Key performance and outcome indicators for heart failure

February 13, 2014

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Objectives

• To discuss previous work on development of heart failure quality indicators
• To discuss previous work related to measurement of heart failure quality indicators in Ontario
  – EFFECT study (process indicators)
  – CMAJ study (incidence/outcome indicators)
• Discuss methodological challenges in measuring the quality of heart failure care using indicators
Congestive heart failure (CHF)

• Leading cause of hospitalization and readmission for older people in Canada

• Prognosis for patients remains poor
  – 1-year mortality rate remains poor after first hospitalization (~33%) – worse prognosis than most cancers

• Multiple evidence-based therapies exist that can improve prognosis but are underutilized

• Focus of quality improvement activities in many jurisdictions
What are quality indicators?

“An instrument that is used to assess a measurable aspect of patient care as a guide to assessing performance of the health care organization or individual practitioners within the organization.” (JCAHO)

“A mechanism to quantify the degree of adherence to a standard of care” (AHRQ)
Donabedian quality of care indicator framework

- **Structure**: the attributes of settings where care is delivered
- **Process**: whether or not good medical/healthcare practices are followed
- **Outcome**: impact of the care on health status

http://www.ahrq.gov/research/findings/final-reports/medteam/figure2.html
Continuous Quality Improvement

Concept → Clinical Trials → Guidelines → Performance Indicators → Performance → Outcomes → Concept

An International Environmental Scan of Quality Indicators for Cardiovascular Care

Lusine Abrahamyan, MD, PhD, MPH, Nicole Boon, MSc, Linda R. Donovan, BScN, MBA, and Jack V. Tu, MD, PhD for the Canadian Cardiovascular Society Quality Indicators Steering Committee

ABSTRACT

Quality indicators (QIs) are increasingly being used to measure and improve the quality of cardiac care. We conducted an international environmental scan to identify and critically appraise published QI development initiatives addressing cardiovascular disease (CVD). A review of the peer-reviewed and grey English-language literature was conducted to identify published CVD QI development initiatives. The quality of identified studies was assessed using a modified version of the Appraisal of Guidelines for Research and Evaluation (AGREE) II QI tool—an instrument originally developed for the assessment of the quality of clinical practice guidelines. An initial literature search identified 2314 potentially relevant abstracts of peer-reviewed articles. After a review of the abstracts, 120 full texts were reviewed and 90 were selected for critical appraisal (n = 21). Most of the initiatives were conducted in North America (76%) and were published after 2005 (62%). The majority (6 of 6) of the AGREE II QI domain scores were skewed toward higher values, including the median score for the overall quality rating (83.3%). Of the CVD categories addressed within the 21 initiatives, heart failure was the most common (n = 10) QI indicator set, followed by acute coronary syndromes (n = 8). Considerable

Despite the availability of multiple evidence-based guidelines for the prevention and treatment of cardiovascular disease (CVD), a large practice gap exists between optimal and actual patterns of cardiac care. Increasingly, quality indicators (QIs) or performance measures are being used as tools to assess adherence to practice guidelines in routine clinical care and as the foundation of many quality improvement initiatives. QIs are typically developed to address clinical practices that have been identified as needing improvement, where significant variation in performance exists, and where evidence indicates that specific interventions can improve the quality of care. Clinical practice guidelines often serve as the basis for the development of QIs; however, they are distinct from one another. Guidelines are systematically developed statements designed to help clinicians make decisions about appropriate
<table>
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<th>Organization/Country</th>
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<th>IHD</th>
<th>AMI</th>
<th>HF</th>
<th>PCI</th>
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<tr>
<td><strong>Total QI sets</strong></td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>15</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<td>1</td>
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<tr>
<td><strong>Total unique QIs</strong></td>
<td>26</td>
<td>20</td>
<td>46</td>
<td>50</td>
<td>27</td>
<td>63</td>
<td>16</td>
<td>23</td>
<td>12</td>
<td>15</td>
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</table>
International environmental scan - heart failure indicators

