ARC WEBINAR

Intermountain Risk Score-Heart Failure and Myocardial Infarction Tool
(IMRS-HF and IMRS-MI)
Avoid Readmissions Through Collaboration

The collaborative is supported by Cynosure Health and the California Quality Collaborative (CQC), leading improvement experts in California, and is generously funded by the Gordon and Betty Moore Foundation.
Overview

• **Goal**
  – Reduce 30 and 90 day readmissions by 30%
• **Successes**
  – >3300 readmissions prevented and > 32 million saved in 2011+2012
  – ARC 2
• **Strategies**
  – Building a collaborative community with a shared goal
  – Sharing evidence-based transitions of care models and implementation practices
    • In-person learning sessions and webinars
  – On-site technical assistance
  – Data collection and monitoring

Please visit [www.avoidreadmissions.com](http://www.avoidreadmissions.com)
ARC 2 Participating Hospitals

San Francisco Bay Area
Alameda County Medical Center
Alta Bates Medical Center
California Pacific Medical Center
Chinese Hospital
Eden Medical Center
El Camino Hospital
Marin General Hospital
Mills Peninsula Hospital
O'Connor Hospital
Saint Francis Memorial Hospital
San Francisco General Hospital Medical Center
Santa Clara Valley Medical Center
Seton Medical Center
Stanford Hospital
St. Mary’s Medical Center
St. Rose Hospital
UCSF Medical Center
VA Medical Center San Francisco
VA Palo Alto Health Care System
ValleyCare Health System
Washington Hospital Healthcare System

Beyond the Bay
Lodi Memorial Hospital
Saint Francis, Lynwood
Saint Vincent Hospital
Sutter Delta Medical Center
Speaker

Benjamin D. Horne, PhD, MPH, FACC, FAHA, Director, Cardiovascular and Genetic Epidemiology, Intermountain Heart Institute
Adjunct Assistant Professor, Genetic Epidemiology Division, Department of Medicine, University of Utah
Intermountain Risk Scores and the Risk of 30-day Hospital Readmission

Benjamin D. Horne, PhD, MPH, FACC, FAHA

July 10, 2013
Beginnings of the Intermountain Risk Score

Question (2005) from Jeffrey L. Anderson, MD:

- Is it possible to create a risk stratification tool that
  - aggregates substantial baseline risk information,
  - uses data elements ubiquitously available for almost all patients,
  - is easily computed within the process of care,
  - adds negligible incremental cost, and
  - predicts early death?
IMRS utilizes common tests ordered for most hospitalized patients

- Those lab tests are very familiar to clinicians
- The lab tests are ubiquitous (most medical facilities have access to them)
- The incremental expense in most cases: $0.00
- Lab data are quantitative and electronic
  - IMRS can be computed and computerized easily
  - It can be delivered within the care process to clinicians
  - Clinicians do not have to take extra time to obtain the data or calculate the risk score
- IMRS contains medically relevant risk information about the underlying health condition of a patient, often regardless of the primary diagnosis
IMRS and Mortality in ICD Recipients

Moderate-risk vs. low-risk:
HR=2.62 (1.65, 4.16), p=4.7 x 10^{-5}

High-risk vs. low-risk:
HR=4.39 (2.61, 7.37), p=2.3 x 10^{-8}

IMRS 7 days Before Cardiac Transplant and Post-transplant Mortality

HR=2.37 (95% CI: 1.10, 4.94)
C-statistic: c=0.64
(N=193 male patients)
COPD Population: IMRS and 5-year Mortality


N=482 females

N=398 males

\( c=0.767 \)

\( c=0.671 \)
Trauma Population (N=9,538): IMRS and 30-day Mortality


**IMRS (Females)**

<table>
<thead>
<tr>
<th>Days</th>
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<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>10</td>
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<tr>
<td>15</td>
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<tr>
<td>20</td>
</tr>
<tr>
<td>25</td>
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<tr>
<td>30</td>
</tr>
</tbody>
</table>

Survival

1.00
0.98
0.96
0.94
0.92
0.90

3-censored
2-censored
1-censored

**IMRS (Males)**

<table>
<thead>
<tr>
<th>Days</th>
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</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>10</td>
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<td>15</td>
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<td>20</td>
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<td>25</td>
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<tr>
<td>30</td>
</tr>
</tbody>
</table>

Survival

1.00
0.98
0.96
0.94
0.92
0.90

3-censored
2-censored
1-censored

**c=0.783**

**c=0.772**
Association of IMRS with Rehospital for Incident Events (>1 year of follow-up)

**Figure 2** Validation population: hazard ratio plot for associations of Intermountain Risk Score categories with event-free survival following index hospitalization (in the second set of patients evaluated in the study) for: (A) heart failure readmission (*P ≤ 2.8 × 10⁻⁶*) and (B) incident myocardial infarction (among coronary artery disease patients only; **P ≤ 9.6 × 10⁻⁴**).
30-day Hospital Readmission

