PCI: The Looming Gold Standard?
Disclosure Statement of Financial Interest

Off label use of emojis…
Heart Failure Remains Underappreciated

Heart Failure Death Rates, 2011-2013
Adults, Ages 35+, by County

Center for Disease Control and Prevention: Division for Heart Disease and Stroke Prevention
https://www.cdc.gov/dhdsp/data_statistics/fact_sheets/fs_heart_disease.htm
Heart Failure: the Sobering Reality

“Wow! Brazil is big.”

Weir HK. et al.
Prev Chronic Dis. 2016 Nov 17;13:E157
Recovering Hearts?
Potential Time - Dependent Pathway of Dysfunctional Myocardium

Wilcox JE. et al.
"Targeting the Heart" in Heart Failure: Myocardial Recovery in Heart Failure With Reduced Ejection Fraction
JACC Heart Fail. 2015 Sep;3(9):661-9
Heart Failure: a Challenging Trajectory

Allen LA. et al.
Decision making in advanced heart failure: a scientific statement from the American Heart Association.
Circulation. 2012 Apr 17;125(15):1928-52
So When is Medical Therapy Insufficient…?

Mann DL. et al. Myocardial recovery and the failing heart: myth, magic, or molecular target? J Am Coll Cardiol. 2012 Dec 18;60(24):2465-72
### Hospital-Level Variation in the Use of CV Testing for Adults with Incident Heart Failure: CVRN HF Study

5.878 Pts. Hospitalized with First Incident HF between 2005-2008

<table>
<thead>
<tr>
<th>Testing Combination</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>2,453</td>
<td>52.8</td>
</tr>
<tr>
<td>Stress echo + SPECT</td>
<td>528</td>
<td>11.4</td>
</tr>
<tr>
<td>Echo + SPECT</td>
<td>244</td>
<td>5.2</td>
</tr>
<tr>
<td>SPECT</td>
<td>212</td>
<td>4.6</td>
</tr>
<tr>
<td>Stress Echo</td>
<td>212</td>
<td>4.6</td>
</tr>
<tr>
<td>RHC + LHC</td>
<td>148</td>
<td>3.2</td>
</tr>
<tr>
<td>LHC</td>
<td>146</td>
<td>3.1</td>
</tr>
<tr>
<td>Echo + LHC</td>
<td>141</td>
<td>3.0</td>
</tr>
<tr>
<td>Echo + RHC + LHC</td>
<td>122</td>
<td>2.6</td>
</tr>
<tr>
<td>Other</td>
<td>441</td>
<td>9.5</td>
</tr>
</tbody>
</table>

Farmer SA. et al.

Hospital-level variation in use of cardiovascular testing for adults with incident heart failure: findings from the cardiovascular research network heart failure study.

JACC Cardiovasc Imaging. 2014 Jul;7(7):690-700
Rates of Invasive/ Non-invasive W.U for CAD in 67,640 Pts. with New HF as Principal Diagnosis

MarketScan Commercial and Medicare Supplemental Databases (01/01/2010 - 31/07/2014)

Doshi D. et al.
**Annual Utilization of Coronary Revascularization in Pts. Diagnosed with CAD**

>75,000,000 Pts. Record Database Analysis Commercial Payers & Medicare Data (1/2010 - 4/2014)

- 52% of patients diagnosed with CAD undergoing cath are not revascularized
- 56% of patients diagnosed with CAD and CHF undergoing cath are not revascularized

Truven Health Analytics MarketScan Comercial and Medicare Supplemental Databases (01/01/2010 - 4/30/2014)
The Advanced Therapy Patient we Seek:

- age less than 60
- no prior surgery
- minimal non-cardiac comorbidities
- no end-organ dysfunction
- well nourished
- adherence to medical therapy
The Advanced Therapy Patient we Get:

- age >70+
- 2 - 3+ prior surgeries
- lots of non-cardiac comorbidities
- cardiorenal syndrome, hepatopathy, etc.
- prealbumin <10
- not possible to assess adherence in cardiogenic shock
### High Risk Patients: Easy to Find

