Improving Surgical Outcomes Through Frailty Screening: An Overview of the Risk Analysis Index

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Reports of Complications Related to Surgery or Invasive Procedures

More than 31,000 events involving complications related to a surgery or invasive procedure were reported to the Pennsylvania Patient Safety Reporting System (PA-PSRS) in the five-year period between January 1, 2020, and December 31, 2024[a]. Of those events, more than 15,000 resulted in serious patient harm or death.

Patient Frailty and Preoperative Use of the Risk Analysis Index Tool

Patient frailty is a significant predictor of postoperative morbidity and mortality.[1-5] The collective body of research over recent years has made a strong argument for preoperative use of a Risk Analysis Index (RAI) tool to evaluate the patients for frailty, as a proxy for physiologic reserve.[3,5,6] The RAI tool can be completed by the patient/representative or staff and the scores are then tallied to estimate the degree of patient frailty. Higher RAI scores indicate that a patient would have greater frailty-associated risks. For ease of interpretation, the RAI scores are often grouped into the following four categories of patient status: robust, normal, frail, or very frail.

This tool is intended to be used with patients who are potential candidates for nonemergent or elective surgeries. Use of the RAI to identify patients who are

[a]The frequency of reports is based on the following category of the PA-PSRS taxonomy: Event Type of "Complication of Procedure/Treatment/Test" and Subtype of "Complication following surgery or invasive procedure."

frail or very frail may guide the surgeon and patient to consider preoperative rehabilitation (i.e., prehabilitation) or to not have surgery (i.e., opting for nonoperative treatments for symptom management, sometimes including palliative care).[3-5,7-10] This decision among frail patients could reduce the likelihood of a morbidity and premature mortality.[3,4,7-10] Overall, the use of RAI and related interventions have been associated with improved long-term outcomes for frail patients.[9,11]

Background and Considerations for Use of the Risk Analysis Index

Validity and Predictive Ability of RAI

- The RAI tool has been validated for point-of-care use for clinicians to screen patients for frailty.[4,6,8,11,12] Readers should note that numerous other frailty indices exist, but some are not suitable for point-of-care use (e.g., other frailty indices use dynamometers and walking tracks, were designed to be used retrospectively, or impose excessive respondent burden).[4,6,13,14]
- The RAI tool is effective for identifying approximately the 10% of patients that are at greatest risk for postoperative morbidity and mortality, due to their extent of frailty.[15,16]
- The RAI has been validated to predict postoperative mortality[13] across 30-,[10] 90-,[3] 180-,[8,10] and 365-day[3] time frames.
- Studies demonstrated the predictive ability of the RAI across a range of clinical context,[4,8,9] including the following surgical specialties: oncology,[16] spine,[3,5] cardiovascular,[17] urology,[18] neurology,[10,19] plastic,[10] otolaryngology,[10] orthopedic,[10] gynecology,[10] vascular,[10] and thoracic.[10]
- Research indicates that the RAI can and should be used with patients of all ages[17] and across the full range of surgical procedures, including procedures of low physiological stress (i.e., operative stress scores).[10,20,21]
- In a study of both young and old patients, those with higher preoperative RAI scores (i.e., greater frailty) were associated with significantly more postoperative days away from home (e.g., rehabilitation, skilled nursing facilities) and a higher likelihood of losing independence after surgery.[22]
- The RAI demonstrates greater predictive ability for both morbidity and mortality when compared with the five-factor modified frailty index[b] (mFI-5)[5,24] and has similar predictive ability when compared to the other indices;[13] Fried frailty phenotype (FFP),[25] Edmonton Frail Scale (EFS),[26] and the Canadian Study of Health and Aging.[27]

Versions and Access to RAI

- There are several similar versions of the RAI tool (e.g., RAI-A, RAI-C, RAI-ICD, and RAI-VQI) and the primary differences are the data sources used to estimate patient frailty.[4,12,28]
- For most clinical applications, we suggest using the RAI-C version, based on its ease of use at the point-of-care.
- The RAI-C is available as a printable version and to users of Epic (through EpicShare),[29] Cerner, REDCap, Microsoft's PowerApp, and Veteran Affairs' Computerized Patient Record System (CPRS).[12,15,28]
- To access the RAI-C and for information about the other RAI versions, see reference 28.

