Update in Perioperative Medicine: Preoperative Risk Evaluation

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University of Tennessee Faculty
No Disclosures
Perioperative Medicine Co-Management

• Society of Hospital Medicine
  • “Co-Management” early 2000’s
  • Collaboration IM Hospitalists, Surgeons & Anesthesiologists
    • Outpatient Specialists (Primary Care Physicians), Cardiologists, Sleep Centers etc.

• Driving Force
  • Aging Population
    • More complex medical history and risk
  • Improved Surgical & Anesthetic Techniques
  • More Surgical Options available
  • Value Based Reimbursement (Quality/Cost Ratio)
Update in Perioperative Medicine: Preoperative Risk Evaluation

Current Influences Perioperative Medicine:

• Electronic Databases and Online Risk Calculators
  NSQIP and others
• Value Based Purchasing
Value Based Purchasing

• Pay for Quality (Outcomes)
• Penalties for 30 day readmissions
• 90 Day Bundling postoperative care
• Designating surgeries as outpatient procedures
  • Justify inpatient status (Total Knee Arthroplasty designated as outpatient)
  • Location of surgery decisions:
    • Ambulatory Surgery Centers
    • Specialty Hospitals
    • Hospital
Perioperative medical care is an indispensable component of overall surgical case management, involving concerted efforts from surgeons, anesthesiologists, internists, and subspecialists alike. With increasing intricacy of the surgical procedures being performed on a spectrum of patients ranging from those in the pediatric age group to geriatric patients with multiple comorbidities, perioperative medicine is being increasingly recognized as a subspecialty unto itself.
What is Preoperative Medicine?

Risk Assessment of each organ system and its' physiologic reserve to tolerate the stress of a specific surgery.

- **Organ Systems:**
  - Cardiovascular
  - Pulmonary
  - Neuro-cognitive
  - Hematologic
  - Renal
  - Gastrointestinal
  - Endocrine
Surgery Stress → Anesthesia Stress

- Blood Loss
- Activation Coagulation System
- Hemodynamic Instability
- Catecholamine Release
- Activation Inflammatory Cascade
Preoperative Consultation

History:
- HPI
- ROS
- Medications
- Allergies
- Past Medical History

Physical Examination:
- Vital Signs, BMI, Neck circumference
- Lungs
- Cardiac: Murmurs, Gallops, JVD
- Neurocognitive

Testing:
- Routine Labs
- EKG
Preoperative Actions

Options:
• Cancel surgery
• Postpone surgery
• Further testing to improve risk stratification accuracy
• Implement new therapeutic options:
  • Medication adjustment
  • Coronary revascularization
• Change Perioperative Locations
  • Ambulatory surgery center, Specialty Hospital, Hospital
  • Postoperative
    • ICU
    • Monitoring options
      • Telemetry, Oxygen saturation, End-Tidal CO2 monitoring
Perioperative Time Period

**Perioperative Medicine**
- **Preoperative Consultation**
  - **Patient Characteristics Screening**
    - BMI < 40
    - Hgb A1c < 8.0%
    - Cardiac Risk
    - OSA/OHS Risk
    - Frailty
  - **Optimization**
    - Testing: CAD, CHF, Polysomnography
    - Revascularization, Medications, Diet, Prehabilitation

**Preoperative Time Period:**
- Testing
- Optimization

**Day of Surgery**
- Surgical Stress
- Anesthesia Stress

**Postoperative**
- **Location of Surgery**
  - Ambulatory Surgery Center
  - Specialty Hospital

**Postop Management**
- Monitoring:
  - ICU
  - Floor/Telemetry
  - End tidal CO2 monitoring
- Medications:
  - Blood sugar control
  - VTE prophylaxis
Preoperative Screening & Potential Actions

• **BMI > 40**
  • Postpone refer to weight loss program

• **Hemoglobin A1c > 8.0%**
  • Postpone and implement diabetic management program

• **High Risk OSA/OHS (STOPBANG score > 5)/Hypercarbia**
  • Refer for Polysomnography and CPAP therapy

• **Cardiac Risk**
  • Testing for CAD
  • Echo for CHF

• **Frailty**
  • Cognitive status
  • Nutritional Status
  • Functional Status
Further Testing or Meds Adjustments

Risks of Delaying Surgery

Options to Optimize
Preoperative Cardiac Risk Evaluation and Management
Perioperative Guidelines

• 2014 ACC/AHA Guideline
• 2014 European Society of Cardiology/European Society of Anesthesiology
• 2017 Canadian Cardiovascular Society (CCS)
American College of Cardiology /AHA guidelines 2014

The first step of the algorithm is to determine the urgency of the surgery.