>3% annual risk of CV mortality

<table>
<thead>
<tr>
<th>Extent of CAD</th>
<th>Prognostic weight (0-100)</th>
<th>5 year Survival Rate (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vessel disease 75%</td>
<td>23</td>
<td>93</td>
</tr>
<tr>
<td>&gt; 1 vessel disease 50-74%</td>
<td>23</td>
<td>93</td>
</tr>
<tr>
<td>1 vessel disease &gt;95%</td>
<td>32</td>
<td>91</td>
</tr>
<tr>
<td>2 vessel disease</td>
<td>37</td>
<td>88</td>
</tr>
<tr>
<td>2 vessel disease both ≥95%</td>
<td>42</td>
<td>86</td>
</tr>
<tr>
<td>1 vessel disease, ≥95% proximal LAD</td>
<td>48</td>
<td>83</td>
</tr>
<tr>
<td>2 vessel disease, ≥95% proximal LAD</td>
<td>56</td>
<td>79</td>
</tr>
<tr>
<td>3 vessel disease</td>
<td>56</td>
<td>79</td>
</tr>
<tr>
<td>3 vessel disease, ≥95% in at least 1</td>
<td>63</td>
<td>73</td>
</tr>
<tr>
<td>3 vessel disease, 75% proximal LAD</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>3 vessel disease, ≥95% proximal LAD</td>
<td>74</td>
<td>59</td>
</tr>
</tbody>
</table>

### Stress test Med. Rx

- High Risk: U A A A A A
- High Risk No/Min. Rx: U U A A A A
- Int. Risk: U U U U A A
- Int. Risk No/Min. Rx: I U U U A A
- Low Risk: I I U U U U
- Low Risk No/Min. Rx: I I U U U U

### Imaging Risk

- Patel MR. et al.


*J Am Coll Cardiol. 2009 Feb 10;53(6):530-53*
Viability Assessment
Diagnostic Accuracy of Imaging Techniques to Predict Viability and Post Revascularization
Recovery is Variable

Schinkel AF. et al.
Hibernating myocardium: diagnosis and patient outcomes.
Curr Probl Cardiol. 2007 Jul;32(7):375-410
Comparison of the short-term survival benefit associated with revascularization compared with medical therapy in patients with no prior coronary artery disease undergoing stress myocardial perfusion single photon emission computed tomography.

Circulation. 2003 Jun 17;107(23):2900-7
Which Way to Viability?

- Variety of modalities available to assess viability: variety of definitions of viability
- Complexity of myocardial substrates present in the same patient
- Challenges in applicability to clinical practice
- Academic equipoise over how to interpret it in regards to revascularization
- No time for academic equipoise in cardiogenic shock + MVD
- CV surgeons and ICs: # standards in regards to the completeness of revascularization
- I still get viability testing in appropriate patients as a CHIP operator
STICH Trial: All-Cause Mortality as Per Protocol

HR 0.76 (0.62, 0.92)
P = 0.005

Velazquez EJ.
Coronary-Artery Bypass Surgery in Patients with Ischemic Cardiomyopathy.
STICH Trial: All-Cause Mortality as Treated

HR 0.70 (0.58 – 0.84)

P < 0.001

Velazquez EJ.
Coronary-Artery Bypass Surgery in Patients with Ischemic Cardiomyopathy.
STICH trial: Time-varying HRs for All-Cause Mortality in Pts. Randomized to CABG or OMT

Extent of coronary and myocardial disease and benefit from surgical revascularization in ischemic LV dysfunction [Corrected]. J Am Coll Cardiol. 2014 Aug 12;64(6):553-61
CABG vs PCI
Revascularization in HFrEF: All Cause Mortality in CABG vs PCI
a Meta-analysis of 16.191 Pts.