- 15 indicator sets
- 50 unique indicators

Most common indicators

- ACEI/ARB in LVSD in eligible (15/15)
- Beta-blocker in LVSD in eligible (12/15)
- Evaluation of LV systolic function (10/15)
- Anticoagulants in AF in eligible (8/15)
- Assessment of patient weight (7/15)
- Patient education/discharge instructions (8/15)
- Appropriate initial laboratory tests/assessments in newly diagnosed (4/15)
- Assessment of clinical signs and/or symptoms of volume overload (4/15)
- Laboratory tests for patients on ACEI/diuretics/digoxin (4/15)
Canadian Cardiovascular Society (CCS) Heart Failure QI’s (2013)

- Daily assessment of blood chemistry: Electrolytes, BUN, creatinine
- Chest x-ray completed as part of initial evaluation
- Inhospital use of ACE or ARB
- Assessment of left ventricular function
- Documentation of 30 day readmission rate
- Patient education re heart failure management

http://ddqi.ccs.ca
## Heart failure indicator data sources

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<thead>
<tr>
<th>#</th>
<th>Category</th>
<th>Data Source</th>
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</tr>
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<td>Medications</td>
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<td>Yes &gt; 65 years</td>
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<td>Readmissions</td>
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<td>3</td>
<td>Death/Mortality</td>
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<td>4</td>
<td>Echo - outpatient</td>
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</tr>
<tr>
<td>5</td>
<td>Incidence</td>
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<td>Some</td>
</tr>
<tr>
<td>6</td>
<td>Preserved or Reduced LVEF</td>
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<td></td>
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<td>7</td>
<td>Quality of life</td>
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<td></td>
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<tr>
<td>8</td>
<td>Counselling</td>
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<td>No</td>
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<td>9</td>
<td>Cardiac rehab</td>
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<tr>
<td>10</td>
<td>Pt weights</td>
<td>✓</td>
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</tr>
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<td>11</td>
<td>Pt symptoms: SOB, edema</td>
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<td>No</td>
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<tr>
<td>12</td>
<td>Prevalence</td>
<td>?</td>
<td></td>
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</table>
“Ideal” subset methodology

All cases

Cases not eligible for process-of-care

Cases “ideal” to receive process-of-care

Cases with contra-indication to process-of-care
Effectiveness of Public Report Cards for Improving the Quality of Cardiac Care

The EFFECT Study: A Randomized Trial

Jack V. Tu, MD, PhD
Linda R. Donovan, BSc-N, MBA
Douglas S. Lee, MD, PhD
Julie T. Wang, MSc
Peter C. Austin, PhD
David A. Alter, MD, PhD
Dennis T. Ko, MSc

PUBLIC RELEASE OF HOSPITAL PERFORMANCE DATA is increasingly being mandated by policy makers with the goal of improving the quality of care.1-2 Advocates of report cards believe that publicly releasing performance data on hospitals will stimulate hospitals and clinicians to engage in quality improvement activities and increase the accountability and transparency of the health care system.3-4 Critics argue that publicly released report cards may contain data that are misleading or inaccurate and may unfairly harm the reputations of hospitals and clinicians.5-6 They also are concerned that report card initiatives may divert resources away from other important needs. Although there has been considerable debate, few empirical data exist to determine whether publicly released report cards on hospital performance improve the overall quality of care provided.

While several uncontrolled studies have suggested that certain report card initiatives have had a beneficial effect, no large randomized trials, to our knowledge, have been conducted to evaluate the effectiveness of public report cards on hospital performance. The EFFECT study was a population-based cluster randomized trial (Enhanced Feedback for Effective Cardiac Treatment [EFFECT]) of 86 hospital corporations in Ontario, Canada, with patients admitted for acute myocardial infarction (AMI) or congestive heart failure (CHF).

Intervention Participating hospital corporations were randomized to early (January 2004) or delayed (September 2005) feedback of a public report card on their baseline performance (between April 1999 and March 2001) on a set of 12 process-of-care indicators for AMI and 6 for CHF. Follow-up performance data (between April 2004 and March 2005) also were collected.

Main Outcome Measures The coprimary outcomes were composite AMI and CHF indicators based on 12 AMI and 6 CHF process-of-care indicators. Secondary outcomes were the individual process-of-care indicators, a hospital report card impact survey, and all-cause AMI and CHF mortality.