The ACC/AHA guidelines defined urgency as the need to have surgery within the following time frames:

- **Emergent** < 6 hours;
- **Urgent** 6-24 hours;
- **Time sensitive** 1-6 weeks;
- **Elective** 1 year or more.
ACC/AHA 2014 Algorithm

Risk of MACE > 1%
- RCRI > 1
- NSQIP

Next STEP
- Functional Status
- METS < 4
METS
- “Too subjective”

<table>
<thead>
<tr>
<th>Table 3. Measures of Functional Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt;4 METs</strong></td>
</tr>
<tr>
<td>- Eat, dress, and use the toilet</td>
</tr>
<tr>
<td>- Walk indoors around the house</td>
</tr>
<tr>
<td>- Walk 1 or 2 blocks slowly (2–3 mph)</td>
</tr>
<tr>
<td>- Do light work around the house</td>
</tr>
<tr>
<td><strong>≥4 METs</strong></td>
</tr>
<tr>
<td>- Walk 4 mph or faster on level ground</td>
</tr>
<tr>
<td>- Climb a flight of stairs</td>
</tr>
<tr>
<td>- Walk up a hill</td>
</tr>
<tr>
<td>- Run a short distance</td>
</tr>
<tr>
<td>- Do heavy work around the house</td>
</tr>
<tr>
<td>- Golf</td>
</tr>
<tr>
<td>- Doubles tennis</td>
</tr>
</tbody>
</table>

MET = metabolic equivalent.
Assessment of functional capacity before major non-cardiac surgery: an international, prospective cohort study

Duminda N Wijeysundera, Rupert M Pearse, Mark A Shulman, Tom E F Abbott, Elizabeth Torres, Althea Ambosta, Bernard L Croal, John T Granton, Kevin E Thorpe, Michael P W Grocott, Catherine Farrington, Paul S Myles, Brian H Cuthbertson, on behalf of the METS study investigators

Summary
Background Functional capacity is an important component of risk assessment for major surgery. Doctors’ clinical subjective assessment of patients’ functional capacity has uncertain accuracy. We did a study to compare preoperative subjective assessment with alternative markers of fitness (cardiopulmonary exercise testing [CPET], scores on the Duke Activity Status Index [DASI] questionnaire, and serum N-terminal pro-B-type natriuretic peptide [NT pro-BNP] concentrations) for predicting death or complications after major elective non-cardiac surgery.

Interpretation Subjectively assessed functional capacity should not be used for preoperative risk evaluation. Clinicians could instead consider a measure such as DASI for cardiac risk assessment.

Lancet 2018; 391: 2631–40
To convert the DASI to METs, divide the sum value of all 12 questions of the DASI by 3.5.
Emphasize the use of Biomarkers

Canadian Cardiovascular Society Guidelines on Perioperative Cardiac Risk Assessment and Management for Patients Who Undergo Noncardiac Surgery.
Table 3. Risk of death or myocardial infarction at 30 days after noncardiac surgery, based upon a patient’s preoperative NT-proBNP or BNP result

<table>
<thead>
<tr>
<th>Test result</th>
<th>Risk estimate, %</th>
<th>95% CI for the risk estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT-proBNP &lt; 300 ng/L or BNP &lt; 92 mg/L</td>
<td>4.9</td>
<td>3.9%-6.1%</td>
</tr>
<tr>
<td>NT-proBNP value ≥ 300 ng/L or BNP ≥ 92 mg/L</td>
<td>21.8</td>
<td>19.0%-24.8%</td>
</tr>
</tbody>
</table>

BNP, brain natriuretic peptide; CI, confidence interval; NT-proBNP, N-terminal pro-brain natriuretic peptide.
Preoperative Cardiac Risk Calculators

- Revised Cardiac Risk Index (RCRI) 1999
- National Surgery Quality Improvement Program (ACS NSQIP)
- Myocardial Infarction-Cardiac Arrest (MICA-Gupta)
- Reconstructed RCRI
- Vascular Surgery Group of New England CRI (VSG CRI)
- American University of Beirut Preoperative Cardiac Evaluation Study (AUB-POCES CRI published 2019)

**RCRI**
- Published 1999
- Not as predictive vascular surgery patients
- Uncertain influence of IDDM
- Better measures renal function that serum creatinine
Comparison of 4 Cardiac Risk Calculators in Predicting Postoperative Cardiac Complications After Noncardiac Operations

Steven L. Cohn, MD\textsuperscript{a,b,*}, and Nerea Fernandez Ros, MD, PhD\textsuperscript{e}