<table>
<thead>
<tr>
<th>Study name</th>
<th>Hazard ratio</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>Z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ann et al., JACC Abstract 2011</td>
<td>0.85</td>
<td>0.628</td>
<td>1.565</td>
<td>-0.622</td>
<td>0.602</td>
</tr>
<tr>
<td>ASAN-MAIN, TCT/JACC 2015</td>
<td>0.84</td>
<td>0.412</td>
<td>1.712</td>
<td>-0.480</td>
<td>0.631</td>
</tr>
<tr>
<td>AWESOME-RCT, Am J Cardiol 2004</td>
<td>0.88</td>
<td>0.471</td>
<td>1.626</td>
<td>-0.422</td>
<td>0.673</td>
</tr>
<tr>
<td>AWESOME-Registry, Am J Cardiol 2004</td>
<td>1.08</td>
<td>0.804</td>
<td>1.451</td>
<td>0.510</td>
<td>0.610</td>
</tr>
<tr>
<td>Bangalore et al., NEJM 2015</td>
<td>0.90</td>
<td>0.599</td>
<td>1.353</td>
<td>-0.507</td>
<td>0.612</td>
</tr>
<tr>
<td>Cieland et al., Eur J Heart Fail 2011</td>
<td>1.11</td>
<td>0.421</td>
<td>2.935</td>
<td>0.213</td>
<td>0.832</td>
</tr>
<tr>
<td>CREDO-Kyoto, Am J Cardiol 2014</td>
<td>0.64</td>
<td>0.390</td>
<td>1.050</td>
<td>-1.766</td>
<td>0.077</td>
</tr>
<tr>
<td>Gocia et al., Cath Cardiovasc Int 2007</td>
<td>1.38</td>
<td>0.602</td>
<td>3.142</td>
<td>0.755</td>
<td>0.450</td>
</tr>
<tr>
<td>Hannan et al., NEJM 2008</td>
<td>0.77</td>
<td>0.591</td>
<td>1.002</td>
<td>-1.942</td>
<td>0.052</td>
</tr>
<tr>
<td>IRIS-MAIN, TCT/JACC 2015</td>
<td>0.71</td>
<td>0.368</td>
<td>1.371</td>
<td>-1.020</td>
<td>0.308</td>
</tr>
<tr>
<td>LaBarbera et al., TCT/JACC 2012</td>
<td>0.68</td>
<td>0.559</td>
<td>0.828</td>
<td>-3.842</td>
<td>0.000</td>
</tr>
<tr>
<td>Nagendran et al., Ann Thorac Surg 2013</td>
<td>0.91</td>
<td>0.789</td>
<td>1.049</td>
<td>-1.299</td>
<td>0.194</td>
</tr>
<tr>
<td>REAL, Eur J Cardiothorac Surg 2013</td>
<td>0.63</td>
<td>0.466</td>
<td>0.852</td>
<td>-2.998</td>
<td>0.003</td>
</tr>
<tr>
<td>REHEAT, Am J Cardiol 2007</td>
<td>2.00</td>
<td>0.20591</td>
<td>5.941</td>
<td>0.596</td>
<td>0.551</td>
</tr>
<tr>
<td>Toda et al., Ann Thorac Surg 2002</td>
<td>0.85</td>
<td>0.488</td>
<td>1.475</td>
<td>-0.582</td>
<td>0.560</td>
</tr>
<tr>
<td>Yang et al., Am J Cardiol 2013</td>
<td>0.88</td>
<td>0.621</td>
<td>1.191</td>
<td>-0.907</td>
<td>0.365</td>
</tr>
<tr>
<td>OVERALL</td>
<td>0.82</td>
<td>0.752</td>
<td>0.900</td>
<td>-4.265</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Wolff G. et al.
Survival Benefits of Invasive Versus Conservative Strategies in Heart Failure in Patients With Reduced Ejection Fraction and Coronary Artery Disease: A Meta-Analysis
Circ Heart Fail. 2017 Jan;10(1). pii: e003255
Revascularization in HFrEF: Secondary End Points in CABG vs PCI
a Meta-analysis of 16,191 Pts.

