How Do We Use Frailty Index to Optimize Results for Our Patients?

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Division of Vascular Surgery and Endovascular Therapy
The Johns Hopkins Hospital
DISCLOSURE
Christopher Abullarage, MD
• No relevant financial relationship reported
Frailty

• A biologic syndrome defined by a culmination of declining physiologic systems resulting in decreased reserve and resistance to stressors culminating in vulnerability to adverse outcomes

• How sick is this patient I am about to operate on?

• What is their risk of complications?
Background

• Patient Frailty
  – Important preoperative assessment
    • Determine if patients will survive the procedure
    • Will patients live long enough to benefit from the intervention
  – Independent predictor of adverse outcomes across many specialties
  – How to quantify frailty?
  – Applicability to vascular surgery?
Measures of Risk

• Eye ball test

• Traditional
  – ASA class, RCRI

• Calculated Frailty Indices
  – Canadian Study on Health and Aging
  – NSQIP mFI

• Online Calculators
Measures of Risk
Eyeball test

“I shall not today attempt further to define the kinds of material I understand to be embraced within ‘hard-core pornography’, and perhaps I could never succeed in intelligibly doing so. But I know it when I see it…”

– Judge Potter Stewart, Jacobellis v. Ohio, 1966
Measures of Risk

Eyeball test

Original article

Predicting postoperative morbidity by clinical assessment

P. M. Markus, J. Martell, I. Leister, O. Horstmann, J. Brinker and H. Becker

Department of General Surgery, Georg-August Universität Goettingen, Robert Kochstrasse 40, 37075 Goettingen, Germany


• Only study to evaluate surgeon’s assessment of perioperative risk
• 1077 patients – major abdominal surgery
• Surgeon’s gut feeling vs. Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM)
Measures of Risk

Eyeball test

Conclusions

- Surgeon’s gut feeling is a good predictor of postoperative outcome

Predicting postoperative morbidity by clinical assessment

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Problems

• Only abdominal and hepatobiliary surgery

• Not reproducible
  – Interobserver variability is invariably high
# Measures of Risk

## Traditional

### ASA Classification

<table>
<thead>
<tr>
<th>ASA PS Classification</th>
<th>Definitions</th>
<th>Examples, including, but not limited to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA 1</td>
<td>Normal healthy patient</td>
<td>Non-smoking, Minimal etoh.</td>
</tr>
<tr>
<td>ASA 3</td>
<td>Severe systemic disease</td>
<td>ESRD on dialysis, Poorly controlled HTN/DM, Substance abuse, Moderate CHF, Moderate/severe functional limitations.</td>
</tr>
<tr>
<td>ASA 4</td>
<td>Systemic disease that is a constant threat to life</td>
<td>Recent MI, CVA, TIA, stents (&lt;3 mos), Severe CHF, Active CAD, Severe valvular dysfunction, Sepsis. ESRD not on dialysis.</td>
</tr>
<tr>
<td>ASA 5</td>
<td>Moribund patient who is not expected to survive w/o the operation</td>
<td>Ruptured TAAA, ruptured AAA, massive trauma, ICH with MLS</td>
</tr>
<tr>
<td>ASA 6</td>
<td>Organs are being removed for donation</td>
<td></td>
</tr>
</tbody>
</table>
Measures of Risk
ASA Class

- ACS-NSQIP
- 2 million surgical cases
- Multiple surgical specialties
- Purpose: Assess predictive value of ASA class for complications and mortality
Measures of Risk
ASA Class

Original research

ASA class is a reliable independent predictor of medical complications and mortality following surgery

Nicholas J. Hackett a, Gildasio S. De Oliveira b, Umang K. Jain a, John Y.S. Kim a, *

a Department of Surgery, Northwestern University, Chicago, IL, USA
b Department of Anesthesiology, Northwestern University, Chicago, IL, USA

Table 3
Regression results of ASA PS a,b.

