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CLSA Webinar Series

Heart Failure: The Perfect Storm in an Aging Society

George Heckman, MD

Noon to 1 p.m. ET | April 27, 2017

Dr. George Heckman holds the Schlegel Research Chair for Geriatric Medicine at the University of Waterloo Research Institute for Aging, and is an associate professor with the School of Public Health and Health Systems at the University of Waterloo. He is an assistant clinical professor of medicine at McMaster University. He provides knowledge translation support for the Waterloo Wellington Local Health Integration Network. He has been primary panelist for the Canadian Cardiovascular Society Consensus Conference on Heart Failure since 2005 and vice-chair of the Quality Indicators for Heart Failure Working Group of the Canadian Cardiovascular Society.

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Heart Failure: The perfect storm in an aging society

George A. Heckman MD MSc FRCPC
RIA-UW Schlegel Research Chair in Geriatric Medicine
Associate Professor, School of Public Health and Health Systems, University of Waterloo
April 27, 2017
What is heart failure?

Complex *chronic* syndrome in which abnormal heart function results in, or increases the subsequent risk of, clinical symptoms and signs of low cardiac output and/or pulmonary or systemic congestion.
<table>
<thead>
<tr>
<th>DISEASE TYPE</th>
<th>ACUTE</th>
<th>CHRONIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONSET</td>
<td>SUDDEN</td>
<td>PROGRESSIVE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Latent Symptom Free Period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sudden “Exacerbation”</td>
</tr>
<tr>
<td>COURSE</td>
<td>BRIEF</td>
<td>LIFELONG, PROGRESSIVE</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>Usually Complete</td>
<td>Usually None</td>
</tr>
<tr>
<td></td>
<td>May Leave Permanent Consequences</td>
<td>Remissions and Relapses</td>
</tr>
<tr>
<td>CARE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- GOAL</td>
<td>CURE</td>
<td>Prolong Life</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintain Quality of Life</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintain Function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rehabilitation</td>
</tr>
<tr>
<td>- DURATION</td>
<td>BRIEF</td>
<td>LIFELONG</td>
</tr>
<tr>
<td>- COST</td>
<td>USUALLY MINIMAL</td>
<td>HIGH</td>
</tr>
</tbody>
</table>
The Cardiac Cycle

Ejection fraction: proportion of blood volume pumped by the ventricle during each contraction

HF with Preserved Ejection Fraction

*HFPEF* (EF > 45-50%)
Left ventricle is too stiff to adequately *fill* in diastole

HF with Reduced Ejection Fraction

*HFREF* (EF < 45-50%)
Left ventricle is too weak to adequately *pump* in systole
Why would heart function be abnormal?

- Coronary artery disease
- Hypertension
- Diabetes mellitus
- Viral cardiomyopathy
- Alcohol
- Chemotherapy
- Valvular heart disease

- Vascular ageing (more on this later)
Epidemiology
Bleumink Eur Heart J 04; Daamen et al 2009; Go et al 2014; Tran et al 2016

• Prevalence
  – Less than 65 years: 1%
  – 80 years+, long term care: 20%

• High mortality, morbidity, system use, cost

• Mortality after first hospitalization is 33% @ 1 year
  – over 60% if older, co-morbidities, dementia

• LTC mortality = 50% @ 1 year (90% if hospitalized)

• Most common cause of hospitalization in > 65 years
  – 3 month readmission rates 23% to 50%

• Inpatient costs: $2.8 billion by 2030
The burden of HF is increasing

Figure 3: Projected Incidence of New Heart Failure Patients, Canada

Source: Adapted from Statistics Canada, Population Projections for Canada, 2005
Projected HF Admissions in Canada

Hospital Separations for HF and for all Other Causes, Canada (excludes Quebec), 2005-2006

|                                | Heart Failure | Other Causes | Total     |
|                                |               |              |           |
| Number of people hospitalized   | 33,693        | 1,779,230    | 1,812,923 |
| Number of hospital separations  | 42,399        | 2,415,128    | 2,457,527 |
| Total number of comorbidities   | 166,084       | 5,589,258    | 5,755,342 |
| Mean number of comorbidities*   | 3.9           | 2.3          | 2.3       |
| per separation                  |               |              |           |
| In-hospital mortality (% of separations) | 13.3 | 4.4 | 4.6 |
| Mean LOS* (d)                   | 12.0          | 6.4          | 6.8       |

LOS, length of stay.
*Significant difference (t test).
HF treatments work but ...  
Chen et al JAMA 2011

- HF mortality in the 1970s was ~ 50% at one year
- Declined gradually until recent decades but stalled
- Median survival 2 years
- Overall mortality @ 5 years is 50%
- Overall mortality @ 10 years is 99%