• Nationally, approximately one in five Medicare patients returns to the hospital within 30 days of discharge.
• The reasons for rehospitalization are many and varied, but it constitutes a serious issue in healthcare delivery (quality and cost).
• The Affordable Care Act mandates Medicare penalties for “excessive” 30-day all-cause readmission
  • The hospital is fined up to 3% of all annual Medicare reimbursement for excessive readmission of heart failure, myocardial infarction, and pneumonia patients
At Intermountain Healthcare, we have been working to improve the quality of medical care and to reduce costs for an extended length of time.

About a decade ago, the discharge medication program was shown to reduce 30-day and 1-year hospital readmissions for cardiac patients, as well as to improve survival.

Other efforts such as HF education (MAWDS) have been shown to improve survival and may have influenced readmission rates.

Hospital readmission rates at Intermountain hospitals are among the lowest in the nation.
Figure 1. Proportions of patients receiving the appropriate discharge prescriptions.

The 5 targeted medications were given as indicated to patients without documented contraindications before and more than 3 years after implementation of the discharge medication program (1998 and 2002, respectively). Data for 1998 and 2002 were collected through the same process. ACE = angiotensin-converting enzyme.
Association of the Discharge Medication Program with Readmissions

The discharge medication program has now been implemented in an electronic discharge tool at Intermountain that is used to:

- document clinical diagnoses and procedures (not ICD-9)
- perform med reconciliation, prescribe discharge medications
- order rehab, physical therapy, speech therapy, and etc.
- order home health, oxygen, post-discharge follow-up appts.
- document JCAHO core measures information
- access and document discharge education and post-procedure care instructions, and (for HF) MAWDS education
- document patient’s condition and where being discharged to

Used by physicians, pharmacists, nurses, PA/NPs, care managers
MAWDS

SELF-MANAGEMENT WITH MAWDS

Self-management is key to heart failure treatment. Teach Intermountain’s MAWDS mnemonic to help promote compliance with these important self-care steps:

MEDICATION “Take your Medications”
Make sure your patients understand the importance of medications in their heart failure management. Tell them which medications they are taking, and why. Most importantly, make sure they understand the necessity of taking their medications every day, even when they are feeling well.

ACTIVITY “Stay Active each day”
Many patients with heart failure are afraid to be active. For others, it just seems like too much of an effort. Encourage your patients to participate in some form of physical activity every day. Participation in a supervised cardiac rehabilitation program is a good way to help patients overcome their fears and understand their limits.

WEIGHT “Weigh yourself each day”
It is critical that your patients understand the importance of weighing themselves daily. Patients will be more likely to comply with daily weighing if they understand that you are concerned about their weight as it relates to heart failure. Patients should notify their provider when they gain more than 2 pounds in one day or 5 pounds from their usual target weight.

DIET “Follow your Diet”
A good diet — especially sodium restriction — is critical to heart failure management. Helping patients understand how to restrict their sodium and learn other important diet elements can be time consuming. A referral to a registered dietitian is recommended for most patients.

SYMPTOMS “Recognize your symptoms”
Make sure your patients know how to recognize the signs and symptoms of heart failure, and tell them what you want them to do when they experience them. The MAWDS Self-Care Diary and Living with Heart Failure booklet described at right provide an action plan to guide patients.

MAWDS Self-Care Diary: Encourage your patients to use the MAWDS self-care diary to record their daily weight and symptoms, and keep track of their medications and appointments. Reviewing the diary at every office visit promotes a partnership between you and your patient, and may help you better coordinate with other physicians involved in the patient’s care — thereby improving treatment outcomes and quality of life.

If your patient smokes, provide resources to help them quit. Intermountain provides a smoking cessation booklet for this purpose.

Other patient education resources: Intermountain also provides a Living with Heart Failure booklet, Heart Failure and Heart Failure Fixed Drug fact sheets, and a Managing Heart Failure DVD for patients. View and order these and other resources from I-printstore.com.