Results The publication of the early feedback hospital report card did not result in a significant statewide improvement in the early feedback group in either the composite AMI process-of-care indicator (absolute change, 1.5%; 95% confidence interval [CI], -2.2% to 5.1%; P=.43) or the composite CHF process-of-care indicator (absolute change, 0.6%; 95% CI, -4.5% to 5.7%; P=.81). During the follow-up period, the mean 30-day AMI mortality rates were 2.5% lower (95% CI, 0.1% to 4.9%; P=.045) in the early feedback group compared with the delayed feedback group. The hospital mortality rates for CHF were not significantly different.

Conclusion Public release of hospital-specific quality indicators did not significantly improve composite process-of-care indicators for AMI or CHF.

Trial Registration clinicaltrials.gov Identifier: NCT00187460

Tu JV, et al. JAMA 2009; 302 (21)
Enhanced Feedback for Effective Cardiac Treatment (EFFECT) study

• Hypothesis – Public release of hospital report cards would improve the quality of cardiac care provided
  – Heart attack (AMI), heart failure (CHF)

• Design – Cluster randomized trial of 86 hospital corporations in Ontario, Canada

• Data collected by trained cardiology research nurses using retrospective chart reviews.

• Intervention
  – Hospitals randomized to Early (Jan 2004) or Delayed (Sept 2005) feedback of a public report card on baseline performance (April 1999 to March 2001) on national AMI / CHF process-of-care quality indicators
  – Follow up data (April 2004 to March 2005) collected to assess for changes in quality indicators and outcomes

http://www.ccort.ca/EFFECTStudy.aspx
### CCORT CHF quality indicators

<table>
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<tr>
<th>PROCESS OF CARE QUALITY INDICATOR</th>
<th>MINIMUM TARGET LEVEL IN IDEAL CANDIDATES</th>
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<tbody>
<tr>
<td>ACEI at discharge</td>
<td>≥85%</td>
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<tr>
<td>Beta-blocker at discharge</td>
<td>≥50%</td>
</tr>
<tr>
<td>Warfarin for atrial fibrillation at discharge</td>
<td>≥85%</td>
</tr>
<tr>
<td>LV function in hospital or prior to admission</td>
<td>≥75%</td>
</tr>
<tr>
<td>Weights measured (≥50% days)</td>
<td>≥90%</td>
</tr>
<tr>
<td>Discharge instruction: medications</td>
<td>≥90%</td>
</tr>
<tr>
<td>Discharge instruction: salt/fluid restriction</td>
<td>≥90%</td>
</tr>
<tr>
<td>Discharge instruction: daily weights</td>
<td>≥90%</td>
</tr>
<tr>
<td>Discharge instruction: symptoms of worsening heart failure</td>
<td>≥90%</td>
</tr>
<tr>
<td>Discharge instruction: re follow-up appointment</td>
<td>≥90%</td>
</tr>
</tbody>
</table>

* Defined by CCORT/CCS CHF Quality Indicator Expert Panel 2002
130 Hospital Corporations Assessed for Eligibility

44 Hospital Corporations Excluded (42 low volume, 2 no longer acute care)

86 Hospital Corporations Randomized

Baseline—44 Hospital corporations randomized to early feedback report card (April, 1999 - March, 2001)

Early feedback report card January 2004

Hospital Report Card Impact Survey June 2004

Follow up—2 Hospital corporations unable to participate in follow up (April, 2004 – March, 2005)

Analysis—42 Hospital corporations 2 Hospital corporations excluded

Baseline—42 Hospital corporations randomized to delayed feedback report card (April, 1999 - March, 2001)

1 Hospital corporation withdrew

Hospital Report Card Impact Survey June 2004

Delayed feedback report card September 2005

Follow up—2 Hospital corporations unable to participate in follow up (April, 2004 – March, 2005)

Analysis—39 Hospital corporations 2 Hospital corporations excluded
Mean change in CHF quality indicators in hospitals after publication of Early Feedback report cards