<table>
<thead>
<tr>
<th>ASA PS</th>
<th>Medical complications</th>
<th>95% confidence interval</th>
<th></th>
<th></th>
<th></th>
<th>Mortality</th>
<th>95% confidence interval</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P value</td>
<td>Odds ratio</td>
<td>Lower</td>
<td>Upper</td>
<td>P value</td>
<td>Odds ratio</td>
<td>Lower</td>
<td>Upper</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 (reference)</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>1 (reference)</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.000</td>
<td>2.049</td>
<td>1.956</td>
<td>2.146</td>
<td>0.000</td>
<td>5.769</td>
<td>4.033</td>
<td>8.253</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.000</td>
<td>4.995</td>
<td>4.767</td>
<td>5.233</td>
<td>0.000</td>
<td>47.171</td>
<td>33.11</td>
<td>67.203</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.000</td>
<td>16.809</td>
<td>16.008</td>
<td>17.650</td>
<td>0.000</td>
<td>292.895</td>
<td>205.479</td>
<td>417.499</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.000</td>
<td>63.254</td>
<td>57.968</td>
<td>69.022</td>
<td>0.000</td>
<td>2011.921</td>
<td>1403.249</td>
<td>2884.609</td>
<td></td>
</tr>
<tr>
<td>Z-score c</td>
<td>0.000</td>
<td>1.426</td>
<td>1.417</td>
<td>1.436</td>
<td>0.000</td>
<td>2.123</td>
<td>2.092</td>
<td>2.154</td>
<td></td>
</tr>
</tbody>
</table>

Heart and Vascular Institute

JOHNS HOPKINS MEDICINE
Measures of Risk
ASA Class

Original research

ASA class is a reliable independent predictor of medical complications and mortality following surgery

Nicholas J. Hackett, Gildasio S. De Oliveira, Umang K. Jain, John Y.S. Kim

*American Society of Anesthesiologists Physical Status Classification
Measures of Risk
Traditional

**REVISED CARDIAC RISK INDEX**

<table>
<thead>
<tr>
<th>Independent Predictors of Post Operative cardiac complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intrathoracic, intraperitoneal, or infrainguinal vascular surgery</td>
</tr>
<tr>
<td>2. History of ischemic heart disease</td>
</tr>
<tr>
<td>3. History of congestive heart failure</td>
</tr>
<tr>
<td>4. Insulin treatment for diabetes mellitus</td>
</tr>
<tr>
<td>5. Serum creatinine level &gt; 2mg/dL</td>
</tr>
<tr>
<td>6. History of cerebrovascular disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scoring (no. of predictors present)</th>
<th>Risk of major cardiac complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.4%</td>
</tr>
<tr>
<td>One</td>
<td>0.9%</td>
</tr>
<tr>
<td>Two</td>
<td>7.0%</td>
</tr>
<tr>
<td>More than two</td>
<td>11%</td>
</tr>
</tbody>
</table>
Measures of Risk
RCRI

- 24 studies
- RCRI good for everything but vascular surgery
Measures of Risk

CSHA Frailty Index

A global clinical measure of fitness and frailty in elderly people

Kenneth Rockwood, Xiaowei Song, Chris MacKnight, Howard Bergman, David B. Hogan, Ian McDowell, Arnold Mitnitski  CMAJ • AUG. 30, 2005; 173 (5)

- Canadian Study on Health and Aging
  - 2305 elderly patients
- 70 measures
- Purpose: “Develop a tool that would be both predictive and easy to use”
Measures of Risk

CSHA Frailty Index

A global clinical measure of fitness and frailty in elderly people

Kenneth Rockwood, Xiaowei Song, Chris Macknight, Howard Bergman, David B. Hogan, Ian McDowell, Arnold Mittnacht CMAJ • AUG. 30, 2005; 173 (5)

Table 2: Cox proportional hazard ratios (HR) for time until death and until the requirement for institutional care

<table>
<thead>
<tr>
<th>Factor</th>
<th>Death, HR (95% CI)</th>
<th>Entry into institution, HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.08 (1.07–1.08)</td>
<td>1.15 (1.10–1.13)</td>
</tr>
<tr>
<td>Sex</td>
<td>0.83 (0.78–0.89)</td>
<td>1.38 (1.21–1.58)</td>
</tr>
<tr>
<td>Education level*</td>
<td>0.98 (0.97–0.99)</td>
<td>0.98 (0.97–0.99)</td>
</tr>
<tr>
<td>Modified Mini-Mental State Examination</td>
<td>0.84 (0.82–0.86)</td>
<td>0.65 (0.60–0.70)</td>
</tr>
<tr>
<td>Cumulative Illness Rating Scale</td>
<td>1.14 (1.11–1.17)</td>
<td>1.22 (1.16–1.27)</td>
</tr>
<tr>
<td>CSHA measuring tools Rules-based definition of frailty</td>
<td>1.17 (1.13–1.20)</td>
<td>1.27 (1.19–1.35)</td>
</tr>
<tr>
<td>Frailty Index</td>
<td>1.26 (1.24–1.29)</td>
<td>1.56 (1.48–1.65)</td>
</tr>
<tr>
<td>Function Scale</td>
<td>1.16 (1.13–1.20)</td>
<td>1.29 (1.20–1.39)</td>
</tr>
<tr>
<td>Clinical Frailty Scale</td>
<td>1.30 (1.27–1.33)</td>
<td>1.46 (1.39–1.53)</td>
</tr>
</tbody>
</table>

Note: CI = confidence interval, CSHA = Canadian Study of Health and Aging. All scales were adjusted for age, sex and number of years of education, and recategorized into 7-level scales to compare with the Clinical Frailty Scale.