The 2014 American College of Cardiology/American Heart Association Perioperative Guidelines suggest using the Revised Cardiac Risk Index, myocardial infarction or cardiac arrest, or American College of Surgeons—National Surgical Quality Improvement Program calculators for combined patient-surgical risk assessment. There are no published data comparing their performance. This study compared these risk calculators and a reconstructed Revised Cardiac Risk Index in predicting postoperative cardiac complications, both during hospitalization and 30 days after operation, in a patient cohort who underwent select surgical procedures in various risk categories. Cardiac complications occurred in 14 of 663 patients (2.1%), of which 11 occurred during hospitalization. Only 3 of 663 patients (0.45%) had a myocardial infarction or cardiac arrest. Because these calculators used different risk factors, different outcomes, and different durations of observation, a true direct comparison is not possible. We found that all 4 risk calculators performed well in the setting they were originally studied but were less accurate when applied in a different manner. In conclusion, all calculators were useful in defining low-risk patients in whom further cardiac testing was unnecessary, and the myocardial infarction or cardiac arrest may be the most reliable in selecting higher risk patients. © 2017 Elsevier Inc. All rights reserved. (Am J Cardiol 2018;121:125–130)
<table>
<thead>
<tr>
<th>Risk Calculators</th>
<th>MI or Cardiac Arrest Calculator (MICA)</th>
<th>ACS NSQIP Surgical Risk Calculator (ACS-SRC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revised Cardiac Risk Index</strong>&lt;sup&gt;4&lt;/sup&gt;</td>
<td>MI/Cardiac Arrest, complete heart block, pulmonary edema during admission</td>
<td>MI/Cardiac Arrest within 30 days after surgery</td>
</tr>
<tr>
<td>High-risk surgery (3 categories)</td>
<td>Type of surgery (21 categories)</td>
<td>Surgical procedure (CPT codes)</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>Age</td>
<td>Age group</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>Functional status</td>
<td>Functional status</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>ASA class</td>
<td>ASA class</td>
</tr>
<tr>
<td>Renal insufficiency (Cr &gt; 2 mg/dl)</td>
<td>Renal insufficiency (Cr &gt; 1.5 mg/dl)</td>
<td>Acute renal failure</td>
</tr>
<tr>
<td>Diabetes treated with insulin</td>
<td></td>
<td>Diabetes on oral meds or insulin</td>
</tr>
</tbody>
</table>

Reconstructed-RCRI<sup>5</sup> *(MI/Cardiac Arrest, complete heart block, pulmonary edema during admission)*

| High-risk surgery (3 categories) | | |
| Ischemic heart disease | | |
| Congestive heart failure | | |
| Cerebrovascular disease | | |
| Renal insufficiency (GFR < 30 cc/min) | | |

ACS-SRC = American College of Surgeons surgical risk calculator; ASA = American Society of Anesthesiology; BMI = body mass index; COPD = chronic obstructive pulmonary disease; GFR = glomerular filtration rate; MI = myocardial infarction; MICA = myocardial infarction or cardiac arrest; RCRI = Revised Cardiac Risk Index; R-RCRI = Reconstructed Revised Cardiac Risk Index.
A New Index for Pre-Operative Cardiovascular Evaluation

ABSTRACT

BACKGROUND Currently used indices for pre-operative cardiovascular evaluation are either powerful, but complex, or simple, but with weak discriminatory power.

OBJECTIVES This study sought to prospectively derive and validate a simple powerful index that can stratify the cardiovascular risk of patients undergoing noncardiac surgery.

METHODS The derivation cohort consisted of 3,284 prospectively enrolled adult patients undergoing noncardiac surgery at the American University of Beirut Medical Center. The validation cohort consisted of 1,167,414 patients registered in the American College of Surgeons National Surgical Quality Improvement Program database. The primary outcome measure was death, myocardial infarction, or stroke at 30 days after surgery.

RESULTS The primary outcome occurred in 38 patients (1.2%) in the derivation cohort. Multivariate logistic regression analysis in the derivation cohort identified 6 data elements to be included in the prediction model: age $\geq$75 years, history of heart disease, symptoms of angina or dyspnea, hemoglobin $<12$ mg/dl, vascular surgery, and emergency surgery. Each patient was assigned a Cardiovascular Risk Index (CVRI) of 0, 1, 2, 3, and $>3$ based on the number of data elements present. The incidence of the primary outcome increased steadily across the CVRI groups in both the derivation (0%, 0.5%, 2.0%, 5.6%, and 15.7%, respectively; $p < 0.0001$) and validation (0.3%, 1.6%, 5.6%, 11.0%, and 17.5%, respectively; $p < 0.0001$) cohorts. The discriminatory power of the new CVRI was further confirmed by constructing a receiver-operating characteristic curve that had an area under the curve of 0.90 in the derivation cohort and 0.82 in the validation dataset.

CONCLUSIONS This study reports a new index for pre-operative cardiovascular evaluation which has a strong discriminatory power that can effectively stratify patients into low- (CVRI 0 to 1), intermediate- (CVRI 2 to 3), and high-risk (CVRI $>3$) groups. This has important implications for the efficient triage and management of patients scheduled for noncardiac surgery. (J Am Coll Cardiol 2019;73:3067-78) © 2019 by the American College of Cardiology Foundation.
The American University of Beirut Pre-Operative Cardiovascular Evaluation Study prospectively derived and validated a new preoperative cardiovascular risk index, referred to as CVRI.

