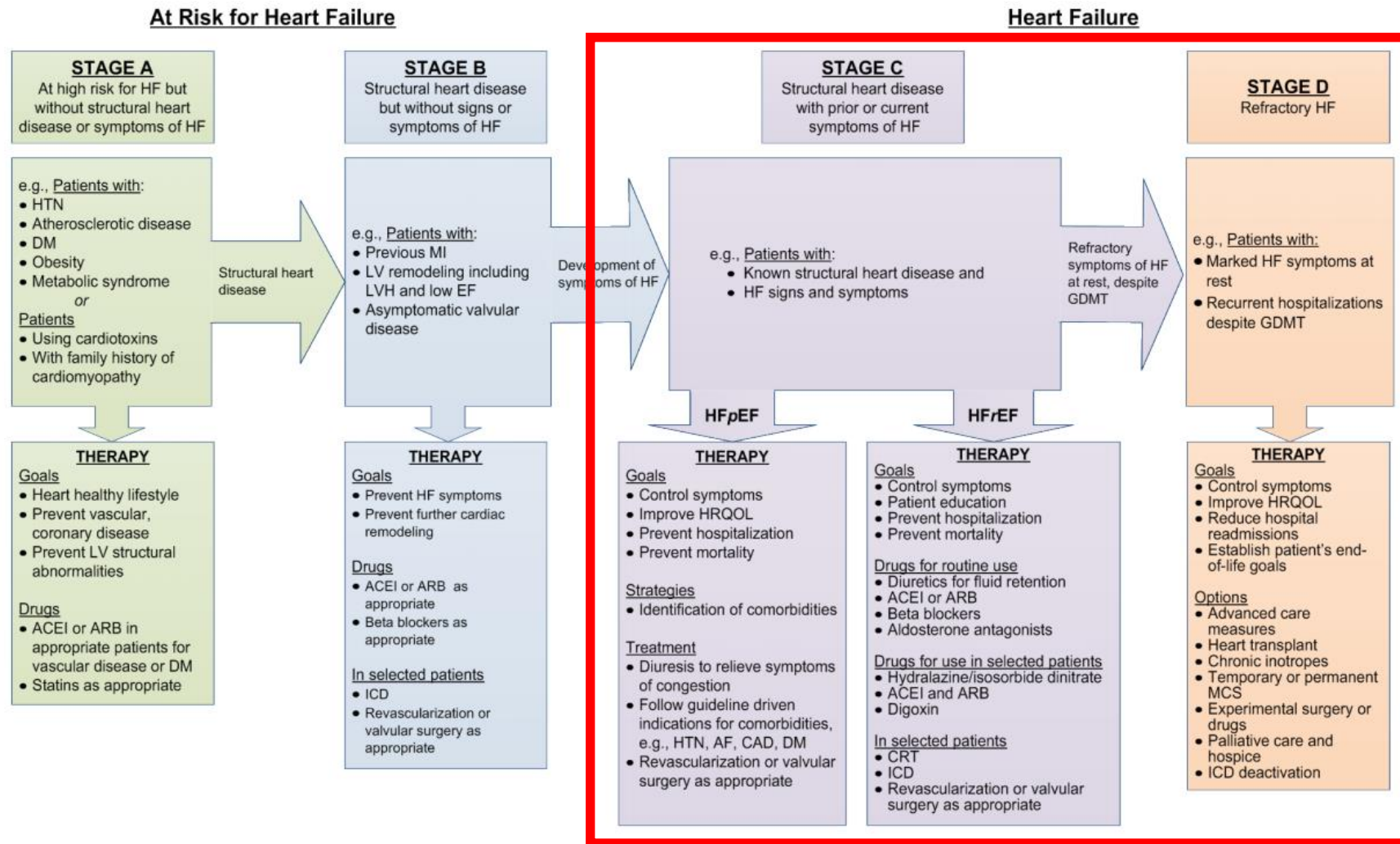


Surg-e-Screener HF:
*Automated screening &
educational tool*

Education & Training –

- It is a quiz-based webapp to **improve HF recognition** with surgical cases in EHR
- It provides a report after completing quizzes to **compare** your clinical judgment to **a pane of HF experts**
- It is designed to **augment clinicians' ability** using EHR data and machine learning (ML) reference

Chronic Heart Failure Definition for this Tool



For purposes of this tool,
Chronic HF defined as:

- **Chronic:**
Signs +/- symptoms or underlying pathophysiology persistent for ≥ 3 months (with onset defined as the *start* of this ≥ 3 month period)
- **HF:**
ACCF/AHA Stage C or D (*prior* or current symptoms + structural heart disease)

Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Journal of the American College of Cardiology*. 2013;62(16):e147-239.



Purpose of this study

To understand how EHR-based heart failure (HF) recognition can be improved as aided by the **Surg-e-Screener HF** tool.

Case Review Process

1. Case Reviews



Assume you are a *preop physician* reviewing the patient's medical history prior to surgery in order to identify factors pertaining to presence/absence of HF

- Previous HF diagnoses (simplest way to detect, but occasionally inaccurate)
- Signs & symptoms, labs, studies/imaging, medications, clinical notes.

2. Pre-test: HF Recognition Quiz



For the first 10 cases, you use EHR data to decide if a patient had HF (chronic ACC/AHA Stage C or D) before the start of the surgery.

3. ML Reference



After completing the quiz, you have access to the **Machine Learning (ML) reference**, ML performance indicators and a list of risk factors ranked by an algorithm.

4. Post-test: HF Recognition Quiz



For the next 10 new cases, you use EHR data **AND** the ML reference to decide if the patient had HF (chronic ACC/AHA Stage C or D) before the start of the surgery.

5. Expert Review Comparison



After completing 20 surgical cases, you can access a result report, comparing your HF decision to pre-determined answers and a short case summary by HF experts.



How to use the tool:

Step-by-step Guide



Step 1. Case Reviews

Click "PRE-TEST"

The screenshot shows the 'Surge-Screener HF' interface. The 'PRE-TEST' tab is selected. A callout box points to the 'PRE-TEST' tab with the text 'Click "PRE-TEST"'. Below the tab, there is a section for 'Set 1' with a progress indicator '3/10 Completed'. A callout box points to 'Set 1' with the text 'Click "Set 1"'. Below this, there is a table of 10 cases. Each case has a status (e.g., '6 Questions Answered', '3 Questions Answered', 'Not Started') and an 'Updated Date'. To the right of each case is a button: 'VIEW' for completed cases and 'START' for cases not started. A callout box points to the 'VIEW' button for Case 7.

Case	Status	Updated Date	Action
Case 1.	6 Questions Answered	January 13, 2022, 9:31 AM	VIEW
Case 2.	3 Questions Answered	January 13, 2022, 1:15 PM	RESUME
Case 3.	6 Questions Answered	January 14, 2022, 11:30 AM	VIEW
Case 4.	Not Started	Updated Date: -	START
Case 5.	Not Started	Updated Date: -	START
Case 6.	Not Started	Updated Date: -	START
Case 7.	6 Questions Answered	January 13, 2022, 11:50 AM	VIEW
Case 8.	Not Started	Updated Date: -	START
Case 9.	Not Started	Updated Date: -	START
Case 10.	Not Started	Updated Date: -	START

Check your assigned cases

- 10 surgical cases are assigned to **Pre-Test** and 10 surgical cases are in **Post-Test**.
- Click **Pre-Test** to review 10 surgical cases.
- Click the **Start** button to begin your case review. The button indicates your status.

Status of your progress:


START No questions completed.

RESUME Partially answered questions, not yet completed.

VIEW Completed questions. You can *only* view the case.