<table>
<thead>
<tr>
<th>CHF Process-of-Care Indicators</th>
<th>Early Feedback Hospitals (N=42)</th>
<th>Delayed Feedback Hospitals (N=39)</th>
<th>Absolute Difference* Early vs Delayed % (95% CI)</th>
<th>P Value</th>
</tr>
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<tr>
<td></td>
<td>Baseline Follow up</td>
<td>Baseline Follow up</td>
<td></td>
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<tr>
<td>Co-Primary Composite Indicator</td>
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<tr>
<td>All 6 CHF indicators</td>
<td>54.8% 54.6%</td>
<td>51.8% 53.6%</td>
<td>0.6 (-4.5 to 5.7)</td>
<td>0.81</td>
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<td>Individual Process-of-Care Indicators</td>
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<tr>
<td>1. LVF assessment</td>
<td>47.9% 55.2%</td>
<td>43.4% 52.5%</td>
<td>1.2 (-5.3 to 7.7)</td>
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<td>2. Daily Weights</td>
<td>14.8% 24.0%</td>
<td>15.1% 22.7%</td>
<td>1.8 (-5.2 to 8.8)</td>
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<td>3. Counselling</td>
<td>68.4% 55.3%</td>
<td>66.7% 56.2%</td>
<td>-0.4 (-8.4 to 7.6)</td>
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<td>4. ACE I / ARB for LVSD</td>
<td>88.2% 92.4%</td>
<td>86.5% 86.1%</td>
<td>5.9 (1.0 to 10.7)</td>
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<td>5. Beta Blockers for LVSD</td>
<td>40.0% 71.7%</td>
<td>38.3% 67.7%</td>
<td>3.5 (-6.1 to 13.1)</td>
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<tr>
<td>6. Warfarin with A Fib</td>
<td>52.4% 64.2%</td>
<td>49.3% 63.6%</td>
<td>-0.2 (-6.5 to 6.2)</td>
<td>0.96</td>
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</table>

ACE I= Angiotensin-Converting Enzyme Inhibitor; ARB= Angiotensin Receptor Blocker; LVSD = Left Ventricular Systolic Dysfunction

*Absolute difference represents the mean relative improvement in each indicator in the early feedback hospitals as compared with the delayed feedback hospitals in the follow up patient cohort after adjusting for indicator performance in the baseline patient cohort and type of hospital. Positive values indicate better performance in the early feedback hospitals.
Trends in the incidence and outcomes of heart failure in Ontario, Canada: 1997 to 2007

Darwin F. Yeung MD, Nicole K. Boom MSc, Helen Guo MSc, Douglas S. Lee MD PhD, Susan E. Schultz MA MSc, Jack V. Tu MD PhD

Abstract

Background: Heart failure is a leading cause of admission to hospital, but whether the incidence of heart failure is increasing or decreasing is uncertain. We examined temporal trends in the incidence and outcomes of heart failure in Ontario, Canada.

Methods: Using population-based administrative databases of hospital discharge abstracts and physician health insurance claims, we identified 419,551 incident cases of heart failure in Ontario between Apr. 1, 1997, and Mar. 31, 2008. All patients were classified as either inpatients or outpatients based on the patient's location at the time of the initial diagnosis. We tracked subsequent outcomes through linked administrative databases.

Results: The age- and sex-standardized incidence of heart failure decreased 32.7% from 454.7 per 100,000 people in 1997 to 306.1 per 100,000 people in 2007 (p < 0.001). A comparable decrease in incidence occurred in both inpatient and outpatient settings. The greatest relative decrease occurred in patients aged 85 and over. Over the study period, 1-year risk-adjusted mortality decreased from 17.7% in 1997 to 16.2% in 2007 (p = 0.02) for outpatients, with a nonsignificant decrease from 35.7% in 1997 to 33.8% in 2007 (p = 0.1) for inpatients.

Interpretation: The incidence of heart failure decreased substantially during the study period. Nevertheless, the prognosis for patients with heart failure remains poor and is associated with high mortality.