- Recent US Medicare/Medicaid trends

---

Table 3. One-Year Mortality Rates After Heart Failure Hospitalization, 1999-2008

<table>
<thead>
<tr>
<th>Year</th>
<th>HF hospitalizations, No.</th>
<th>Overall rate, %</th>
<th>Rate by age, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>506,234</td>
<td>31.7</td>
<td>23.8</td>
</tr>
<tr>
<td>2000</td>
<td>511,176</td>
<td>31.4</td>
<td>23.4</td>
</tr>
<tr>
<td>2001</td>
<td>513,158</td>
<td>31.9</td>
<td>23.4</td>
</tr>
<tr>
<td>2002</td>
<td>513,205</td>
<td>31.2</td>
<td>22.5</td>
</tr>
<tr>
<td>2003</td>
<td>526,617</td>
<td>31.1</td>
<td>22.4</td>
</tr>
<tr>
<td>2004</td>
<td>521,486</td>
<td>30.6</td>
<td>21.7</td>
</tr>
<tr>
<td>2005</td>
<td>495,929</td>
<td>30.7</td>
<td>21.4</td>
</tr>
<tr>
<td>2006</td>
<td>457,777</td>
<td>30.7</td>
<td>20.9</td>
</tr>
<tr>
<td>2007</td>
<td>421,764</td>
<td>31.7</td>
<td>21.7</td>
</tr>
<tr>
<td>2008</td>
<td>398,963</td>
<td>32.0</td>
<td>22.0</td>
</tr>
</tbody>
</table>
How did we get here?

• We created a health care system for acute disease

• We then “created” a chronic disease that is most common in older persons

• The population is aging
The Evolution of the Canadian Health System

1957: *Hospital Insurance and Diagnostic Services Act* provided federal government cost sharing for public insurance for services offered in acute hospitals.

1984: *Canada Health Act*: Provinces responsible for administration & delivery, how much money they will spend.

Insured Services: Medically necessary hospital inpatient & ambulatory services
- Medically necessary = services provided by a physician in office, hospital or other settings.

Services funded, at least in part, by provinces, but not covered by Canada Health Act:
- Drug Plans
- Home Care, Supportive housing
- Long-Term Care
- Non-hospital Rehabilitation

Added after the fact, piece-meal, *not* integrated.
Consequences

• System centered on hospital care and geared towards *acute* illnesses
  – Care processes (and fee schedule) designed to address acute problems
  – Clinician training mainly hospital-based, as opposed to community

• *More on the system later...*
Enter Evidence-based cardiology

• Hypertension control
• Better therapies for acute myocardial infarction and coronary artery disease
• Pharmaceuticals: statins, anti-platelet, ACE inhibitors
• Prevention: fall in smoking rates
• Rehabilitation
CVD mortality has fallen substantially

Public Health Agency of Canada

Figure 4-17

Rates of death due to heart attack*, by sex and year, Canada, 1969-2004

The price of success...

People living longer with cardiovascular disease

**Figure 4.4** Rates of hospitalization due to ischemic heart disease*, by sex and age group, Canada, 2005/06
... and many live to develop heart failure...

![Figure 4-25](image)

**Figure 4-25** Rates of hospitalization due to congestive heart failure*, by sex and age group, Canada, 2005/06

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>75-84</th>
<th>85+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women</strong></td>
<td>3.2</td>
<td>6.6</td>
<td>26.2</td>
<td>108.7</td>
<td>395.9</td>
<td>1,155.9</td>
<td>2,737.0</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>3.7</td>
<td>11.5</td>
<td>50.0</td>
<td>198.0</td>
<td>622.4</td>
<td>1,595.2</td>
<td>3,373.3</td>
</tr>
<tr>
<td><strong>Both</strong></td>
<td>3.5</td>
<td>9.1</td>
<td>38.0</td>
<td>152.8</td>
<td>503.6</td>
<td>1,339.2</td>
<td>2,934.4</td>
</tr>
</tbody>
</table>

*ICD-10-CA code: I50. Notes: Hospitalizations are based on the most responsible diagnosis for the length of stay in hospital. Québec data not available in 2005/06. Source: Chronic Disease Surveillance Division, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using data from the Hospital Morbidity Database (Canadian Institute for Health Information).
To sum up...

• Evidence-based cardiology has led to significantly greater survival of persons affected with cardiovascular risk factors and cardiovascular disease
  – However, they are NOT cured of these
  – The grow old WITH these conditions
  – These conditions become CHRONIC

• Many eventually develop CHRONIC heart failure

• But what else happens as we age?
“A man is as old as his arteries.” Thomas Sydenham, 1624-1689

Women too...

George Heckman, now
First, a bit of wave physics...