Step 1. Case Reviews: Dashboard

 Surg-e-Screener HF 8

[Quiz Home](#) [TAKE QUIZ](#)

1

Pa

Paul Bevoir

MRN: 900001038

Age

Gender

Race

87 yrs

Female

W

Height

Weight

BMI

173 cm

56 kg

18 kg/m²

2

SURGICAL CASE

Procedure: Left thrombectomy - specify body sit left above knee amputation

Diagnosis: Lle embolus, acute limb ischemia

Date: Jan 23rd 2010, 07:30PM

3

PREOP VITALS

Temp.

Pulse Rate

BP

36.8 °C

96 /min

145/99

Resp. Rate

SaO2

18 /min

94%

4

SUMMARY

DIAGNOSES

PROCEDURES

VITALS

LABORATORY

HOME MEDS

INPATIENT MEDS

SIGNS & SYMPTOMS

IMAGING / STUDIES

NOTES

5

Date Range Filters

January 24

July

February

September

April

November

June

January

August

March

October

May

December

July

February

September

April

November

2000

2001

2002

2003

2004

2005

2006

2007

2008

2009

☐ Expand All Groups

Select a date range before surgery:

☐ 1 mo.

☐ 3 mo.

☐ 6 mo.

☐ 1 yr.

☐ 3 yr.

☐ 5 yr.

☐ 10 yr.

☒ All

Elixhauser

Diagnosis

Diagnosis Source

Type

Code

Lexicon

Date

Present On Admission

▼ CardiacArrhythmias

► Fibrillation, atrial (count: 2)

► Paroxysmal atrial fibrillation (count: 1)

► Persistent atrial fibrillation (count: 1)

► Unspecified atrial fibrillation (count: 3)

▼ ChronicPulmonaryDisease

► Bronchitis, obstr chrn w/exacrb (count: 1)


► Chronic obstructive pulmonary disease, unspecified (count: 1)


6

ML REFERENCE

Key components

1. Demographics
2. Surgical Case
3. Preoperative Vitals
4. Subject Domains
5. Date Filter & EHR data
6. ML reference





Step 2. *Pre-test*: HF Recognition Quiz

M Surg-e-Screener HF

Quiz Home

TAKE QUIZ

Question 1

Before the start of this surgery, do you think this patient had CHRONIC HEART FAILURE (i.e. structural heart disease with >3 months of current or prior heart failure symptoms)?

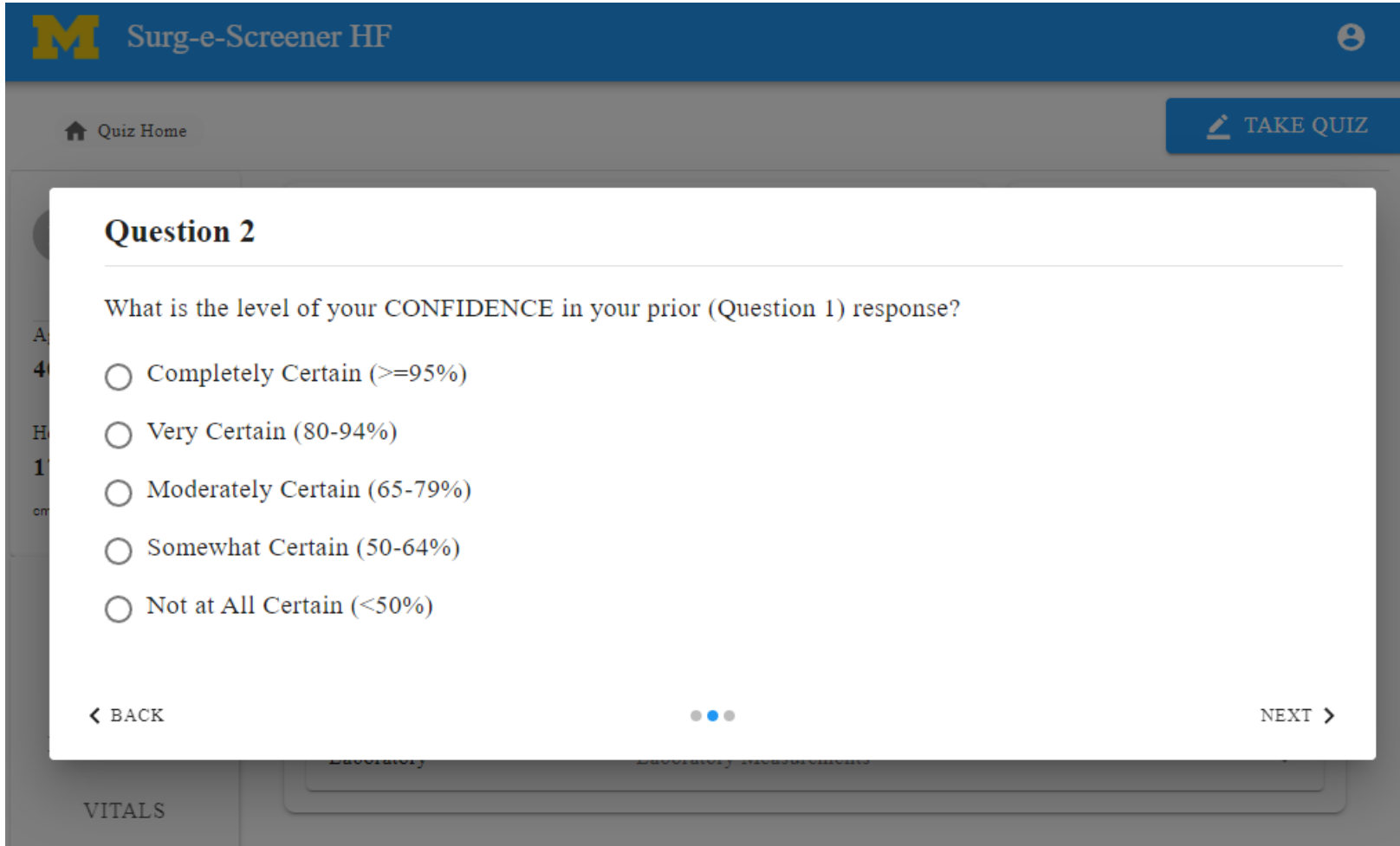
☐ Yes

☐ No

< BACK ... NEXT >

Click "Take Quiz" to answer your decision

Step 2. *Pre-test*: HF Recognition Quiz



The screenshot displays the 'Surg-e-Screener HF' web application. At the top, there is a blue header with a yellow 'M' logo and the text 'Surg-e-Screener HF'. Below the header, a grey navigation bar contains a 'Quiz Home' link and a 'TAKE QUIZ' button. The main content area shows 'Question 2' with the text: 'What is the level of your CONFIDENCE in your prior (Question 1) response?'. Five radio button options are listed: 'Completely Certain (>=95%)', 'Very Certain (80-94%)', 'Moderately Certain (65-79%)', 'Somewhat Certain (50-64%)', and 'Not at All Certain (<50%)'. At the bottom of the question card, there are 'BACK' and 'NEXT' navigation links, and a progress indicator showing three dots, with the second dot being blue.