Heart failure is a leading cause of admission to hospital and is associated with a poor long-term prognosis. In 1996, it was projected that the number of incident hospital admissions for heart failure in Canada would more than double by 2025 because of the aging population and increasing numbers of myocardial infarction survivors.1 By 2000, patients with heart failure accounted for the second highest number of hospital days in Canada, and the estimated 1-year case-fatality rate, after the first hospital admission, exceeded 35%.2,3 However, some recent studies suggest that admission and mortality rates for heart failure may actually be falling. It is unclear whether these changes represent lower rates of new incident cases, fewer readmissions, a shift to more outpatient care or improved survival.4,5

Methods

Study setting

We conducted a population-based study of patients in Ontario who received a diagnosis of heart failure for the first time between Apr. 1, 1997, and Mar. 31, 2008. Ontario accounts for 39% of the Canadian population.6 Its publicly funded Ontario Health Insurance Plan (OHIP) covers most physician and hospital services for all Ontario residents with no associated copayments.

This study was approved by the ethics review board of Sunnybrook Health Sciences Centre.

Identification of patients

Data were obtained from the linkage of 2 administrative databases: the Canadian Institute for Health Information's (CIHI) Discharge Abstract Database for hospital admission data (i.e., inpatient data) and the OHIP physicians claims database for ambulatory data (i.e., outpatient data). We identified heart failure events from the CIHI database using diagnosis codes 428 and 450 from the International Classification of Diseases (ICD), Ninth Revision Clinical Modification.
Trends in the incidence and outcomes of heart failure in Ontario, Canada: 1997 to 2007

Heart failure events 1997-2007
N= 5,175,179

Incident cases of HF
N= 419,551

Excluded N= 4,755,628
- HF within 5 years prior to index event = 4,740,154
- Not 1st incidence HF event in study period = 12,515
- Non Ontario resident = 381
- Aged < 20 or > 105 yrs = 2,608
- Dx date > date of death = 108
- Discharge date missing = 6

Inpatient setting
N= 216,190

Outpatient setting
N= 203,361

Yeung et al. CMAJ Aug 2012
Age-standardized trends in incidence of heart failure, by sex
Sex-standardized trends in incidence of heart failure, by age group

Yeung et al. CMAJ Aug 2012
HF Temporal trends – Readmission rates any reason

<table>
<thead>
<tr>
<th>Variable</th>
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<th>2007</th>
<th>% change 1997-2007</th>
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<td>N=16 777 N=14 462</td>
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<tr>
<td>Readmission for any reason</td>
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<td>30 day readmission rate</td>
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<td>Crude</td>
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<td>15.9</td>
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<tr>
<td>Risk adjusted</td>
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<td>15.9</td>
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<tr>
<td>1 year readmission rate</td>
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<tr>
<td>Crude</td>
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<td>45.5</td>
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<tr>
<td>Risk adjusted</td>
<td>49.0</td>
<td>45.6</td>
<td>-6.8</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Yeung DF et al. CMAJ 2012
## HF Temporal trends – Readmission rates for HF

<table>
<thead>
<tr>
<th>Variable</th>
<th>1997</th>
<th>2007</th>
<th>% change 1997-2007</th>
<th>P value</th>
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<tr>
<td><strong>Readmission for heart failure</strong></td>
<td></td>
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<tr>
<td><strong>30 day readmission rate</strong></td>
<td></td>
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<tr>
<td>Crude</td>
<td>4.2</td>
<td>3.6</td>
<td>-14.5</td>
<td>0.11</td>
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<tr>
<td>Risk adjusted</td>
<td>4.3</td>
<td>3.5</td>
<td>-19.2</td>
<td>0.040</td>
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<td><strong>1 year readmission rate</strong></td>
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<tr>
<td>Crude</td>
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<td>10.8</td>
<td>-18.2</td>
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Yeung DF et al. CMAJ 2012
<table>
<thead>
<tr>
<th>Variable</th>
<th>1997</th>
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<th>% change</th>
<th>P value</th>
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<tr>
<td>N=39 869 N=34 545</td>
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<tr>
<td>a) 30 day mortality rate</td>
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</tr>
<tr>
<td>- Crude</td>
<td>10.6</td>
<td>10.2</td>
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<td>11.2</td>
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<td>b) 1 year mortality rate</td>
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<tr>
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<tr>
<td>1 year mortality rates</td>
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<td>- Crude</td>
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<tr>
<td>- Risk adjusted</td>
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<td>0.13</td>
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<td>Outpatient</td>
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<tr>
<td>1 year mortality rates</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>- Crude</td>
<td>17.6</td>
<td>15.8</td>
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</tr>
<tr>
<td>- Risk adjusted</td>
<td>17.7</td>
<td>16.2</td>
<td>-8.3</td>
<td>0.020</td>
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</table>