Six risk factors were identified in multivariate analysis:

- age ≥75 years,
- hemoglobin <12 mg/dL,
- history of heart disease,
- symptoms of angina or dyspnea,
- vascular surgery, and
- emergency surgery
NSQIP Online
- Periodic changes

**Surgical Risk Calculator**

**Enter Patient and Surgical Information**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>44140 - Colectomy, partial with anastomosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Calculator Homepage</td>
<td>About</td>
</tr>
</tbody>
</table>

**Procedure**

- Begin by entering the procedure name or CPT code. One or more procedures will appear below the procedure box. You will need to click on the desired procedure to properly select it. You may also search using two words (or two partial words) by placing a "+" in between, for example: "cholecystectomy+cholangiography".

**Are there other potential appropriate treatment options?**

- Other Surgical Options
- Other Non-operative options
- None

**Other Information**

- Age Group: Under 65 years
- Sex: Male
- Functional status: Independent
- Emergency case: No
- ASA class: I - Healthy patient
- Wound class: Clean
- Steroid use for chronic condition: Yes
- Ascites within 30 days prior to surgery: No
- Systemic sepsis within 48 hours prior to surgery: None
- Ventilator dependent: No
- Disseminated cancer: No

**BMI Calculation**

- Height (in): 6
- Weight (lbs): 230

Please enter as much of the following information as you can to receive the best risk estimates. A rough estimate will still be generated if you cannot provide all of the information below.
## Cardiac Risk

<table>
<thead>
<tr>
<th>Cardiac Risk</th>
<th>Risk Scoring System</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSQIP</td>
<td><a href="Http://riskcalculator.facs.org/RiskCalculator/PatientInfo.jsp">Http://riskcalculator.facs.org/RiskCalculator/PatientInfo.jsp</a></td>
</tr>
<tr>
<td>Gupta MICA</td>
<td><a href="http://www.surgicalriskcalculator.com/miorcardiacarrest">http://www.surgicalriskcalculator.com/miorcardiacarrest</a></td>
</tr>
<tr>
<td>VSGNE</td>
<td><a href="https://qxmd.com/vascular-study-group-new-england-decision-support-tools">https://qxmd.com/vascular-study-group-new-england-decision-support-tools</a></td>
</tr>
</tbody>
</table>
Gupta MICA

• Type of surgery
• Dependent functional status
• Abnormal creatinine, > 1.5 mg/dL
• ASA Class
• Age
Preoperative Cardiac Risk Calculators

- RCRI still standard but perhaps would use another calculator for vascular surgery:
  - Can use MICA, NSQIP, VSGNE CRI, AUB-POCES CRI
  - Note the RCRI indicators:
    - Insulin requiring DM (development several antidiabetic medications since 1999)
    - Creatinine > 2.0 (Perhaps eGFR or eCr Cl is more precise)

- Expect online calculators to become the standard
  - Value of being surgery specific, however
  - Most are not validated
  - NSQIP is adjusted periodically
Other Preoperative Risk Calculators

Pulmonary Complications

• Gupta Pneumonia
• Gupta Respiratory Failure
• ARISCAT Respiratory Failure
• STOPBANG Extended
## Perioperative Pulmonary Risk Calculators

<table>
<thead>
<tr>
<th>Risk Calculator</th>
<th>URL</th>
</tr>
</thead>
</table>
# Preoperative OSA/OHS Screening

## Enhanced STOP-Bang questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snoring? (loud enough to be heard through closed doors, or your bed partner elbows you for snoring at night)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tired? (feeling tired, fatigued, or sleepy during the daytime)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Observed? (stop breathing or choking/gasping during your sleep)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Pressure? (high blood pressure)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Body mass index more than 35 kg/m²?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Age older than 50 years old?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Neck size large? (measured around Adam's apple)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Gender = Male?</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Scoring criteria:

- **Low risk of OSA**: Yes to 0 to 2 questions
- **Intermediate risk of OSA**: Yes to 3 to 4 questions
- **High risk of OSA**: Yes to 5 to 8 questions
  - or Yes to 2 or more of 4 STOP questions + male gender
  - or Yes to 2 or more of 4 STOP questions + BMI >35kg/m²
  - or Yes to 2 or more of 4 STOP questions + neck circumference 17 inches/43 cm in male or 16 inches/41 cm in female
Ambulatory versus inpatient surgery for patients with known OSA or suspected OSA

STOP-Bang questionnaire (enhanced)

**STOP:**
- Snoring loudly
- Tiredness during the day
- Observed stopped breathing or choking/gasping during sleep
- High blood pressure