FOR MORE INFORMATION
Intermountain heart failure patient education materials:

- Clinicians can view and order materials from www.printstore.com or call (801) 442-2863.
- Send patients to intermountainhealth.org/heartfailure

Other helpful websites:
- Heart Failure Society of America (HFSA) — provider: www.hfsa.org
- American College of Cardiology: www.acc.org
- American Association of Heart Failure Nurses — provider: www.aahfn.org
- American Heart Association: www.heart.org

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HF Readmission Risk Models
(Not 30-day Readmission)

Table 1. Characteristics of Identified Publications Developing Models or Risk Scores to Predict Patient Readmission Risk After Heart Failure (HF) Hospitalization (Second Objective of Our Systematic Review)

<table>
<thead>
<tr>
<th>Source</th>
<th>Study Type</th>
<th>Data Source (Study Period)</th>
<th>Study Location</th>
<th>No. of Hospitals/No. of Patients</th>
<th>Study Outcome</th>
<th>Follow-up Period</th>
<th>Analytic Model</th>
<th>Derivation or Validation</th>
<th>C Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin and Goldman, 27, 1997</td>
<td>Prospective cohort</td>
<td>Medical record review (1993-1994)</td>
<td>Boston, Massachusetts</td>
<td>1/257</td>
<td>All-cause readmission or death</td>
<td>60 d</td>
<td>Cox proportional hazards regression</td>
<td>Derivation only</td>
<td>Not provided</td>
</tr>
<tr>
<td>Philbin and DiSalvo, 23, 1999</td>
<td>Retrospective cohort</td>
<td>SPARCS, from the New York State Department of Health (1995)</td>
<td>New York State</td>
<td>236/42,731^6</td>
<td>HF-specific readmission</td>
<td>1 y</td>
<td>Multivariate logistic regression</td>
<td>Derivation and validation</td>
<td>0.60</td>
</tr>
<tr>
<td>Felker et al, 28, 2004</td>
<td>RCT cohort</td>
<td>Collected during RCT (1997-1999)</td>
<td>United States</td>
<td>78/949</td>
<td>All-cause readmission or death</td>
<td>60 d</td>
<td>Multivariate logistic regression</td>
<td>Derivation only</td>
<td>0.69</td>
</tr>
<tr>
<td>Yamokoski et al, 29, 2007</td>
<td>RCT cohort</td>
<td>Collected during RCT (study period given)</td>
<td>United States and Canada</td>
<td>26/373</td>
<td>All-cause readmission</td>
<td>6 mo</td>
<td>Multivariate logistic regression</td>
<td>Derivation only</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Discharge Models for 30-day Readmission

- HF patients: Readmission risk stratification models
  - Keenan/Krumholz (2008, CMS claims data)
  - LACE Index (2010, Ottawa, Canada)
  - Amarasingham (2010, Parkland Health System, TX)
  - McNaughton (2013, Vanderbilt/KaiserPermanente)
  - Eapen (2013, Get With The Guidelines registry)
- Others:
  - HOSPITAL score (2013, medical pts at Partners/Harvard)
  - Riccardi (2012, PCI patients in NHLBI Dynamic Registry)
IMRS and 30-day Mortality in Patients with a Primary Diagnosis of Heart Failure

Horne BD et al. Conference of the American College of Cardiology, 2013
IMRS and All-Cause 30-day Readmission among Heart Failure Patients

Horne BD et al. Conference of the American College of Cardiology, 2013
IMRS-HF: a Newly-derived Risk Score for 30-day Readmission in HF Patients

• Among 3,461 females and 3,155 males with a primary diagnosis of heart failure, predictors of 30-day readmission included:
  • Females: length of hospital stay, hematocrit, sodium, creatinine
  • Males: age, length of stay, hematocrit, mean corpuscular volume, red cell distribution width, sodium, potassium, and creatinine
• Among 15 comorbidities, only peripheral vascular disease weakly predicted 30-day readmission, but it was excluded to simplify the risk calculation.
• Validation was performed in independent populations.
### IMRS-HF: Association with 30-day Readmission

<table>
<thead>
<tr>
<th>IMRS-HF Risk Group</th>
<th>Females Range</th>
<th>HR (95% CI)</th>
<th>Males Range</th>
<th>HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0 - 3</td>
<td>1.0 (referent)</td>
<td>0 - 8</td>
<td>1.0 (referent)</td>
</tr>
<tr>
<td>Moderate</td>
<td>4</td>
<td>3.37 (1.22, 9.31)*</td>
<td>9 - 14</td>
<td>2.95 (0.40, 21.81)</td>
</tr>
<tr>
<td>High</td>
<td>5 - 9</td>
<td>2.13 (0.88, 1.33)</td>
<td>15 - 19</td>
<td>8.58 (1.09, 67.70)*</td>
</tr>
</tbody>
</table>

**C-statistics**

<table>
<thead>
<tr>
<th></th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derivation</td>
<td>0.609</td>
<td>0.640</td>
</tr>
<tr>
<td>Validation</td>
<td>0.566 (p=0.06)</td>
<td>0.649 (p=0.003)</td>
</tr>
</tbody>
</table>

Horne BD et al. Conference of the American College of Cardiology, 2013
IMRS-HF: Association with 30-day Readmission

Horne BD et al. Conference of the American College of Cardiology, 2013
Validating IMRS-HF for 30-day Readmission