Yeung DF et al. CMAJ 2012
Trends in heart failure management/outcomes

- Process-of-care measures have improved over time
- Most outcomes measures have also improved modestly
- Wide variations in care and outcomes persist
- Ideally performance measurement and report cards would be based on rich clinical data eg EFFECT study
  - However collecting high quality clinical data may be time consuming and expensive (ie chart abstraction or clinical registry)
  - Can we supplement admin data with a limited number of additional clinical variables?
Which ICD-codes to define heart failure?

- HF codes: ICD 9 428 – ICD 10 I50
- I50 Heart Failure
  - I50.0 Congestive Heart Failure
    - Congestive heart disease (CHF)
    - Right ventricular failure (2\textsuperscript{nd} to left heart failure)
  - I50.1 Left ventricular failure
    - Cardiac asthma
    - Left heart failure
    - Edema of lung, pulmonary edema with mention of heart disease or heart failure
  - I50.9 Heart failure unspecified
    - Cardiac, heart or myocardial failure NOS

Which codes to define heart failure (cont’d)

• HF may also involve other codes
  – I25.5 Ischemic cardiomyopathy
  – I40.x, I41.x Myocarditis
  – I42.x, I43.x Cardiomyopathies
  – I11.x plus I50.x (secondary Dx) Hypertensive heart disease plus heart failure, left ventricular dysfunction
  – I13.x plus I50.x (secondary Dx) Hypertensive heart disease and renal disease plus heart failure, left ventricular dysfunction

• Less clear-cut diagnosis than other diagnoses eg AMI, stroke
Framingham criteria for CHF

• Diagnosis of CHF = ≥ 2 major criteria or 1 major criterion + 2 minor criteria

• Major criteria
  • Paroxysmal nocturnal dyspnea
  • Neck vein distention
  • Rales
  • Radiographic cardiomegaly (increasing heart size on chest radiography)
  • Acute pulmonary edema
  • S3 gallop
  • Increased central venous pressure (>16 cm H2O at right atrium)
  • Hepatojugular reflux
  • Weight loss >4.5 kg in 5 days in response to treatment

• Minor criteria
  • Bilateral ankle edema
  • Nocturnal cough
  • Dyspnea on ordinary exertion
  • Hepatomegaly
  • Pleural effusion
  • Decrease in vital capacity by one third from maximum recorded
  • Tachycardia (heart rate>120 beats/min.)

• Sensitivity 100%; Specificity 78%
Identifying cases of congestive heart failure from administrative data: a validation study using primary care patient records

S. E. Schultz, MA, MSc (1); D. M. Rothwell, MSc (2); Z. Chen, MD (1); K. Tu, MD (1, 3, 4)

This article has been peer reviewed.

Abstract

Introduction: To determine if using a combination of hospital administrative data and ambulatory care physician billings can accurately identify patients with congestive heart failure (CHF), we tested 9 algorithms for identifying individuals with CHF from administrative data.

Methods: The validation cohort against which the 9 algorithms were tested combined data from a random sample of adult patients from EMRALD, an electronic medical record database of primary care physicians in Ontario, Canada, and data collected in 2004/05 from a random sample of primary care patients for a study of hypertension. Algorithms were evaluated on sensitivity, specificity, positive predictive value, area under the curve on the ROC graph and the combination of likelihood ratio positive and negative.