Implementation and Features of RAI-C

- For a user guide and supporting materials, see references 12 and 28.
- The RAI-C is intended to be used preoperatively within the existing workflow to estimate patient frailty.[12]
- The tool targets the following five domains of health: physical, functional, social, nutritional, and cognitive.[4,6]
- The RAI-C consists of 14 questions[3,6,9,28] and is available in English, Spanish, Portuguese, and Chinese languages.[28]
- The questions on the tool can be completed by staff, but are most often completed by the patient/representative, which will take them less than two minutes.[12]
- The score from a completed tool can be quickly tallied manually or with an online calculator (available at efrailty.hsl.harvard.edu/ToolRiskAnalysisIndex.html) by a range of staff, including medical assistants and nurses.[6,8,12,15] Staff have reported calculating the RAI-C score in a median of less than 40 seconds per patient.[8,13]
- The cutoff scores used to classify frailty can be adjusted to fit the setting and available resources.[4]
- The RAI-C score, ranging from 0 to 81, will categorize the patient as being robust (≤29), normal (30–36), frail (37–44), or very frail (≥45).[12]

[b]The modified frailty index (mFI)[23] was developed before the RAI, based on 11 variables in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) dataset, but has never been widely validated for prospective survey-based administration. A shortened version (mFI-5) became necessary when the ACS eliminated six of the original 11 variables, degrading its predictive power and construct validity as a frailty measure, and for these reasons it should be considered obsolete.[12]

Treatment Decisions and Clinical Actions

- Patients identified through the RAI as being frail or very frail should then participate in a more thorough assessment that would be used to further inform patient and provider decisions.[6,15] The follow-up could target multiple areas of frailty through various tests, such as geriatric assessment, serological biomarkers, and functional performance (e.g., gait speed, grip strength).[6,15]
- Patients and providers engage in shared decision-making based on the predicted trajectory of frailty-associated risks[4,6,9,11,22] and the patient's health-related goals.[15]
- Depending on the degree of patient frailty and their goals, the patient may choose not to proceed with the surgery and instead opt for medical symptom management, sometimes including palliative care. Other patients may choose to prepare for surgery with preoperative rehabilitation (i.e., prehabilitation).[9,13] Use of preoperative rehabilitation may increase the odds of postoperative recovery at home, as opposed to being postoperatively placed in a rehabilitation facility.[15]
- Frailty-associated risks can be reduced through optimized care and prehabilitation,[3,7,9,11,15] which may include glycemic control, anemia management, adjustment of medication, multimodal anesthesia, nutritional supplementation, evaluation of home support, care coordination, respiratory muscular training, balance and strength training, cardiovascular exercise, and use of upper body ergometers.

References

1. Arya S, Kim SI, Duwayri Y, et al. Frailty Increases the Risk of 30-Day Mortality, Morbidity, and Failure to Rescue After Elective Abdominal Aortic Aneurysm Repair Independent of Age and Comorbidities. *J Vasc Surg*. 2015;61(2):324-31. doi:10.1016/j.jvs.2014.08.115

2. Revenig LM, Canter DJ, Master VA, et al. A Prospective Study Examining the Association Between Preoperative Frailty and Postoperative Complications in Patients Undergoing Minimally Invasive Surgery. *J Endourol*. 2014;28(4):476-80. doi:10.1089/end.2013.0496

3. Agarwal N, Goldschmidt E, Taylor T, et al. Impact of Frailty on Outcomes Following Spine Surgery: A Prospective Cohort Analysis of 668 Patients. *Neurosurgery*. 2021;88(3):552-7. doi:10.1093/neuros/nyaa468

4. Arya S, Varley P, Youk A, et al. Recalibration and External Validation of the Risk Analysis Index: A Surgical Frailty Assessment Tool. *Ann Surg*. 2020;272(6):996-1005. doi:10.1097/SLA.0000000000003276

5. Bowers CA, Varela S, Conlon M, et al. Comparison of the Risk Analysis Index and the Modified 5-Factor Frailty Index in Predicting 30-day Morbidity and Mortality After Spine Surgery. *J Neurosurg Spine*. 2023;39(1):136-45. doi:10.3171/2023.2.SPINE221019

6. Hall DE, Arya S, Schmid KK, et al. Development and Initial Validation of the Risk Analysis Index for Measuring Frailty in Surgical Populations. *JAMA Surg*. 2017;152(2):175-82. doi:10.1001/jamasurg.2016.4202

7. Hall DE, Youk A, Allsup K, et al. Preoperative Rehabilitation is Feasible in the Weeks Prior to Surgery and Significantly Improves Functional Performance. *J Frailty Aging*. 2023;12(4):267-76. doi:10.14283/jfa.2022.42

8. Varley PR, Borrebach JD, Arya S, et al. Clinical Utility of the Risk Analysis Index as a Prospective Frailty Screening Tool Within a Multi-Practice, Multi-Hospital Integrated Healthcare System. Ann Surg. 2021;274(6):e1230-e7. doi:10.1097/SLA.0000000000003808

9. Hall DE, Arya S, Schmid KK, et al. Association of a Frailty Screening Initiative With Postoperative Survival at 30, 180, and 365 Days. *JAMA Surg*. 2017;152(3):233-40. doi:10.1001/jamasurg.2016.4219

10. George EL, Hall DE, Youk A, et al. Association Between Patient Frailty and Postoperative Mortality Across Multiple Noncardiac Surgical Specialties. *JAMA Surg*. 2021;156(1):e205152-e. doi:10.1001/jamasurg.2020.5152

11. Varley PR, Buchanan D, Bilderback A, et al. Association of Routine Preoperative Frailty Assessment With 1-year Postoperative Mortality. *JAMA Surg*. 2023;158(5):475-83. doi: 10.1001/jamasurg.2022.8341.