When the densities of the two media are closely matched, there is

• More wave transmission
• Less wave reflection
• Elastic arteries
  • Aorta and major branches
• Muscular arteries and arterioles
• Capillary bed
Arteries are conduits for blood pressure waves

**Elastic arteries**
- Major distribution vessels: aorta & major branches
- Walls contain elastin to accommodate blood ejected by heart

**Muscular arteries**
- Include arms and legs
- Distribute and regulate blood flow more distally

**Arterioles**
- Muscular vessels that **cushion/dampen** fragile capillary beds/organs from systemic blood pressures & mediate peripheral vascular resistance

*Different impedance!*
Vascular physiology

- Systole: ejection of blood
  - Elastic arteries expand to accommodate pressure, thus storing elastic energy

- Systolic blood pressure: 120/70
When a wave hits a boundary...

Elastic arteries

Muscular arteries/arterioles

Incident wave → Rigid boundary

Rarer

Denser

Trasmitted wave

Reflected wave

A
Vascular physiology

• Partially reflected pressure wave goes back towards the heart
• Normally arrives just *after* diastole begins
• Diastole: aortic valve closes
  – Elastic arteries contract: release stored energy
    • Supports diastolic blood pressure: 120 / 70
    • Also supplies coronary arteries and heart itself
Changes with age: from *distensible balloon* to *stiff garden hose*

- **Elastic arteries**
  - Fractured elastin: *wear and tear*
  - Replaced by more collagen
  - Thickening of wall
    - Stiffer vessel

- **Muscular arteries**
  - Endothelial dysfunction
  - Increased muscular tone
Abnormal physiology

- Systole: ejection of blood
  - Major arteries can’t expand to accommodate pressure
  - Systolic blood pressure rises: 120/70 -> 170/?
• Pressure wave travels faster towards muscular arteries
  – Less mismatched “stiffness”
    • Less pressure wave reflection
    • More pressure transmission: to brain, kidneys

• Partially reflect wave heads back
  – Arrives early while heart is still in systole
    • Heart has to work harder
    • Too early to supply coronary arteries: less blood for the heart itself
    • Too early to support diastole blood pressure which falls
    • 170/50
Consequences of vascular aging

• Increased vascular resistance and higher blood pressure
  – Increased heart workload
  – Cardiac muscle enlargement “hypertrophy” and stiffness
  – Decreased blood supply: ischemia

• Hypertension:
  – Strokes
  – Dementia
  – Kidney failure

• Low diastolic blood pressure: falls, fainting, brain impact...
Lack of physical activity is a major risk factor for vascular aging!

From Heckman et al, Hazzard’s Text., 2017
In summary...

• Vascular aging leads to additional cardiac injury over time which increases risk for heart failure

• Contributes to general cardiovascular risk

• Leads to additional comorbidities

• *But wait! There’s more!*
HF is a cardiogeriatric syndrome
Newman 2001; Rich 2001; Vogels 2007; Afilalo 2012; Harkness 2012

• Heart failure is associated with greater risk for
  – Frailty
  – Cognitive impairment
  – Atypical disease presentation
  – Functional decline
  – Incontinence
  – Polypharmacy

• Combination leads to more rapid decline, frequent decompensation, hospitalization, death
# Ontario Home Care Care clients with HF (2004-7): RAI HC outcomes

Foebel, Hirdes, Heckman et al, Age & Ageing 2011

<table>
<thead>
<tr>
<th>Variable</th>
<th>HF Sample N = 21,968</th>
<th>Non-HF Sample N = 154,898</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (SD) years</td>
<td>82.8 (7.2)</td>
<td>81.2 (7.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender (Female)</td>
<td>58.8%</td>
<td>64.1%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Living Alone</td>
<td>33.4%</td>
<td>35.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cognitive Performance Scale &gt; 0</td>
<td>53.8%</td>
<td>55.9%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Depression Rating Scale &gt; 0</td>
<td>37.4%</td>
<td>37.4%</td>
<td>0.75</td>
</tr>
<tr>
<td>ADL Hierarchy Scale &gt; 0</td>
<td>44.2%</td>
<td>39%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Aggressive Behavior</td>
<td>10.0%</td>
<td>12.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Comorbid Conditions</td>
<td>4.0 (2.0)</td>
<td>3.3 (1.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Medication Count</td>
<td>8.44 (4.0)</td>
<td>6.8 (3.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Home Care Service Use</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Homemaking</td>
<td>35.9%</td>
<td>31.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Nursing</td>
<td>33.9%</td>
<td>25.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Physical Therapy</td>
<td>11.1%</td>
<td>12.3%</td>
<td></td>
</tr>
</tbody>
</table>
## Disposition of HF Patients by Age Ontario, 2011