Validated algorithms using combinations of physician billing data and hospital discharge abstracts have been developed to identify patients with chronic disease conditions that do not necessarily require hospitalization, for example, hypertension, diabetes, ischemic heart disease and asthma. However, of the 35 studies listed in the systematic review conducted by Saczynski et al., only 9 used data from both hospital discharges and ambulatory claims data, and only 2 were also population-based, although the population was still limited to patients enrolled in a large...
Heart failure chronic disease algorithms

- Study by Schulz et al
  - Determining the prevalence of HF using administrative data
  - Used a combination of ON hospital admin data and ambulatory care physician billing data
    - One hospital record or physician billing followed by a second record from either source within one year
    - Sensitivity 84.8%, Specificity of 97.0%
    - Used ‘physician diagnosis’ of HF in EMR as gold standard
Outcome of Heart Failure with Preserved Ejection Fraction in a Population-Based Study

R. Sacha Bhatia, M.D., M.B.A., Jack V. Tu, M.D., Ph.D.,
Douglas S. Lee, M.D., Ph.D., Peter C. Austin, Ph.D., Jiming Fang, Ph.D.,
Annick Haouzi, M.D., Yanyan Gong, M.Sc., and Peter P. Liu, M.D.

ABSTRACT

BACKGROUND
The importance of heart failure with preserved ejection fraction is increasingly recognized. We conducted a study to evaluate the epidemiologic features and outcomes of patients with heart failure with preserved ejection fraction and to compare the findings with those from patients who had heart failure with reduced ejection fraction.

METHODS
From April 1, 1999, through March 31, 2001, we studied 2802 patients admitted to 103 hospitals in the province of Ontario, Canada, with a discharge diagnosis of heart failure whose ejection fraction had also been assessed. The patients were categorized in three groups: those with an ejection fraction of less than 40 percent (heart failure with reduced ejection fraction), those with an ejection fraction of 40 to 50 percent (heart failure with borderline ejection fraction), and those with an ejection fraction of
Preserved vs reduced ejection fraction

- **Left ventricular ejection fraction (LVEF)**
  - A measurement of how much blood is being pumped out of the left ventricle of the heart (the main pumping chamber) with each contraction, expressed as a percentage

- **Preserved (HFpEF)**
  - Heart muscle contracts normally but the ventricles do not relax as expected during ventricular filling or when ventricles relax

- **Reduced (HFREF)**
  - Heart muscle does not contract effectively, less oxygen-rich blood is pumped to body

### Ejection fraction (LVEF)

<table>
<thead>
<tr>
<th>Ejection fraction (LVEF)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50%</td>
<td>Preserved</td>
</tr>
<tr>
<td>40-50%</td>
<td>Borderline</td>
</tr>
<tr>
<td>&lt; 40%</td>
<td>Reduced</td>
</tr>
</tbody>
</table>
Adjusted survival curves for patients with HF with reduced or preserved ejection fraction over the year post first hospital admission

Bhatia et al NEJM 2006
Risk adjustment statistical models

• Takes into account case mix differences
• Important when comparing outcomes over time or between institutions
• Range from simple to complex models
• Both administrative and clinical data-based models have been developed
An Administrative Claims Model Suitable for Profiling Hospital Performance Based on 30-Day Mortality Rates Among Patients With Heart Failure
Harlan M. Krumholz, Yun Wang, Jennifer A. Mattera, Yongfei Wang, Lein Fang Han, Melvin J. Ingber, Sheila Roman and Sharon-Lise T. Normand

Circulation. 2006;113:1693-1701; originally published online March 20, 2006;
doi: 10.1161/CIRCULATIONAHA.105.611194
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2006 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539
Administrative claims models for Heart Failure

• Krumholz et al developed a hierarchical regression model using Medicare claims data to produce hospital risk standardized 30 day mortality rates
  – Based on 1998 derivation sample n = 222 424
• The final model included 24 variables
• C statistic 0.70
• Correlation between risk-standardized mortality rates from claims data and rates derived from medical record data was 0.95 (SE= 0.015)