**Bang:**
- BMI > 35 kg/m²
- Age > 50 years
- Neck circumference ≥ 17 inches in males, ≥ 16 inches in females
- Gender male

**Scoring:**
- OSA low risk: Yes to 0 to 2 questions
- OSA intermediate risk: Yes to 3 or 4 questions
- OSA high risk: Yes to ≥ 5 questions
  OR Yes to ≥ 2 STOP + gender male
  OR Yes to ≥ 2 STOP + BMI > 35 kg/m²
  OR Yes to ≥ 2 STOP + neck circumference ≥ 17 inches in males, ≥ 16 inches in females

OSA/OHS Algorithm
Frailty & Cognition: Perioperative Impact
Frailty

Frailty, the loss of resilience with increased vulnerability to stressors, is independently associated with

• greater risk for postoperative complications,
• increased length of hospital stay, and
• greater likelihood of being discharged being dependent for care.
## Frailty Calculators

<table>
<thead>
<tr>
<th>Frailty tool</th>
<th>Type</th>
<th>Time to administer</th>
<th>Tool components</th>
<th>Frailty definition</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fried frailty phenotype</td>
<td>observational</td>
<td>5-10 min</td>
<td>Weight loss, exhaustion, weakness, gait, low physical activity.</td>
<td>1–2 = pre-frail, 3 or more = frail.</td>
<td>Extensively validated, predictive of outcomes, can be extracted from a health questionnaire.</td>
<td>Requires special equipment and patient participation.</td>
</tr>
<tr>
<td>Frailty index</td>
<td>self-reported</td>
<td>20-30 min</td>
<td>Accumulated symptoms, signs, diseases, and disabilities.</td>
<td>A dimensionless fraction with cut-off greater than ~0.25.</td>
<td>Validated, predictive.</td>
<td>Requires a long time to complete.</td>
</tr>
<tr>
<td>Modified frailty index</td>
<td>self-reported</td>
<td>10-15 min</td>
<td>List of co-morbidities and conditions.</td>
<td>Similar to frailty index.</td>
<td>Shorter than frailty index.</td>
<td>Not as reliable/predictive as frailty index.</td>
</tr>
<tr>
<td>FRAIL scale</td>
<td>self-reported</td>
<td>5-10 min</td>
<td>Fatigue, resistance, ambulation, illness and loss of weight.</td>
<td>1–2 = pre-frail, 3 or more = frail.</td>
<td>Simple, no training needed to administer.</td>
<td>Needs to be further validated.</td>
</tr>
<tr>
<td>Risk analysis index</td>
<td>self-reported</td>
<td>5-10 min</td>
<td>Age/cancer, co-morbidities, residence, ADLs, cognitive decline.</td>
<td>Composite score of 0 to 81, cut-off greater than 16–21.</td>
<td>Simple, performed by clinical staff.</td>
<td>Most questions are part of standard nursing interviews.</td>
</tr>
<tr>
<td>VESPA (short form)</td>
<td>self-reported</td>
<td>10 min</td>
<td>Gender, ADLs, functional status, Charlson comorbidity index, surgical complexity.</td>
<td>A dimensionless fraction with cut-off greater than ~0.25.</td>
<td>Simple, performed by physician assistants.</td>
<td>Modest sensitivity for postoperative complications.</td>
</tr>
<tr>
<td>Edmonton frailty scale</td>
<td>observational/ self-reported</td>
<td>10-15 min</td>
<td>Cognition, hospitalisation, general health, independence, social support, medication, nutrition, mood, continence, timed up and go.</td>
<td>Composite score ≥ 8 out of 17 = frail.</td>
<td>App available for tablet or phone.</td>
<td>Older adults may not be familiar or comfortable with tablet/phone.</td>
</tr>
<tr>
<td>Clinical frail scale</td>
<td>observational</td>
<td>&lt; 5 min</td>
<td>Clinical descriptors and pictographs.</td>
<td>≥ 5 out of 9 = frail.</td>
<td>Simple, accompanied by a visual chart.</td>
<td>Gestalt, unclear reliability.</td>
</tr>
<tr>
<td>ACS NSQIP</td>
<td>electronic health record</td>
<td>5-10 min</td>
<td>Demographics, symptoms, diseases, conditions.</td>
<td>Provides predicted 30 days mortality and complications.</td>
<td>Based on very large database, highly predictive.</td>
<td>Limited to 30 days outcomes.</td>
</tr>
</tbody>
</table>

Fig 2. Commonly used clinical tools to assess frailty. Clinical modalities that are commonly used to assess frailty in the preoperative population. Tools are different in the type of data components that are collected and the definition of frailty, which leads to different time burdens to administer the tool. For a more comprehensive description, please see main article. ACS NSQIP, American College of Surgeons National Surgical Quality Improvement Program; ADL, activities of daily living; FRAIL, Fatigue, Resistance, Ambulation, Illnesses, and Loss of Weight; VESPA, Vulnerable Elders Surgical Pathways and Outcomes Assessment.
Impact of frailty on outcomes in surgical patients: A systematic review and meta-analysis

A.C. Panayi a, A.R. Orkaby b,³, D. Sakhivel a, Y. Endo d, D. Varon e, D. Roh f, D.P. Orgill a, R.L. Nepp l, H. Javedan g, S. Bhasin h, I. Sinha h, l

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ABSTRACT

Introduction: Age has historically been used to predict negative post-surgical outcomes. The concept of frailty was introduced to explain the discrepancies that exist between patients’ chronological and physiological age. The efficacy of the modified frailty index (mFI) to predict surgical risk is not clear.