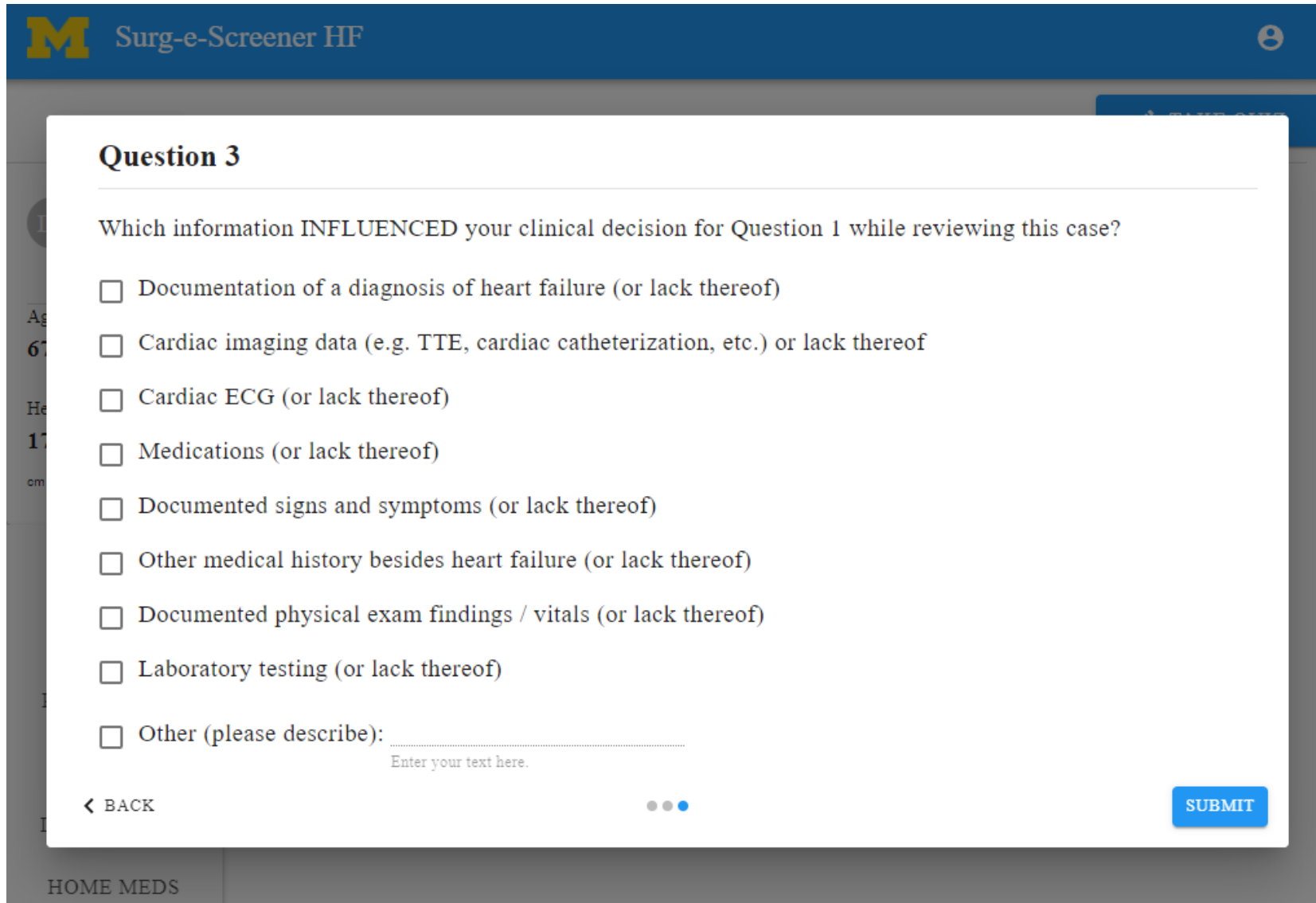
Question 2

What is the level of your CONFIDENCE in your prior (Question 1) response?

- ☐ Completely Certain ($\geq 95\%$)
- ☐ Very Certain (80-94%)
- ☐ Moderately Certain (65-79%)
- ☐ Somewhat Certain (50-64%)
- ☐ Not at All Certain ($< 50\%$)

[< BACK](#) [NEXT >](#)

Step 2. *Pre-test*: HF Recognition Quiz



The screenshot shows a web-based quiz interface titled "Surg-e-Screener HF". A modal window displays "Question 3" with the text: "Which information INFLUENCED your clinical decision for Question 1 while reviewing this case?". Below the text is a list of nine options, each preceded by an unchecked checkbox. The options are: "Documentation of a diagnosis of heart failure (or lack thereof)", "Cardiac imaging data (e.g. TTE, cardiac catheterization, etc.) or lack thereof", "Cardiac ECG (or lack thereof)", "Medications (or lack thereof)", "Documented signs and symptoms (or lack thereof)", "Other medical history besides heart failure (or lack thereof)", "Documented physical exam findings / vitals (or lack thereof)", "Laboratory testing (or lack thereof)", and "Other (please describe):". Below the "Other" option is a text input field with the placeholder "Enter your text here.". At the bottom left of the modal is a "< BACK" button, and at the bottom right is a blue "SUBMIT" button. The background of the interface shows a sidebar with a large yellow "M" logo and a list of items including "HOME MEDS".

Question 3

Which information INFLUENCED your clinical decision for Question 1 while reviewing this case?

- ☐ Documentation of a diagnosis of heart failure (or lack thereof)
- ☐ Cardiac imaging data (e.g. TTE, cardiac catheterization, etc.) or lack thereof
- ☐ Cardiac ECG (or lack thereof)
- ☐ Medications (or lack thereof)
- ☐ Documented signs and symptoms (or lack thereof)
- ☐ Other medical history besides heart failure (or lack thereof)
- ☐ Documented physical exam findings / vitals (or lack thereof)
- ☐ Laboratory testing (or lack thereof)
- ☐ Other (please describe):

Enter your text here.

< BACK SUBMIT



M Surg-e-Screener HF

Pa

Paul Bevoir

MRN: 900001038

Age

Gender

Race

70 yrs

Male

W

Height

Weight

BMI

178 cm

87 kg

27 kg/m²

SUMMARY

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ML REFERENCE

1

ML Reference: A collection of risk factors synthesized by a machine learning algorithm

The ML Reference contains a collection of important risk factors (features) identified and ranked by the ML algorithm using **365-day EHR data prior to surgery**. You can use this ML reference as reviewing this surgical case to determine the presence of HF.

> The key information to understand the ML reference.

2

True Positive Rate

False Positive Rate

85%

22%

3

Top 5 HF risk factors

- Comorbidity Hypertension Complicated
- Age In Years
- Comorbidity Hypertension Uncomplicated
- Essential (primary) hypertension (I10.X)
- Dermatological Agents

4

Section	Risk Factors	Odds Ratio	Relative Significance (%)
3. Past Medical History	Comorbidity Hypertension Complicated	1.32	<div></div>
	Comorbidity Hypertension Uncomplicated	1.28	<div></div>
	Essential (primary) hypertension (I10.X)	1.22	<div></div>
	Other anemias (D64.X)	0.9	<div></div>
5. Medications	Dermatological Agents	1.21	<div></div>
	Antibiotics	1.13	<div></div>
6. Physical Exam	Age In Years	1.15	<div></div>
	SaO2	0.97	<div></div>
	Heart Rate var	0.95	<div></div>
	Heart Rate min	1.11	<div></div>

1. The ML Reference description
2. TPR and FPR
3. Top 5 HF risk factors
4. Risk factors calculated and ranked by ML algorithms

Using the Machine Learning (ML) Reference

Key HF features are identified and ranked in each category

Odds Ratio

- **OR = 1:** No Effect
- **OR > 1:** Higher Odds to HF
- **OR < 1:** Lower Odds to HF

Risk Factor Relative Significance (%)

- Positive assoc. with HF in **red**, meaning a patient is more *likely* to have chronic HF
- Negative assoc. with HF in **green**, meaning a patient is *less likely* to have chronic HF