12. Hall DE, Jacobs CA, Reitz KM, et al. Frailty Screening Using the Risk Analysis Index: A User Guide. *Jt Comm J Qual Patient Saf*. 2025;51(3):178-91. doi:10.1016/j.jcjq.2024.12.005

13. Shah R, Borrebach JD, Hodges JC, et al. Validation of the Risk Analysis Index for Evaluating Frailty in Ambulatory Patients. *J Am Geriatr Soc*. 2020;68(8):1818-24. doi:10.1111/jgs.16453

14. Kojima G, Iliffe S, Walters K. Frailty Index as a Predictor of Mortality: A Systematic Review and Meta-Analysis. *Age Ageing*. 2018;47(2):193-200. doi:10.1093/ageing/afx162

15. Hall DE, Hagan D, Ashcraft L, et al. The Surgical Pause: The Importance of Measuring Frailty and Taking Action to Address Identified Frailty. *Jt Comm J Qual Patient Saf*. 2024;51(3):167-77. doi:10.1016/j.jcjq.2024.11.011

16. Estock JL, Schlegel C, Shinall MC, et al. Interpreting the Risk Analysis Index of Frailty in the Context of Surgical Oncology. *J Surg Oncol*. 2023;127(6):1062-70. doi:10.1002/jso.27218

17. Kochar A, Deo SV, Charest B, et al. Preoperative Frailty and Adverse Outcomes Following Coronary Artery Bypass Grafting Surgery in US Veterans. *J Am Geriatr Soc*. 2023;71(9):2736-47.

18. Isharwal S, Johanning JM, Dwyer JG, Schimid KK, LaGrange CA. Preoperative Frailty Predicts Postoperative Complications and Mortality in Urology Patients. *World J Urol*. 2017;35:21-6. doi:10.1007/s00345-016-1845-z

19. Thommen R, Kazim SF, Rumalla K, et al. Preoperative Frailty Measured by Risk Analysis Index Predicts Complications and Poor Discharge Outcomes After Brain Tumor Resection in a Large Multi-Center Analysis. *J Neuro-Oncol*. 2022;160:285-97. doi: 10.1007/s11060-022-04135-z.

20. Shinall MC, Arya S, Youk A, et al. Association of Preoperative Patient Frailty and Operative Stress With Postoperative Mortality. *JAMA Surg*. 2020;155(1):e194620-e. doi:10.1001/jamasurg.2019.4620

21. Yan Q, Kim J, Hall DE, Shinall Jr MC, Reitz KM, Stitzenberg KB, et al. Association of Frailty and the Expanded Operative Stress Score with Preoperative Acute Serious Conditions, Complications, and Mortality in Males Compared to Females: A Retrospective Observational Study. *Ann Surg*. 2023;277(2):e294-e304. doi:10.1097/SLA.0000000000005027

22. Jacobs MA, Jacobs CA, Intrator O, et al. Long-Term Trajectories of Postoperative Recovery in Younger and Older Veterans. *JAMA Surg*. 2025;160(1):56-64. doi:10.1001/jamasurg.2024.4691

23. Velanovich V, Antoine H, Swartz A, Peters D, Rubinfeld I. Accumulating Deficits Model of Frailty and Postoperative Mortality and Morbidity: Its Application to a National Database. *J Surg Res*. 2013;183(1):104-10. doi:10.1016/j.jss.2013.01.021

24. Deol ES, Sharma V, Fadel AE, et al. Comparing Frailty Indices for Risk Stratification in Urologic Oncology: Which Index to Choose? *Urology*. 2024;194:154-61. doi:10.1016/j.urology.2024.08.055

25. Fried LP, Tangen CM, Walston J, et al. Frailty in Older Adults: Evidence for a Phenotype. *J Gerontol: Series A*. 2001;56(3):M146-M57. doi:10.1093/gerona/56.3.M146

26. Rolfson DB, Majumdar SR, Tsuyuki RT, Tahir A, Rockwood K. Validity and Reliability of the Edmonton Frail Scale. *Age Ageing*. 2006;35(5):526-9. doi:10.1093/ageing/afl041

27. Rockwood K, Song X, MacKnight C, et al. A Global Clinical Measure of Fitness and Frailty in Elderly People. *Can Med Assoc J*. 2005;173(5):489-95. doi:10.1503/cmaj.050051

28. Hall DE, Jacobs CA, Reitz KM, Jacobs MA. Repository for "Frailty Screening Using the Risk Analysis Index: A User Guide." OSFHOME. https://osf.io/egn8u/. Published January 25, 2025. Accessed March 2025.

29. Walker P. Risk Score Helps Patients and Doctors Make Informed Decisions About Whether to Go Ahead With Surgery. EpicShare. https://www.epicshare.org/share-and-learn/risk-score-helps-patients-and-doctors-make-informed-decisions-about-whether-to-go-ahead-with-surgery. Published January 11, 2025. Accessed March 2025.

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