Objective: We sought to synthesize the current literature to quantify the impact of frailty as a prognostic indicator across all surgical specialties.

Methods: Studies utilizing the modified Frailty Index (mFI) as a post-operative indicator of any type of surgery. The mFI was selected based on a preliminary search showing it to be the most commonly applied index in surgical cohorts.

Data extraction and synthesis: Articles were selected via a two-stage process undertaken by two reviewers (AP and DS). Statistical analysis was performed in Revman (Review Manager V5.3). The random-effects model was used to calculate the Risk Ratios (RR).

Main outcome(s) and measure(s): The primary outcomes were post-operative complications, re-admission, re-operation, discharge to a skilled care facility, and mortality.

Results: This meta-analysis of 16 studies randomises 88,487 patients, 444,885 frail, from gastrointestinal, vascular, orthopedic, urogenital, head and neck, emergency, neurological, oncological, cardiological, as well as general surgery cohorts. Frail patients were more likely to experience complications (RR 1.48, 95%CI 1.35–1.61; p < 0.0001), major complications (RR 2.03, 95%CI 1.26–3.29; p = 0.004), and wound complications (RR 1.52, 95%CI 1.47–1.57; p < 0.0001). Furthermore, frail patients had higher risk of re-admission (RR 1.61, 95%CI 1.44–1.80; p < 0.0001) and discharge to skilled care (RR 2.15, 95%CI 1.92–2.40; p < 0.0001). Notably, the risk of mortality was 4.19 times more likely in frail patients (95% CI 2.96–5.02; p < 0.0001).

Conclusions: Relevance: This study is the first to synthesize the evidence across multiple surgical specialties and demonstrates that the mFI is an underappreciated prognostic indicator that strongly correlates with the risk of post-surgical morbidity and mortality. This supports that formal incorporation of pre-operative frailty assessment improves surgical decision-making.
Table 1
Examples of factors included in the geriatric preoperative assessment

<table>
<thead>
<tr>
<th>Domain</th>
<th>Assessment</th>
<th>Follow-up/Implications of Low Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognition</td>
<td>Mini-Cog: clock draw and 3-item recall; Montreal Cognitive Assessment</td>
<td>Delirium risk; Decision-making potential; Increased risk of nonhospital discharge; Increased length of stay</td>
</tr>
<tr>
<td>Behavioral</td>
<td>Alcohol history; Depression screening</td>
<td>Delirium risk; Quality of life; Decision making</td>
</tr>
<tr>
<td>Function</td>
<td>ADL; Instruments ADL; Timed up and go; Walking speed</td>
<td>Increased risk of postoperative complications; Increased mortality; Delirium; Preoperative exercise: prehabilitation opportunity</td>
</tr>
<tr>
<td>Polypharmacy</td>
<td>Medication list; Screen for inappropriate medications</td>
<td>Delirium; Readmission; Morbidity/mortality</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Albumin/prealbumin levels; Mini–nutritional short form assessment</td>
<td>Preoperative nutrition supplements; Increased risk of postoperative complications</td>
</tr>
<tr>
<td>Frailty</td>
<td>Phenotype: weight loss/grip strength/exhaustion/gait speed/low physical activity</td>
<td>Preoperative nutrition supplements; Increased risk of postoperative complications; Prehabilitation opportunity; Treatment decisions</td>
</tr>
</tbody>
</table>

*Abbreviation: ADL, activities of daily living.

Modified Frailty Index – 11 (NSQIP)

Fig. 1. The eleven mFI variables.
New 5-Factor Modified Frailty Index Using American College of Surgeons NSQIP Data

**BACKGROUND:** The modified frailty index (mFI-11) is a NSQIP-based 11-factor index that has been proven to adequately reflect frailty and predict mortality and morbidity. These 11 factors, made of 16 variables, map to the original 70-item Canada Study of Health and Aging Frailty Index. In past years, certain NSQIP variables have been removed from the database; as of 2015, only 5 of the original 11 factors remained. The predictive power and usefulness of these 5 factors in an index (mFI-5) have not been proven in past literature. The goal of our study was to compare the mFI-5 to the mFI-11 in terms of value and predictive ability for mortality, postoperative infection, and unplanned 30-day readmission.