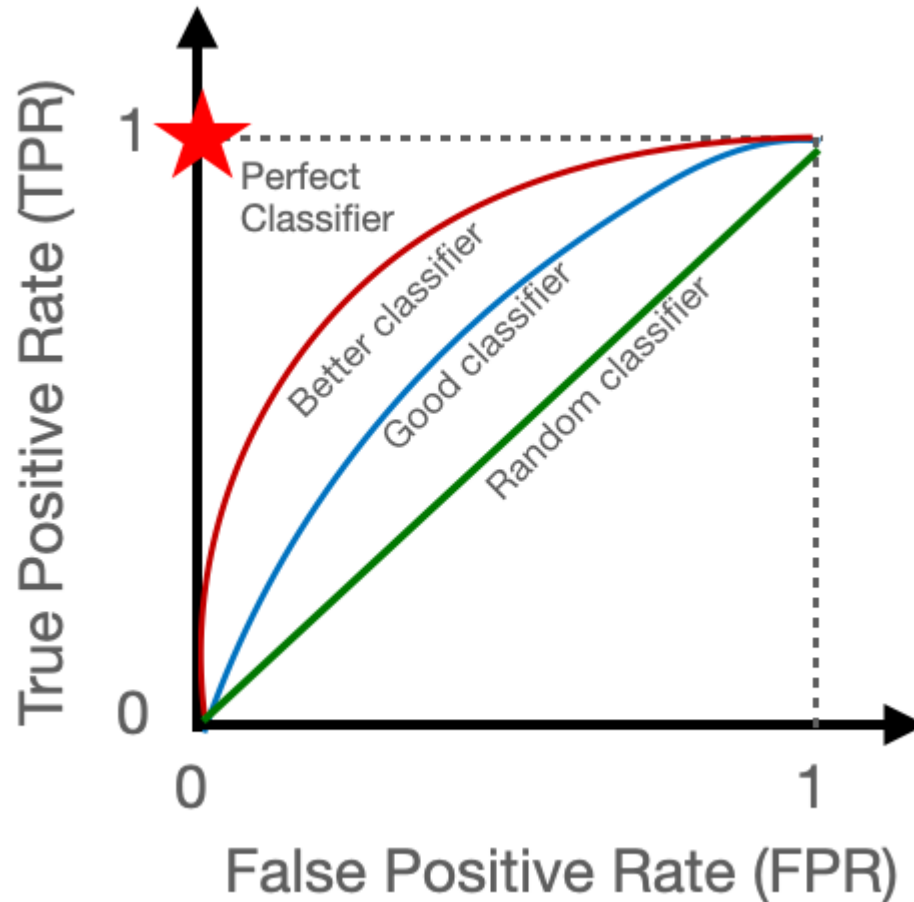
Category	Feature Name	Odds Ratio	Relative Significance (%)
Signs and Symptoms	Acute Pain*	1.12	0.76
	angina*	1.21	1.30
	associated symptoms*	1.15	0.95
	back pain*	1.13	0.85
	calf pain*	0.91	-0.64
	cough*	0.94	-0.40
	Dizziness*	1.05	0.34
	dry skin*	1.18	1.17
	dyspnea on exertion*	1.21	1.33
	eye pain*	1.20	1.27
	fatigue*	1.23	1.44
	Heartburn*	1.17	1.09
	nervousness*	0.88	-0.89
	photophobia*	1.16	1.04
	rashes*	1.16	1.03
	rest pain*	0.92	-0.56
	stridor*	1.16	1.04
	tarry stools*	0.90	-0.75
	urinary symptoms*	1.18	1.12
Past HF History	wheezing*	1.43	2.44
	Cardiomyopathy	1.45	2.55
Past Medical History	Heart Failure	1.85	4.25
	Disorders of fluid, electrolyte, and acid-base balance	1.14	0.91
	Other and unspecified anemias (285.X)	1.11	0.69
	Cardiac dysrhythmias (427.X)	1.26	1.61
	apnea*	0.93	-0.52
	Comorbidity Chronic Pulmonary Disease	1.13	0.84
	Comorbidity Diabetes Complicated	1.28	1.73
	Comorbidity Hypertension Complicated	1.32	1.92
	Comorbidity Hypertension Uncomplicated	1.28	1.71
	Comorbidity Peripheral Vascular Disorders	1.43	2.45
	Comorbidity Pulmonary Circulation Disorders	1.24	1.49
	Comorbidity Valvular Disease	1.28	1.72
	Coronary Artery Disease	1.40	2.31
	Other anemias (D64.X)	0.90	-0.73
	Other disorders of fluid, electrolyte and acid-base balance	0.95	-0.36
	Nicotine dependence (F17.X)	1.12	0.80
	Other anxiety disorders (F41.X)	0.84	-1.16
	Essential (primary) hypertension (I10.X)	1.22	1.38

Past Medical History	Gastro-esophageal reflux disease (K21.X)	0.85	-1.10
	Abnormalities of breathing (R06.X)	1.31	1.87
	Abnormal findings on diagnostic imaging of lung (R94.X)	0.89	-0.78
	Abnormal results of function studies (R94.X)	0.92	-0.55
	Smoking Classification - Former Smoker	0.91	-0.67
	Personal history of malignant neoplasm (Z85.X)	0.84	-1.22
Past Surgical History	Presence of cardiac and vascular implants and grafts	1.77	3.92
Medications	ANTIBIOTICS	1.13	0.83
	ANTIVIRALS	0.88	-0.91
	AUTONOMIC_DRUGS	1.11	0.72
	MUSCLE_RELAXANTS	0.81	-1.44
	SEDATIVE_HYPNOTICS	1.14	0.89
	SKIN_PREPS	1.21	1.33
Physical Exam	Age In Years	1.15	0.99
	Baseline Blood Pressure Diastolic	1.23	1.43
	Baseline Blood Pressure Systolic	0.83	-1.28
	BMI max	1.23	1.41
	BP Systolic mean	0.94	-0.39
	Heart Rate max	1.08	0.54
	Heart Rate min	1.11	0.69
	Heart Rate var	0.95	-0.35
	Physical Exam Resp Rate	1.10	0.64
	Physical Exam Temperature	0.92	-0.55
	pitting edema*	1.28	1.72
	Race African American	1.16	1.04
	Respiratory Rate max	0.91	-0.64
	SaO2	0.97	-0.20
	SPO2 min	0.84	-1.18
	Temperature max	0.98	-0.11
Test - Lab	Albumin max	0.89	-0.84
	Creatinine var	1.23	1.41
	HbA1c last is below 5.7	0.85	-1.12
	Hematocrit var	0.89	-0.83
	No INR Test	0.80	-1.53
	INR variance	0.92	-0.60
	PlateletCount last is b/w 150-449.99 K/uL	0.90	-0.71
	PlateletCount var	0.72	-2.22
	Potassium last is b/w 3.5-4.99 mmol/L	1.12	0.77
	Troponin var	0.97	-0.23
	WBC var	0.92	-0.61
	LVEF min is below 50	2.04	4.92
Test - Image	No LVEF Test	0.57	-3.84
Test - ECG	Atrioventricular and left bundle-branch block	1.24	1.45



ML Quick Review – Evaluation Metrics

Area Under the Receiver Operating characteristic Curve (AUROC or AUC)