- Our validation c-statistics for IMRS-HF were similar to the GWTG-HF model (c=0.57 in females, c=0.65 in males compared to Eapen’s c=0.59).
- Currently we are working with other hospital systems to externally validate IMRS-HF. These hospital systems are part of the Federal Health Engagement Network (HEN) that Intermountain started through the leadership of Dr. Lucy Savitz and Dr. Brent James.
IMRS and 30-day Mortality among Myocardial Infarction Patients

IMRS and All-Cause 30-day Readmission among Myocardial Infarction Patients

IMRS-MI: a Risk Score Specifically for 30-day Readmission among Acute-MI Patients

• 51 variables were evaluated to determine what predicts risk of returning to the hospital within 30 days after discharge, including demographics, CBC components, BMP factors, cardiac risk factors, comorbidities, presentation, number of diseased variables, procedures, and discharge medications.

• Predictors of 30-day readmission among MI patients included:
  • Females (N=1,251): not smoking, atrial fibrillation, depression, longer length of hospital stay, more medications (no lab tests)
  • Males (N=2,850): age, mean corpuscular hemoglobin concentration, depression, longer length of stay, more medications

• Validation was performed in independent populations (N=546 females, 1,373 males)

Horne BD et al. Conference of the American College of Cardiology, 2013
IMRS-MI: Association with 30-day Readmission

Horne BD et al. Conference of the American College of Cardiology, 2013
IMRS-HF, IMRS-MI and 30-day Readmission

• Our readmission risk models provide new information that can risk stratify patients in a system where efforts over more than a decade have already been reducing hospital readmissions of cardiac patients and where an electronic discharge orders tool is in place.
• Our models are unique because they are sex-specific, demonstrating substantial differences between the genders in what predicts readmission.
• The predictive ability of IMRS-HF and IMRS-MI (c=0.60-0.65) is greater than other models for 30-day readmission (c≈0.55).
Admission Risk Score for Fetal Hypoxia

Table 4. Individual predictors of adverse neonatal outcome, Initial Risk Score model

- Maternal age > 35 years
- Current BMI
- Gestational age
- Nulliparity
- Maternal diabetes
- Maternal hypertension
- Preeclampsia
- Placental abruption
- Induction of labor
- Category II FHR in the first hour of monitoring

Table 5. Outcomes associated with Initial Risk Score (Derivation Population)

<table>
<thead>
<tr>
<th>Initial Risk Score</th>
<th>Risk Category</th>
<th>N</th>
<th>Percent of Cohort</th>
<th>Incidence of Adverse Neonatal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>Low</td>
<td>6,511</td>
<td>21.2%</td>
<td>0.23%</td>
</tr>
<tr>
<td>4-6</td>
<td>Moderate</td>
<td>15,676</td>
<td>51.1%</td>
<td>0.57%</td>
</tr>
<tr>
<td>7-14</td>
<td>High</td>
<td>8,515</td>
<td>27.7%</td>
<td>1.83%</td>
</tr>
</tbody>
</table>

High-Risk OB Patients: Intrapartum Risk Score for Fetal Hypoxia

Table 6. Individual predictors of adverse neonatal outcome, Intrapartum Risk Score model, as applied to Initial High Risk Score group.

- Chorioamnionitis
- Minimal FHR variability
- Recurrent FHR variable decelerations
- FHR tachycardia
- Prolonged FHR deceleration between 1 and 3 hours of monitoring
- Prolonged FHR deceleration between 3 and 5 hours of monitoring
- Initial Risk Score

Table 7. Outcomes associated with Intrapartum Risk Score (Derivation Population, Initial High Risk Score group)

<table>
<thead>
<tr>
<th>Intrapartum Risk Score</th>
<th>Risk Category</th>
<th>N</th>
<th>Percent of Initial High-Risk Cohort</th>
<th>Incidence of Adverse Neonatal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>Low</td>
<td>3853</td>
<td>45%</td>
<td>1.0%</td>
</tr>
<tr>
<td>2-6</td>
<td>Moderate</td>
<td>4378</td>
<td>51%</td>
<td>1.9%</td>
</tr>
<tr>
<td>7-14</td>
<td>High</td>
<td>284</td>
<td>3%</td>
<td>11.3%</td>
</tr>
</tbody>
</table>
Predicting 30-day Readmission

- 30-day readmission of MI and HF patients is challenging to predict.
- 30-day readmission and 30-day mortality are weakly related.
- IMRS-MI and IMRS-HF are new clinical decision tools for stratifying 30-day readmission risk that use data elements commonly available during a patient’s initial hospitalization and may aid in better personalizing patient care.
- We have also made risk scores for predicting 30-day readmission using data available at the time of the index admission so that hospitals can implement risk reducing measures during the index hospitalization (we expect these to be published later this year).
- We also are in the process of creating readmission risk scores for pneumonia patients.