**STUDY DESIGN:** The mFI was calculated by dividing the number of factors present for a patient by the number of available factors for which there were no missing data. Spearman’s rho was used to assess correlation between the mFI-5 and mFI-11. Predictive models, using both unadjusted and adjusted logistic regressions, were created for each outcome for 9 surgical subspecialties using 2012 NSQIP data, the last year all mFI-11 variables existed.

**RESULTS:** Correlation between the mFI-5 and mFI-11 was above 0.9 across all surgical specialties except for cardiac and vascular surgery. Adjusted and unadjusted models showed similar c-statistics for mFI-5 and mFI-11, and strong predictive ability for mortality and postoperative complications.

**CONCLUSIONS:** The mFI-5 and the mFI-11 are equally effective predictors in all sub-specialties and the mFI-5 is a strong predictor of mortality and postoperative complications. It has credibility for future use to study frailty within the NSQIP database. It also has potential in other databases and for clinical use. (J Am Coll Surg 2018;226:173–182. © 2017 Published by Elsevier Inc. on behalf of the American College of Surgeons.)

Sneha Subramaniam, BA, Jeffrey J Aalberg, MPH, Rainier P Soriano, MD, Celia M Divino, MD, FACS
Modified Frailty Index (NSQIP)

mFI-11

1. Diabetes mellitus
2. Functional status (Not independent)
3. COPD or Pneumonia
4. CHF
5. Hypertension on medications
6. Myocardial Infarction
7. Prior Percutaneous Coronary Procedure or Angina
8. Peripheral Vascular Disease
9. Impaired Sensorium
10. TIA or CVA
11. Neurologic Deficit after prior CVA

mFI-5 (Changed in 2015)

1. DM (either IDDM, or NIDDM)
2. Partially or Totally dependent functional status
3. COPD or Pneumonia
4. Congestive Heart Failure within 30 days
5. HTN requiring medication
Geriatric Surgery Quality Improvement Program

Patients with dementia were found to have a higher incidence of several postoperative complications:

- acute renal failure (OR 1.32, 95% CI 1.19–1.47),
- pneumonia (OR = 2.18, 95% CI 1.69–1.92),
- septicemia (OR = 1.8, 95% CI 1.69–1.92),
- stroke (OR = 1.51, 95% CI 1.43–1.6), and
- urinary tract infection (OR = 1.62, 95% CI 1.5–1.74).
5.6 Geriatric Vulnerability Screens

Optimal Resources for Geriatric Surgery
2019 Standards

Definition and Requirements

Patients must be screened for the following high-risk characteristics to identify potential areas of vulnerability:

- Age ≥ 85 years
- Impaired cognition
- Delirium risk
- Impaired functional status
- Impaired mobility
- Malnutrition
- Difficulty swallowing
- Need for palliative care assessment

A positive screen in any category will designate the patient as “high risk.”

In elective settings, the screening must be conducted prior to the operation to allow for time to address identified positive screens.

In non-elective settings, the screening must be conducted prior to the operation,* if possible, to flag areas of vulnerability that must be addressed within the 48-hour postoperative window, or as soon as is clinically appropriate.

*Often, the clinical situation will not allow for the completion of some or all preoperative vulnerability screens (for example, the patient cannot perform a mobility screen because they are immobilized due to a hip fracture). In these situations, information must be gathered from the patient, his or her family, or caregiver as appropriate.
Geriatric Surgery Program Preop Assessment (ACS)

- Assess **cognitive** ability and capacity to understand anticipated surgery
- Screen for **depression**
- Identify risk factors for postoperative **delirium**
- Screen for **alcohol and substance abuse/dependence**
- Perform **preoperative cardiac evaluation** according to 2014 ACC Guideline
- Identify risk factors for postoperative **pulmonary** complications
- Document **functional** status and history of **falls**
- Determine **frailty** score
- Assess patient’s **nutritional** status
- Take an accurate and detailed **medication history** and consider adjustments for **polypharmacy**
- Determine patient’s **family** and **social support system**
- Order appropriate preoperative diagnostic tests focused on the elderly
- Determine patient’s **treatment goals and expectations**
ASSESSING BASELINE AND CURRENT FUNCTIONAL STATUS IN AMBULATORY PATIENTS

**Short Simple Screening Test for Functional Assessment**\(^{21,85}\)

Ask the patient the following four questions:

1. *Can you get out of bed or chair yourself?*
2. *Can you dress and bathe yourself?*
3. *Can you make your own meals?*
4. *Can you do your own shopping?*

**Interpretation of Functional Screening Test**

- If NO to any of these questions, more in-depth evaluation should be performed, including full screening of ADLs and IADLs.
- Deficits should be documented and may prompt perioperative interventions (for example, referral to occupational therapy and/or physical therapy) and proactive discharge planning.