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Discharged Home</th>
<th>Transfers</th>
<th>Other</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Support Services</td>
<td>With Support Services</td>
<td>Acute Inpatient Facility</td>
<td>Continuing Care Facility</td>
</tr>
<tr>
<td>20-24</td>
<td>0.1%</td>
<td>0.0%</td>
<td>0.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>25-29</td>
<td>0.2%</td>
<td>0.0%</td>
<td>0.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>30-34</td>
<td>0.4%</td>
<td>0.2%</td>
<td>0.3%</td>
<td>0.1%</td>
</tr>
<tr>
<td>35-39</td>
<td>0.6%</td>
<td>0.1%</td>
<td>0.7%</td>
<td>0.1%</td>
</tr>
<tr>
<td>40-44</td>
<td>1.0%</td>
<td>0.1%</td>
<td>1.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>45-49</td>
<td>1.6%</td>
<td>0.6%</td>
<td>3.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>50-54</td>
<td>3.2%</td>
<td>1.4%</td>
<td>3.0%</td>
<td>0.4%</td>
</tr>
<tr>
<td>55-59</td>
<td>5.2%</td>
<td>2.2%</td>
<td>6.2%</td>
<td>0.7%</td>
</tr>
<tr>
<td>60-64</td>
<td>8.2%</td>
<td>3.5%</td>
<td>10.8%</td>
<td>2.0%</td>
</tr>
<tr>
<td>65-69</td>
<td>10.7%</td>
<td>6.5%</td>
<td>13.4%</td>
<td>3.6%</td>
</tr>
<tr>
<td>70-74</td>
<td>13.9%</td>
<td>8.0%</td>
<td>15.0%</td>
<td>6.6%</td>
</tr>
<tr>
<td>75-79</td>
<td>15.8%</td>
<td>14.6%</td>
<td>16.7%</td>
<td>11.1%</td>
</tr>
<tr>
<td>80-84</td>
<td>18.3%</td>
<td>22.0%</td>
<td>14.8%</td>
<td>20.1%</td>
</tr>
<tr>
<td>85-89</td>
<td>14.3%</td>
<td>23.3%</td>
<td>10.9%</td>
<td>28.6%</td>
</tr>
<tr>
<td>90+</td>
<td>6.7%</td>
<td>17.6%</td>
<td>3.0%</td>
<td>26.4%</td>
</tr>
<tr>
<td>Totals</td>
<td>50.1%</td>
<td>23.0%</td>
<td>3.6%</td>
<td>13.3%</td>
</tr>
</tbody>
</table>
Heart Failure:

The BIG picture

Patient centered outcomes

1. Optimal HF therapies through to advanced stages

2. Engagement of patients and caregivers in self-care
   i. To monitor symptoms and weights for decompensation detection and timely intervention
   ii. Define care goals
   iii. Advance care planning

Medical Complexity, Mental Health and Frailty Burden on patient, caregiver, and health care system

Arrows = death

Optimization of therapy, including surgery or devices

Terminal phase

Usual course

Independent Community living
Rehabilitative / community support services
Institutionalization/ Hospice palliative care

Functional capacity/Quality of life
Heart Failure in 2017: a perfect storm

• More persons affected
  – Better treatments (not cures) for CV disease
  – Vascular aging and its consequences
  – Population ageing

• Rising patient complexity
  – Geriatric syndromes
  – Comorbidities
  – Risk of recurrent episodes and progressive decline to death

• A complex, fragmented system designed for acute problems
  – Heavy multisector resource use
  – Multiple transitions
Implications

O’Connor JACC: Heart Failure 2017; Beaulieu CMAJ 2013; Fenton 2006

• Health care systems with better HF outcomes have better outcomes overall

• Substantial evidence on how to manage heart failure
  – Inpatient care
  – Chronic disease management programs
  – Transitional care
  – Palliative care

• Increased primary care, long term care capacity:
  – Shared care models: specialists embedded in primary care
  – Interprofessional care
  – Adapt fee schedules
  – Clinician training implications

• Greater system integration is required
Prevention

• Physical activity to prevent vascular aging: public health issue

• CLSA: opportunity to look at vascular aging
  – Consider adding measures of vascular stiffness

• Astronaut arteries age 10 to 30 years in space
Conclusions

• Heart failure is an archetype
  – Common
  – Geriatric
  – Multimorbidity
  – High system impact

• Lots of evidence: we know what to do

• We just need to do it

• Fix heart failure, fix the health care system
Helpful resources and references

• Guidelines (update this year): [https://www.ccs.ca/en/heart-failure-program](https://www.ccs.ca/en/heart-failure-program)


• O’Connor CM: *High Heart Failure Readmission Rates: Is It the Health System’s Fault?* JACC: Heart Failure 2017: [http://dx.doi.org/10.1016/j.jchf.2017.03.011](http://dx.doi.org/10.1016/j.jchf.2017.03.011)


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Multimorbidity in Canada
Philip St. John, MD
Associate Professor, University of Manitoba
Co-lead Manitoba site investigator, CLSA

May 24, 2017 | Noon ET

Register: bit.ly/clsaawebinars