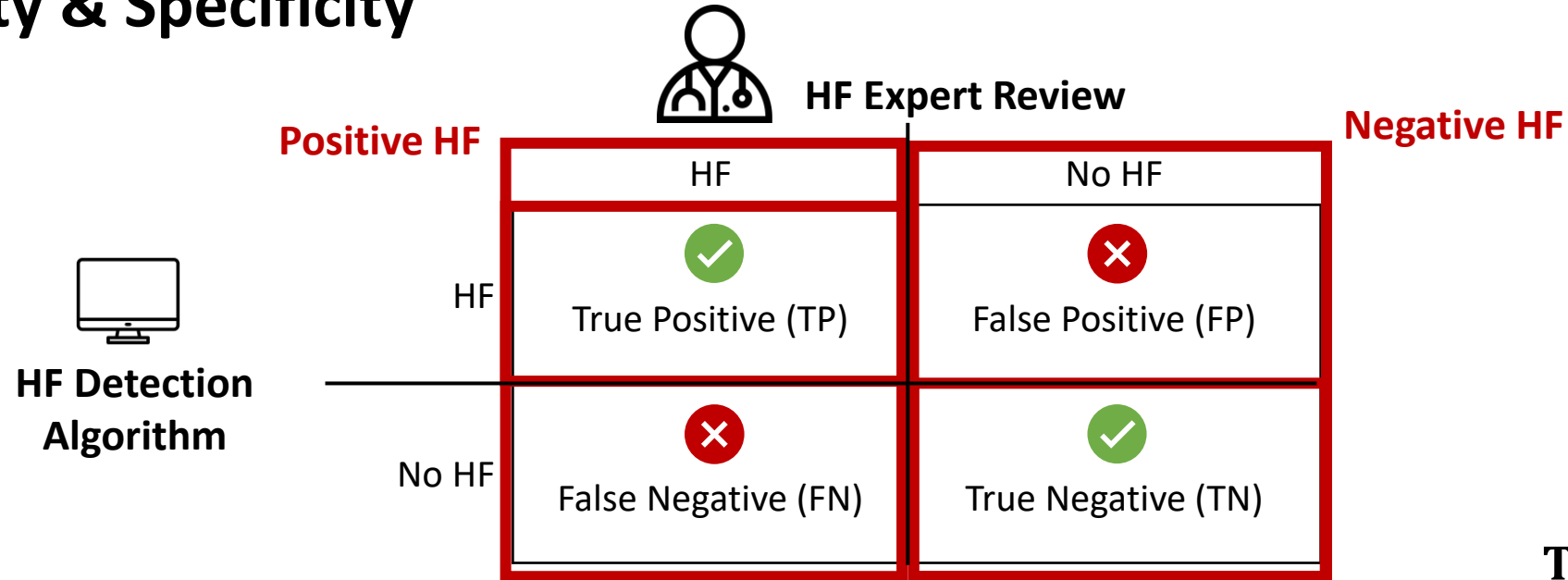
AUROC Values	Test Quality
1.00	Perfect test; 100% accurate
0.90	Better, Excellent
0.80	Good, Acceptable
0.70	Poor
0.50	No better than coin flip





TPR = Sensitivity

FPR = 1 – Specificity

ML Quick Review – Evaluation Metrics

Sensitivity & Specificity



		HF Expert Review	
		Positive HF	Negative HF
HF Detection Algorithm	HF	 True Positive (TP)	 False Positive (FP)
	No HF	 False Negative (FN)	 True Negative (TN)

$$\text{Sensitivity} = \frac{TP}{TP + FN}$$

The ability of HF algorithm to correctly detect patients **with** HF.

$$\text{Specificity} = \frac{TN}{FP + TN}$$

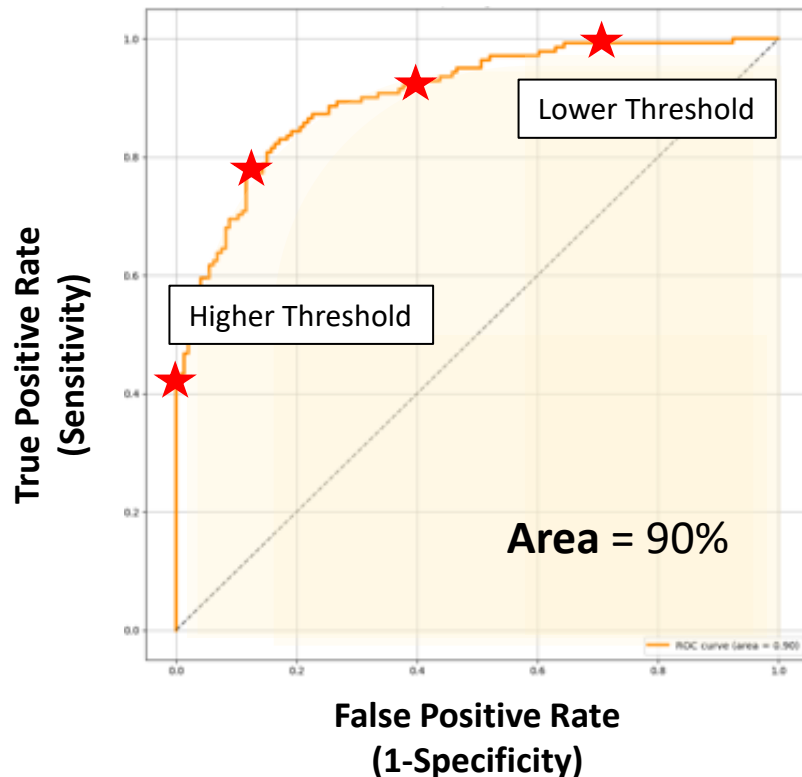
The ability of HF algorithm correctly detect patients **without** HF.

TPR = Sensitivity

FPR = 1 – Specificity

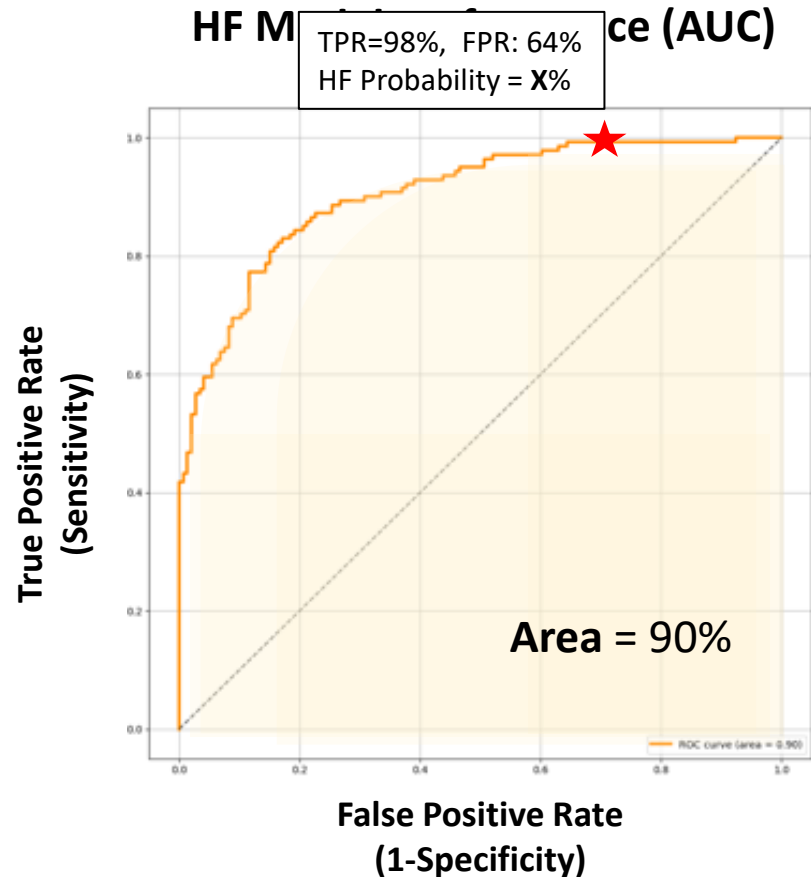
Interpretation of AUC

HF Model Performance (AUC)



- **AUC** is a curve that plots TPR against FPR at **various thresholds**.
- **Threshold** is a **cut-off probability** to discriminate *HF* from *No HF*, a probability between 0 – 1 estimated by the HF model.
- **Lower** vs. **High** threshold
- In this study, we show TPR and FPR when **threshold** is set to the HF probability, estimated by the algorithm.