*Univariate estimate.

Pearson Coefficient 0.80, P<0.01
Measures of Risk
CSHA Frailty Index

• Changes in everyday activities
• Head and neck problems
• Poor muscle tone in neck
• Bradykinesia, facial
• Problems getting dressed
• Problems with bathing
• Problems carrying out personal grooming
• Urinary incontinence
• Toileting problems
• Bulk difficulties
• Rectal problems
• Gastrointestinal problems
• Problems cooking
• Sucking problems
• Problems going out alone
• Impaired mobility
• Musculoskeletal problems
• Bradykinesia of the limbs
• Poor muscle tone in limbs
• Poor limb coordination
• Poor coordination, trunk
• Poor standing posture
• Irregular gait pattern
• Falls
• Mood problems
• Feeling sad, blue, depressed
• History of depressed mood
• Tiredness all the time
• Seizures, partial complex
• Seizures, generalized
• Syncope or blackouts
• Headache
• Cerebrovascular problems
• History of stroke
• History of diabetes mellitus
• Arterial hypertension
• Peripheral pulses
• Cardiac problems
• Myocardial infarction
• Arrhythmia
• Congestive heart failure
• Lung problems
• Respiratory problems
• History of thyroid disease
• Thyroid problems
• Skin problems
• Malignant disease
• Breast problems
• Abdominal problems
• Presence of snout reflex
• Presence of palomental reflex
• Other medical history

70 Data Points
# Measures of Frailty

**mFI**

- **Modified Frailty Index**
  - 11 data points
  - Time efficient, easy to use

<table>
<thead>
<tr>
<th>General</th>
<th>PAD</th>
<th>CAD</th>
<th>CVD</th>
<th>Comorbid Dz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impaired sensorium</td>
<td>CLI</td>
<td>Recent MI/angina</td>
<td>TIA/Stroke</td>
<td>HTN</td>
</tr>
<tr>
<td>Dependent Functional Status</td>
<td>Prior revasc/amputation</td>
<td>Prior CABG/PCI</td>
<td>Diabetes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHF</td>
<td>COPD/Pneumonia</td>
<td></td>
</tr>
</tbody>
</table>
To compare the utility of this modified Frailty Index to predict adverse outcomes against other recognized and commonly used risk indices in vascular surgery populations.
Validation of a modified Frailty Index to predict mortality in vascular surgery patients

Bryan A. Ehlert, MD,\textsuperscript{a} Alireza Najafian, MD,\textsuperscript{b} Kristine C. Orion, MD,\textsuperscript{a} Mahmoud B. Malas, MD, MS,\textsuperscript{a} James H. Black III, MD,\textsuperscript{a} and Christopher J. Abularrage, MD,\textsuperscript{a} \textit{Baltimore, Md}
\textit{(J Vasc Surg 2016;63:1595-601.)}

- **ACS-NSQIP database**
  - Carotid revascularization
  - Aortic aneurysm repair
  - Lower extremity revascularization
- **Patient populations: Open & Endo**
Methods

Validation of a modified Frailty Index to predict mortality in vascular surgery patients

Bryan A. Ehlert, MD, a Alireza Najafian, MD, b Kristine C. Orion, MD, a Mahmoud B. Malas, MD, MS, a
James H. Black III, MD, a and Christopher J. Abularrage, MD, a Baltimore, Md
(J Vasc Surg 2016;63:1595-601.)