Survival Benefits of Invasive Versus Conservative Strategies in Heart Failure in Patients With Reduced Ejection Fraction and Coronary Artery Disease:
A Meta-Analysis.
Circ Heart Fail. 2017 Jan;10(1). pii: e003255
Remember! : This is **NOT** a Job for the Faint of Heart
The **C.H.I.P** Patient

- old, frail pts. with many comorbidities
- hemodynamic support
- multivessel CAD
- bifurcations, trifurcations
- Left Main
- CTO
- rota amenable lesions
- etc, etc

Back to basics: PA catheter is your best friend

* Complex Higher Risk and Indicated Patient
Incomplete Revascularization is Common

Riley RF.
CHIP Seattle, August 10-11/ 2017
The negative impact of incomplete angiographic revascularization on clinical outcomes and its association with total occlusions: the SYNTAX (Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery) trial.

The Case for Complete Revascularization

Quantification and impact of untreated coronary artery disease after percutaneous coronary intervention: the residual SYNTAX (Synergy Between PCI with Taxus and Cardiac Surgery) score.

J Am Coll Cardiol. 2012 Jun 12;59(24):2165-74
Incomplete Revascularization in the DES Era:
NY State Registry Database, n: 11,294 MVD pts.

Hannan EL. et al.
Incomplete revascularization in the era of drug-eluting stents: impact on adverse outcomes.

Adjusted 18-Month Survival

Significant baseline differences
- age
- gender
- diabetes
- race
- prior MI
- PAD
- CHF
- # ds vessels
- LVEF
- type of stent

p 0.01
Outcomes after complete versus incomplete revascularization of patients with multivessel coronary artery disease: a meta-analysis of 89,883 patients enrolled in randomized clinical trials and observational studies.

The One Million Dollar Question: Define Complete Revascularization

<table>
<thead>
<tr>
<th>Anatomical or Traditional</th>
<th>all diseased arterial systems, vessel size 1.5 (2.0-2.25 mm for PCI) with at least one significant stenosis &gt; 50% receive a graft (or stent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional</td>
<td>all ischemic myocardial territories are grafted (or stented); areas of old infarction with no viable myocardium are not required to be reperfused</td>
</tr>
<tr>
<td>Numerical</td>
<td>number of distal anastomosis number of diseased coronary segments/ systems</td>
</tr>
<tr>
<td>Score-based</td>
<td>SYNTAX, NCDR</td>
</tr>
<tr>
<td>Physiology-based</td>
<td>all coronary lesions with FFR ≤ 0.80 -0.85 receive a graft or stent</td>
</tr>
</tbody>
</table>
What Do We Know About Health Status and Risk Prediction in the CHIP Population?

- Patients excluded from clinical trials
- Limited prospective data describing symptoms, function and quality of life after CHIP PCI
- Current procedural risk prediction tools were created using “standard risk” PCI
- No tools to help identify patients with greatest chance to benefit
Reasons viable myocardium may not recover function following revascularization

- Lengthy duration of hibernation
- Severe LV remodeling
- Sub-endocardial scar
- Procedure related necrosis
- Incomplete revascularization
- Timing of repeat LV assessment
- Graft occlusion or in stent restenosis
- Pre procedural factors
- Peri procedural factors
- Post procedural factors
Clinical Assessment and Heart Team Decision

Patient with ischemic heart failure

- Symptoms
- Comorbidities
- Local expertise
- Procedural risk
- Tailored optimal medical therapy
- Myocardium and LV morphology
- Coronary anatomy
- EP abnormalities
- Valvular disease
- Evidence base data

Evidence base data

Local expertise

Coronary anatomy

EP abnormalities

Myocardium and LV morphology

Tailored optimal medical therapy

Symptoms

Comorbidities
Case in Point: the Attention Seeking Case of Robinson Crusoe

➢ male, 61 years old
➢ Known CAD: CAGBx4 10 years ago
➢ Risk factors: DM/HT

➢ Multiple hospitalizations in the past months
➢ Cor.angio in another hospital 2 months prior: no SVGs patent
  LIMA > LAD patent
  Native vessels diffusely diseased
➢ Patient released with the indication for conservative treatment

➢ Admission in our department due to NSTEMI: on OMT
  EF of 20% with global hypokinesis
  ACC/AHA angina status class IV

➢ Referred to the Cardiothoracic Dept. for redo: pt. deemed inoperable
…When Interventionalists Dash to the Resque
...When Interventionalists Dash to the Rescue
...and with that...

I REST

MY CASE.