Interpretation of AUC



Ex1. TPR=98% and FPR=64%

The model was able to *correctly* detect 98% of patients **with HF**, but *incorrectly* detect 64% of patients **without HF**.

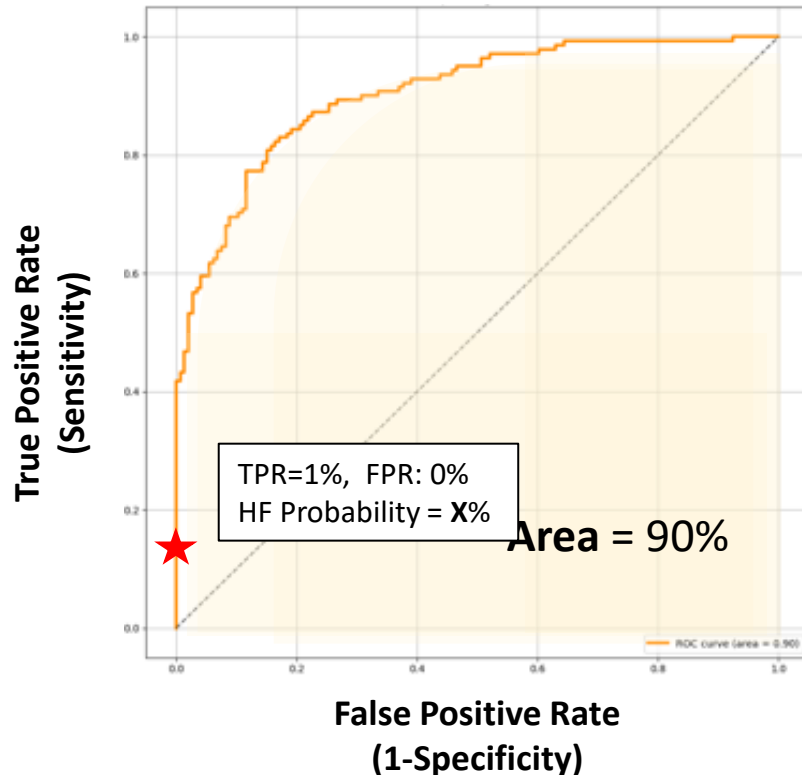
Key takeaways

- *High true positives* (98%), but also *high false positives* (64%)
- This is due to the **low threshold** (e.g., 12%), HF probability higher than 12% is HF.

Do you think this patient had HF or No HF?

Interpretation of AUC

HF Model Performance (AUC)



Ex2. TPR=1% and FPR=0%

The model was able to *correctly* detect 1% of patients **with HF**, but *incorrectly* detect 0% of patients **without HF**.

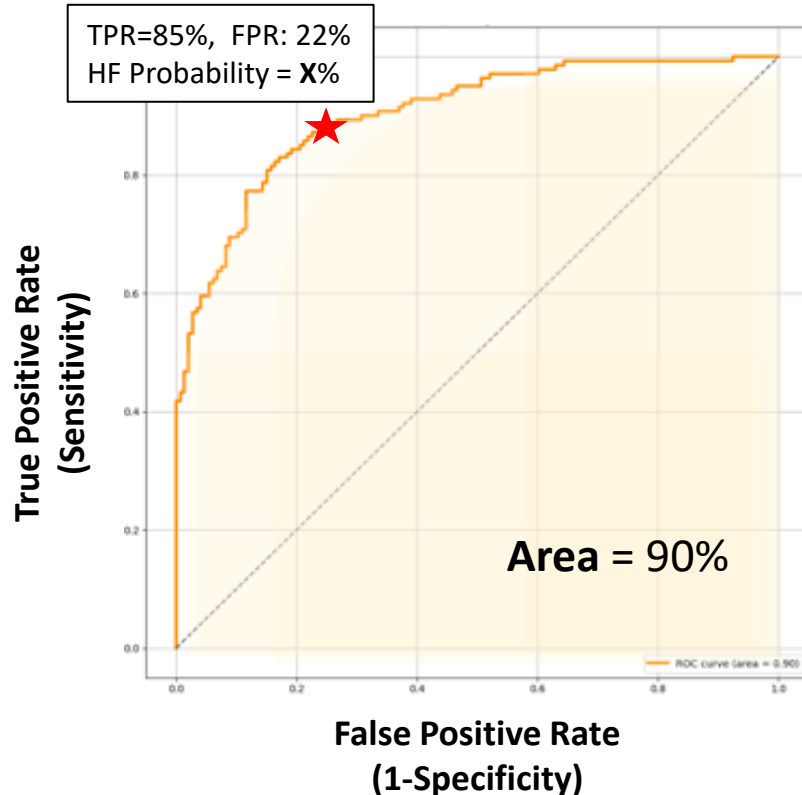
Key takeaways

- *Low true positives* (1%), but also *low false positives* (0%)
- This is due to the **high threshold** (e.g., 96%), HF probability higher than 96% is HF.

Do you think this patient had HF or No HF?

Interpretation of AUC

HF Model Performance (AUC)



Ex3. TPR=85% and FPR=22%

The model was able to *correctly* detect 85% of patients **with HF**, but *incorrectly* detect 22% of patients **without HF**.

Key takeaways

- *Relatively high true positives (85%) and relatively low false positives (22%)*
- The **threshold** is in gray zone (e.g., 45%) where HF and No HF overlap the most. HF probability higher than 45% is HF.

Do you think this patient had HF or No HF?

Step 3. Machine Learning (ML) Reference

ML Reference: A collection of risk factors synthesized by a machine learning algorithm

The ML Reference contains a collection of important risk factors (features) identified and ranked by the ML algorithm using **365-day LHK data prior to surgery**. You can use this ML reference as reviewing this surgical case to determine the presence of HF.

> The key information to understand the ML reference.

True Positive Rate

85%

False Positive Rate

22%

Top 5 HF risk factors

- Comorbidity Hypertension Complicated
- Age In Years
- Comorbidity Hypertension Uncomplicated
- Essential (primary) hypertension (I10.X)
- Dermatological Agents

Paul Bevoir

MRN: 900001038

Age

70_{yr}

Gender

Male

Race

W

Height

178_{cm}

Weight

87_{kg}

BMI

27_{kg/m²}

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ML REFERENCE

Search...

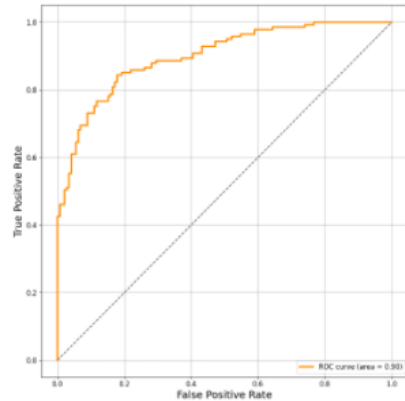
Section	Risk Factors	Odds Ratio	Relative Significance (%)
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	SaO2	0.97	<div></div>
	Heart Rate var	0.95	<div></div>
	Heart Rate min	1.11	<div></div>



Step 3. Machine Learning (ML) Reference

✓ The key information to understand the ML reference.