• Comparative indices
  – Lee Cardiac Risk Index (LCRI)
  – American Society of Anesthesiologists (ASA)
Methods

• Study endpoints
  – Primary: 30-day mortality
  – Secondary: Clavien-Dindo Class IV complications
    • Septic shock
    • Cardiac arrest
    • ARF with hemodialysis
    • Unplanned intubation
    • Graft failure
    • Myocardial infarction
    • Pulmonary embolism
    • Ventilation >48 hours
    • Coma/stroke

• Receiver operating characteristic
  – Area Under Curve analysis
## Table II. Morbidity and mortality of the open and endovascular cohorts

<table>
<thead>
<tr>
<th>Outcome</th>
<th>AAA</th>
<th>PAD</th>
<th>Carotid stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open</td>
<td>EVAR</td>
<td>LEB</td>
</tr>
<tr>
<td></td>
<td>(n = 5621), No. (%)</td>
<td>(n = 15,354), No. (%)</td>
<td>(n = 8367), No. (%)</td>
</tr>
<tr>
<td>Mortality</td>
<td>196 (3)</td>
<td>223 (1)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Clavien-Dindo class 4 IV complications</td>
<td>800 (14)</td>
<td>541 (4)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Clavien-Dindo class 5 IV complications</td>
<td>273 (&lt;1)</td>
<td>0 (0)</td>
<td>.35</td>
</tr>
</tbody>
</table>

AAA, Abdominal aortic aneurysm; CAS, carotid artery stenting; CEA, carotid endarterectomy; EVAR, endovascular aortic aneurysm repair; LEB, lower extremity bypass; PAD, peripheral arterial disease; PVI, peripheral vascular intervention.
Carotid Endarterectomy Mortality

\[ P\text{-value} = 0.002 \]
Open LEB Mortality

\[ P\text{-value} = 0.08 \]

---

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Johns Hopkins Medicine
Open Aneurysm Mortality

$P$-value = 0.02
Aneurysm Morbidity

CHF
OR 2.51, P=.01
Open AAA
P-value = <0.01

Dep FS
OR 2.96, P<.0001
EVAR
P-value = 0.01
Frailty in Practice
Online Calculators

- Procedure
  - Fem-Pop with vein

- Patient
  - 72 yo, Male, 6 ft, 200 lbs, smoker

- Comorbidities
  - IDDM, HTN, ESRD on HD

- ASA3
Measures of Frailty

Online Calculators
# Measures of Frailty

## Online Calculators

![Surgical Risk Calculator](image)

**Outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Risk Factors</th>
<th>Your Risk</th>
<th>Average Risk</th>
<th>Chance of Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Complication</td>
<td></td>
<td>22.7%</td>
<td>16.4%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Any Complication</td>
<td></td>
<td>26.3%</td>
<td>20.6%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Pneumonia</td>
<td></td>
<td>1.3%</td>
<td>0.9%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Cardiac Complication</td>
<td></td>
<td>5.1%</td>
<td>1.1%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Surgical Site Infection</td>
<td></td>
<td>10.6%</td>
<td>7.1%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Urinary Tract Infection</td>
<td></td>
<td>0.6%</td>
<td>0.6%</td>
<td>Below Average</td>
</tr>
<tr>
<td>Venous Thromboembolism</td>
<td></td>
<td>0.8%</td>
<td>0.8%</td>
<td>Average</td>
</tr>
<tr>
<td>Renal Failure</td>
<td></td>
<td>10.7%</td>
<td>12.0%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Readmission</td>
<td></td>
<td>12.4%</td>
<td>9.8%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Return to OR</td>
<td></td>
<td>5.5%</td>
<td>0.7%</td>
<td>Above Average</td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td>24.9%</td>
<td>13.2%</td>
<td>Above Average</td>
</tr>
</tbody>
</table>

**Predicted Length of Hospital Stay:** 6 days

---

**How to Interpret the Graph Above:**

- **Your Risk:** Your calculated risk compared to the average patient risk.
- **Average Patient Risk:** The average risk of patients in the same condition.
- **X%:** The percentage of risk.

**Surgeon Adjustment of Risks:**

This tool allows surgeons to adjust the estimated risks if they feel the calculated risks are underestimated. This should only be done if the reason for the increased rate was not already entered into the risk calculator.

1. **No adjustment necessary.**

---

**Heart and Vascular Institute**

[Image]
Summary

• Applicability of mFI
  – Simplified definition of frailty
  – Based on objective data
  – Not limited to single organ system

• Predicts significant morbidity in AAA populations

• Utility as preoperative mortality risk assessment
  – Superior compared to other established indices
  – Low yield in endovascular populations
Summary

• Frailty indices in practice
  – Better than traditional measures of risk
  – Time consuming
  – Not really modifiable
    • Patient’s frailty cannot be changed
  – Online calculators simplify the process
  – Utility
    • Complex patients undergoing complex procedures
    • Patient education