**NOTE:** Patient’s responses may not be reliable in the presence of cognitive impairment or dementia.

Document deficits in vision, hearing, or swallowing.

Inquire about history of falls ("*Have you fallen in the past year?*").

Evaluate the patient for limitations in gait and mobility and determine risk for falls.
Timed Up and Go Test (TUGT)\textsuperscript{86-88}

Patients should sit in a standard armchair with a line 10 feet in length in front of the chair. They should use standard footwear and walking aids and should not receive any assistance.

Have the patient perform the following commands:

1. Rise from the chair (if possible, without using the armrests)
2. Walk to the line on the floor (10 feet)
3. Turn
4. Return to the chair
5. Sit down again

Interpretation of TUGT

Any person demonstrating difficulty rising from the chair or requiring more than 15 seconds to complete the test is at high risk for falls. Consider preoperative referral to physical therapy for more detailed gait assessment.
Frailty Criteria

• Shrinkage (Weight Loss)
• Weakness
• Exhaustion
• Low Physical Activity
• Slowness
COGNITIVE ASSESSMENT: MINI-COG

Mini-Cog: 3 Item Recall and Clock Draw¹⁹

1. GET THE PATIENT’S ATTENTION, THEN SAY:

“I am going to say three words that I want you to remember now and later. The words are Banana Sunrise Chair

Please say them for me now.”

Give the patient 3 tries to repeat the words. If unable after 3 tries, go to next item.

2. SAY ALL THE FOLLOWING PHRASES IN THE ORDER INDICATED:

“Please draw a clock in the space below. Start by drawing a large circle. Put all the numbers in the circle and set the hands to show 11:10 (10 past 11).”

If subject has not finished clock drawing in 3 minutes, discontinue and ask for recall items.

3. SAY: “What were the three words I asked you to remember?”
## Interpretation of the Mini-Cog

**SCORING:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 item recall</td>
<td>1 point for each correct word</td>
</tr>
<tr>
<td>Clock draw</td>
<td>0 points for abnormal clock, 2 points for normal clock</td>
</tr>
</tbody>
</table>

**A NORMAL CLOCK HAS ALL OF THE FOLLOWING ELEMENTS:**

- All numbers 1–12, each only once, are present in the correct order and direction (clockwise) inside the circle.
- Two hands are present, one pointing to 11 and one pointing to 2.

**ANY CLOCK MISSING ANY OF THESE ELEMENTS IS SCORED ABNORMAL. REFUSAL TO DRAW A CLOCK IS SCORED ABNORMAL.**

**Total Score of 0, 1, or 2 suggests possible impairment.**

**Total Score of 3, 4, or 5 suggests no impairment.**

If the patient has evidence of cognitive impairment on the Mini-Cog, consider a referral to a primary care physician, geriatrician, or mental health specialist.20,21
Mini-Cog

• Cognitive impairment can be quickly assessed by several validated screening tools, one of which is the **Mini-Cog**, which consists of a **three-item recall** and **clock drawing exercise**.

• The Mini-Cog has low inter-observer variability and has been **validated in the geriatric surgery population**.
Scoring the Mini-Cog®

The Mini-Cog® is scored in two parts: 1) 3-item recall, and 2) clock drawing. These are added together for a total score.

3-Item Recall Score:
1 point for each word recalled without cues, for a 3-item recall score of 1, 2, or 3.

Clock Drawing Score:
2 points for a normal clock or 0 (zero) points for an abnormal clock drawing. A normal clock must include all numbers (1-12), each only once, in the correct order and direction (clockwise). There must also be two hands present, one pointing to the 11 and one pointing to 2. Hand length is not scored in the Mini-Cog® algorithm.
Preoperative Screening Tools

• Cardiac
  • Revised Cardiac Risk Index (RCRI)
  • Reconstructed RCRI
  • National Surgical Quality Improvement Program (NSQIP)
  • Gupta Myocardial Infarction-Cardiac Arrest Index (MICA)
  • AUB-POCES (CVRI)

• Pulmonary
  • Gupta Pneumonia Risk Index
  • Gupta Respiratory Failure Index
  • ARISCAT (Respiratory Failure)
  • STOPBANG

• Frailty
  • Cognition
  • Functional Status
  • Nutritional status
Which of the following cardiac risk indices does the 2014 American College of Cardiology guideline recommend using?

A. Revised Cardiac Risk Index
B. Gupta Myocardial Infarction-Cardiac Arrest Index
C. NSQIP American College of Surgeons
D. Either A or B
E. Either A or C
According to the 2014 American College of Cardiology guideline on preoperative cardiac risk assessment, it is reasonable to consider preoperative stress testing if the patient has poor or unknown functional status and the risk of a major adverse cardiac event is:

A. > 1%
B. > 2%
C. > 3%
D. > 4%