The ML Performance in AUC:



[Click Me!](#)

Abbreviations:

- LVEF: Left Ventricular Ejection Fraction
- INR: International Normalized Ratio of prothrombin times
- WBC: White Blood Cell
- SaO2: Oxygen saturation of the arterial blood
- SpO2: Oxygen saturation from a pulse oximeter
- var: variance of the measurements (e.g., Creatinine var)
- min: minimum value (e.g., Heart Rate min)
- max: maximum value (e.g., Heart Rate max)
- last: last (latest) value before surgery (e.g., HbA1c last)

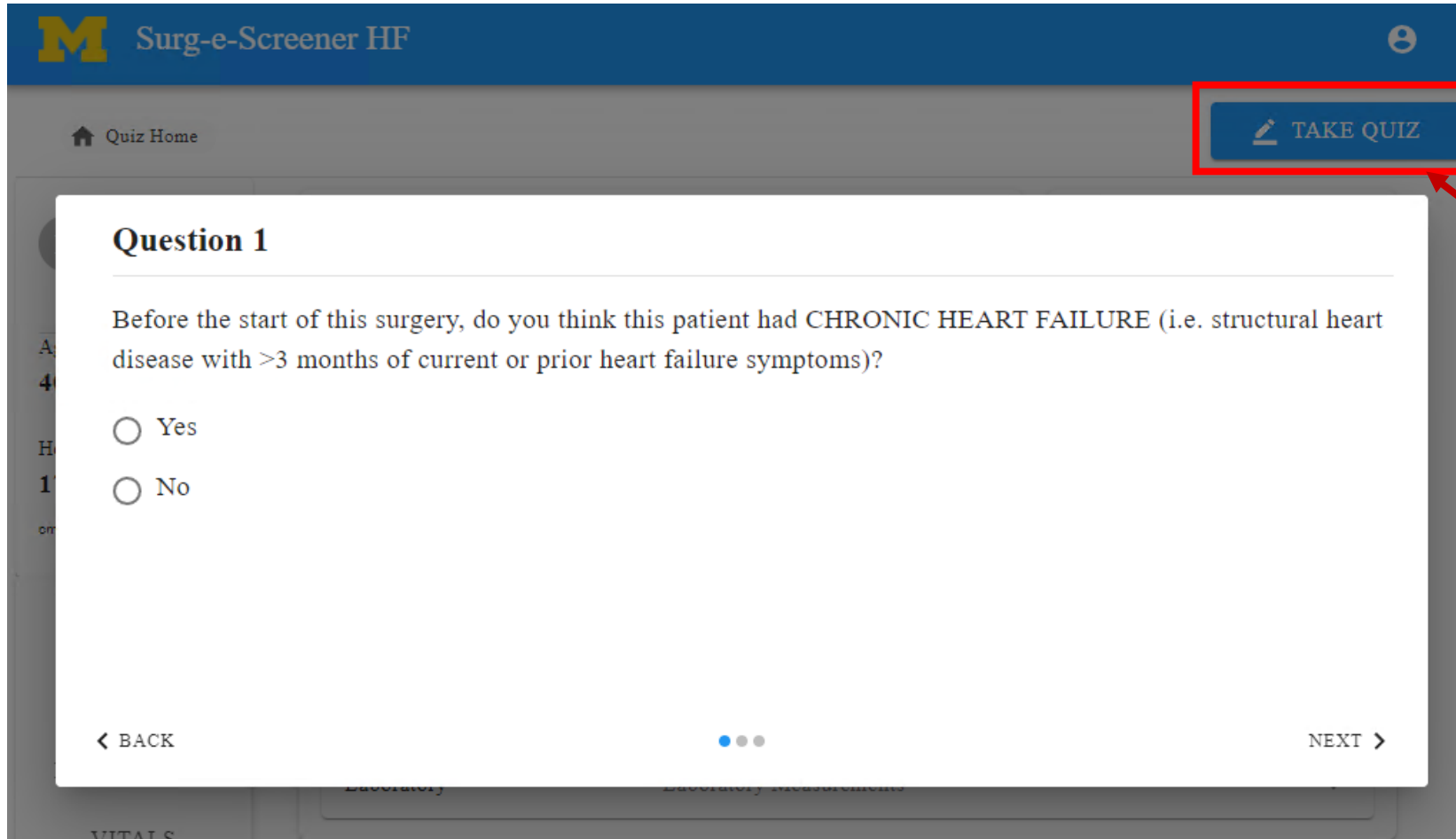
Note:

- An **asterisk** next to the risk factor (e.g., wheezing*) describes that *the risk factor was "mentioned" in clinical notes*, which **does not indicate either "positive" or "negative"**. You can confirm positive/negative by searching the risk factor from [Signs and Symptoms](#) or [Notes](#).
- Risk factors or entire section(s) will **not be displayed** if they are older than one year or not documented in EHR.

Key components

1. The ML Performance in AUC
2. Abbreviations
3. Notes about risk factors

Step 4. *Post-test*: HF Recognition Quiz



M Surg-e-Screener HF

Quiz Home

TAKE QUIZ

Question 1

Before the start of this surgery, do you think this patient had CHRONIC HEART FAILURE (i.e. structural heart disease with >3 months of current or prior heart failure symptoms)?

☐ Yes

☐ No

< BACK

...

NEXT >

Click "Take Quiz" to answer your decision

Step 4. *Post-test*: HF Recognition Quiz

The screenshot displays the 'Surg-e-Screener HF' web application. At the top, there is a blue header with a yellow 'M' logo and the text 'Surg-e-Screener HF'. Below the header, a grey navigation bar contains a 'Quiz Home' link and a 'TAKE QUIZ' button. The main content area shows 'Question 2' with the text: 'What is the level of your CONFIDENCE in your prior (Question 1) response?'. There are five radio button options: 'Completely Certain (>=95%)', 'Very Certain (80-94%)', 'Moderately Certain (65-79%)', 'Somewhat Certain (50-64%)', and 'Not at All Certain (<50%)'. At the bottom of the question card, there are navigation links: '< BACK', a progress indicator with three dots (the second dot is blue), and 'NEXT >'. The background of the application shows a sidebar with 'VITALS' and 'Laboratory' sections.