Krumholz et al Circ 2006
## HF Admin Claims model – 30 day mortality (selected variables)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td>Age, years &gt;65</td>
<td>1.05</td>
<td>1.04-1.05</td>
</tr>
<tr>
<td>Male</td>
<td>1.28</td>
<td>1.24-1.31</td>
</tr>
<tr>
<td>Hx of HF</td>
<td>1.57</td>
<td>1.52-1.62</td>
</tr>
<tr>
<td>Hx of MI</td>
<td>1.24</td>
<td>1.19-1.30</td>
</tr>
<tr>
<td>Cardiopulmonary-resp failure/shock</td>
<td>1.20</td>
<td>1.16-1.25</td>
</tr>
<tr>
<td>Valvular disease</td>
<td>1.16</td>
<td>1.12-1.19</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.14</td>
<td>1.09-1.19</td>
</tr>
<tr>
<td>Renal failure</td>
<td>1.53</td>
<td>1.48-1.59</td>
</tr>
<tr>
<td>COPD</td>
<td>1.15</td>
<td>1.12-1.18</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1.16</td>
<td>1.12-1.19</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.11</td>
<td>1.08-1.14</td>
</tr>
<tr>
<td>Protein-calorie malnutrition</td>
<td>2.09</td>
<td>1.99-2.19</td>
</tr>
<tr>
<td>Dementia</td>
<td>1.47</td>
<td>1.42-1.52</td>
</tr>
<tr>
<td>Hemi/paraplegia/paralysis/disability</td>
<td>1.19</td>
<td>1.13-1.26</td>
</tr>
<tr>
<td>PVD</td>
<td>1.12</td>
<td>1.09-1.16</td>
</tr>
<tr>
<td>Metastatic cancer</td>
<td>2.22</td>
<td>2.11-2.35</td>
</tr>
<tr>
<td>Trauma in last year</td>
<td>1.09</td>
<td>1.06-1.12</td>
</tr>
<tr>
<td>Major psych disorder</td>
<td>1.10</td>
<td>1.05-1.16</td>
</tr>
<tr>
<td>Chronic liver disease</td>
<td>1.50</td>
<td>1.36-1.65</td>
</tr>
</tbody>
</table>

Krumholz et al Circ 2006
EFFECT Heart failure mortality prediction – HF risk index

- Stratify the risk of death in patients with HF, used at bedside
- Predict risk of death at 30 days & 1 year

Risk index variables
- Age
- Respiratory rate at hospital presentation
- Systolic BP at hospital presentation
- Blood urea nitrogen BUN
- Serum sodium < 136 Meq/L: Yes/No
- Comorbidities (if present)
  - Cerebrovascular disease
  - Dementia
  - Chronic obstructive pulmonary disease
  - Hepatic cirrhosis
  - Cancer
  - Anemia

Risk score
- < 60 = very low risk
- 61-90 = low risk
- 91-120 = intermediate risk
- 121-150 = high risk
- >150 = very high risk

C Statistic = 0.80 for 30 day mortality; 0.77 for 1 year mortality
Emergency Heart Failure Mortality Risk Grade (EHMRG)

- **Predict risk of death within 7 days of presentation to ED for HF**
- **May guide admission versus discharge decision making**

**Risk index variables**
- Age
- Arrival by ambulance
- Triage Systolic BP
- Triage heart rate
- Triage O2 saturation
- Potassium
- Creatinine
- Troponin
- Active cancer
- Metolazone
- BNP

**Risk score**
- $\leq -15.9$  
- -15.8 to 17.9
- 18.0 to 56.5
- 56.6 to 89.3
- $>89.4$

**Risk quintile**
- 1-2
- 3
- 4
- 5a
- 5b

- **C Statistic** = 0.80 derivation data set; 0.83 for validation data set

Conclusions

• A number of key heart failure performance and outcome indicators have been developed
  – Many can only be measured using clinical databases
• Inability to distinguish cases with preserved vs reduced ejection fraction is a key issue when using administrative data alone
• Need to design efficient clinical data collection mechanisms
• Significant improvements in certain processes of care but heart failure outcomes remain poor in Ontario
Acknowledgements

• We thank the following agencies for supporting the studies presented
  – Canadian Institutes of Health Research
  – Heart and Stroke Foundation of Ontario
  – Ontario MOHLTC
  – Public Health Agency of Canada

• The results and conclusions are those of the presenter, and should not be attributed to the funding agencies.
Thank You