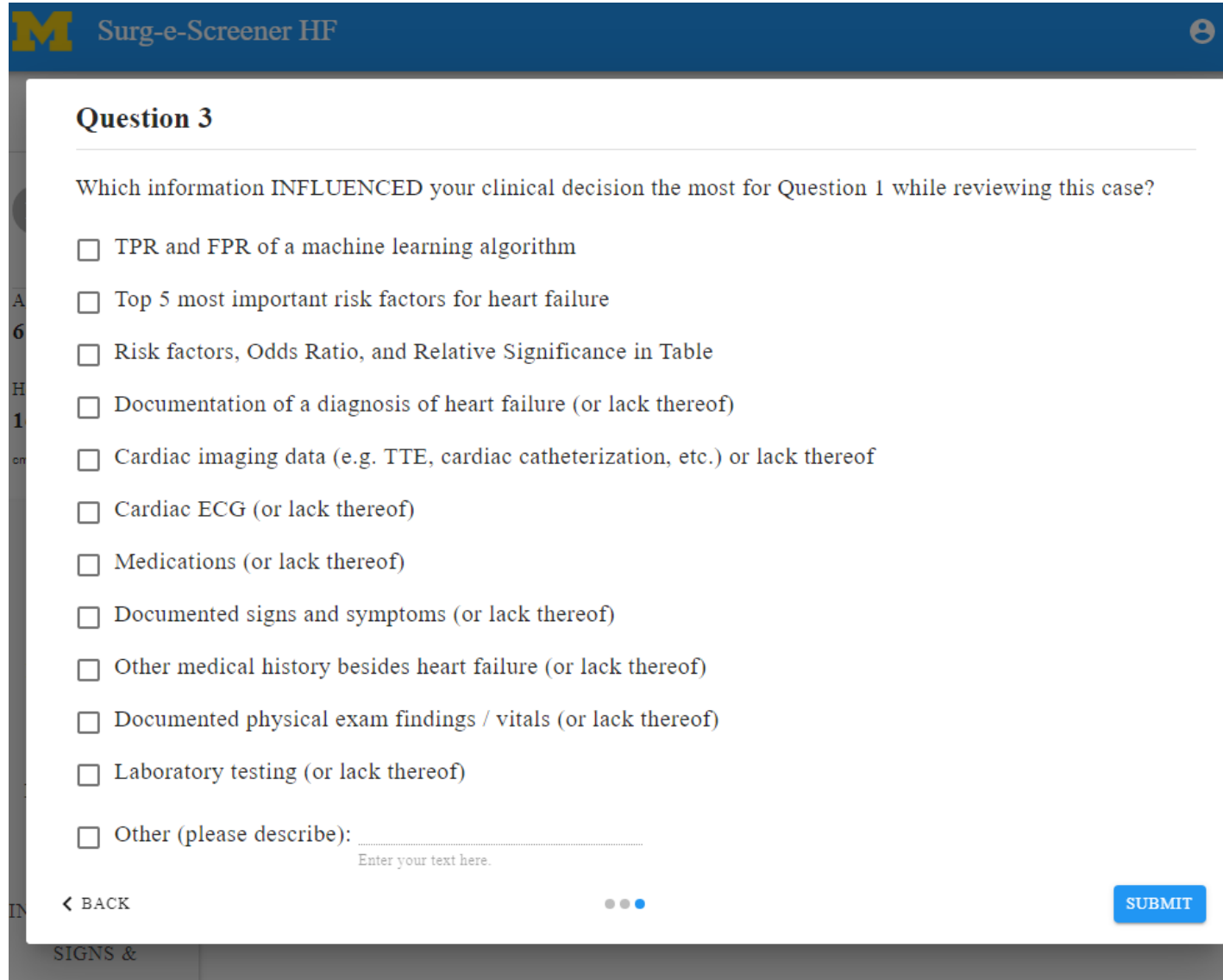
Question 2

What is the level of your CONFIDENCE in your prior (Question 1) response?

- ☐ Completely Certain ($\geq 95\%$)
- ☐ Very Certain (80-94%)
- ☐ Moderately Certain (65-79%)
- ☐ Somewhat Certain (50-64%)
- ☐ Not at All Certain ($< 50\%$)

< BACK ● ● ● NEXT >

Step 4. Post-test: HF Recognition Quiz



The screenshot shows a web-based quiz interface titled "Surg-e-Screener HF". The quiz is titled "Question 3" and asks: "Which information INFLUENCED your clinical decision the most for Question 1 while reviewing this case?". There are 12 checkboxes for different factors, followed by an "Other" option with a text input field. At the bottom, there is a "BACK" button, a progress indicator (three dots, the third is blue), and a "SUBMIT" button.

Question 3

Which information INFLUENCED your clinical decision the most for Question 1 while reviewing this case?

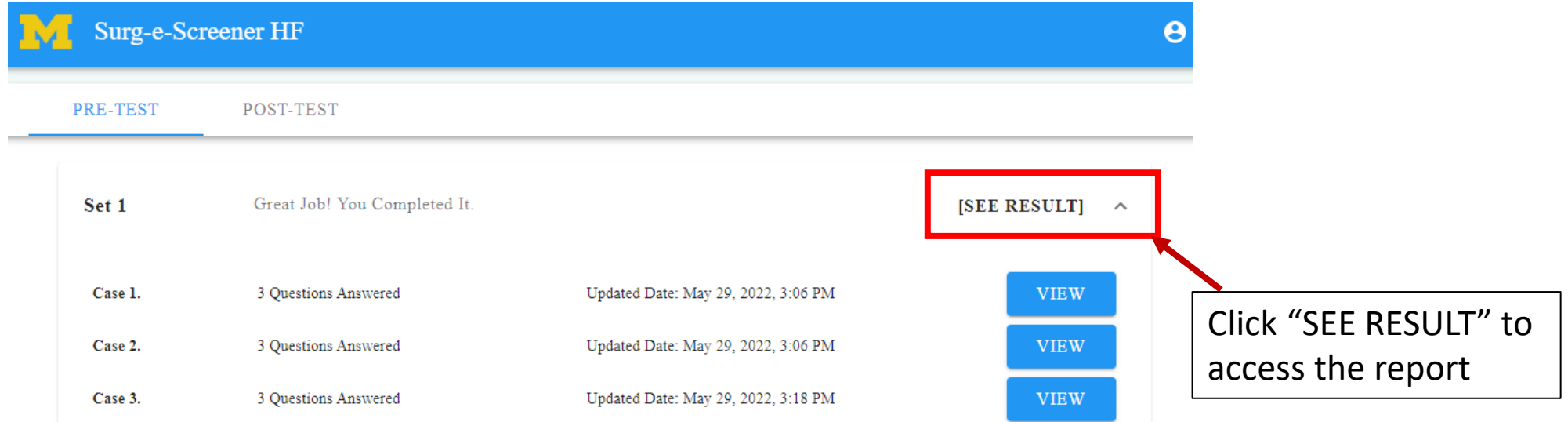
- ☐ TPR and FPR of a machine learning algorithm
- ☐ Top 5 most important risk factors for heart failure
- ☐ Risk factors, Odds Ratio, and Relative Significance in Table
- ☐ Documentation of a diagnosis of heart failure (or lack thereof)
- ☐ Cardiac imaging data (e.g. TTE, cardiac catheterization, etc.) or lack thereof
- ☐ Cardiac ECG (or lack thereof)
- ☐ Medications (or lack thereof)
- ☐ Documented signs and symptoms (or lack thereof)
- ☐ Other medical history besides heart failure (or lack thereof)
- ☐ Documented physical exam findings / vitals (or lack thereof)
- ☐ Laboratory testing (or lack thereof)
- ☐ Other (please describe):

Enter your text here.

< BACK SUBMIT



Step 5. Result Report Access



M Surg-e-Screener HF

PRE-TEST POST-TEST

Set 1	Great Job! You Completed It.	[SEE RESULT] ^
Case 1.	3 Questions Answered	Updated Date: May 29, 2022, 3:06 PM
Case 2.	3 Questions Answered	Updated Date: May 29, 2022, 3:06 PM
Case 3.	3 Questions Answered	Updated Date: May 29, 2022, 3:18 PM

VIEW
VIEW
VIEW

Click "SEE RESULT" to access the report

Key components

- SEE RESULT will be available after reviewing 20 surgical cases, 10 case review results in PRE-TEST and 10 case review results in POST-TEST.

Step 5. Expert Review Comparison

	Your Response	Expert Review	HF Expert Case Summary
Case 1	Yes	Yes	REVIEW
Case 2	Yes (Incorrect)	No	REVIEW
Case 3	Yes	Yes	REVIEW

Summary 1:
87 F PMH chronic afib with pulmonary HTN ... who had a significant reduction in EF ... that had not recovered 1 month later.

Summary 2:
87-year-old female admitted 6-months before surgery Following that, she most likely developed she underwent ... for LLE ischemia.

Case 10	Yes	Yes	REVIEW
Your Score:	60%	-	

BACKHOME

Review your result report

- Compare your HF recognition with the pre-determined answers by HF experts in each case.
- Re-examine cases when you are misaligned with the answers.
- Review **a short description** of the surgical cases summarized by the HF experts.

Summary of e-Learning Module

After watching this e-Learning module, you should be able to:

1. Understand the **process and activities required** to complete the HF recognition study
2. Interpret evaluation metrics such as **AUC, True Positive Rate (Sensitivity)**, and **False Positive Rate (1-Specificity)**
3. Describe how **TPR and FPR change** as the threshold increases or decreases

The short quiz will ask you mainly about Point 2 and Point 3.



Demo

Final Step

- No further actions after completing the test cases. We appreciate your participation.
- Reimbursement:
 - **Follow-up** if any case reviews remain **incomplete**
 - Pending follow-up / completion of all cases, you will receive reimbursement of **\$50 as a check** delivered to your mailing address
- Email Hyeon Joo (thejoo@med.umich.edu) if any questions

