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Peri-operative management of frailty in the orthopedic patient

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ABSTRACT

The purpose of this investigation was to summarize current research on diagnosis, outcomes, and management of frail patients undergoing orthopedic surgery. Because frail patients are at increased risk of negative post-operative outcomes including increased 30-day mortality and post-operative complications including infections and delirium, such a review is timely. Strategies including supervised exercise training programs before surgery, early identification of frailty, prophylactic antibiotics, regular drug chart review, regular monitoring of electrolytes, and other strategies to prevent post-operative delirium are helpful in the management of frail orthopedic patients. It is important for surgeons and anesthesiologists to take action in attempt to alleviate adverse post-operative outcomes in frail patients. Ultimately, more research is needed to identify new strategies and to evaluate whether pre-operative optimization can effectively mitigate post-operative outcomes in large-scale randomized controlled trials.

1. Introduction

With medical and technological advances, global life expectancy has increased significantly in the past few decades and by year 2030, at least 30% of the population in the United States is expected to be older than 65 years.[1] To keep pace with the increasing lifespan, surgical and anesthetic services will need to be adapted to provide safe and specialized care for the older population. Accordingly, there has been heightened attention focused on the concept of frailty in the older adult surgical population in the past decade.

It was only in 2001 that Fried and colleagues defined frailty as a biological condition with its own symptoms and functional impairments that is not synonymous to advanced age,.[2] An international panel in 2011 concluded that frailty is a multidimensional concept comprised of 6 domains including physical performance, gait speed, mobility, nutritional status, mental health, and cognition.[3] We and others conclude that ultimately frailty is a measure of decreased physiologic reserve across multiple organ systems.[4] Frailty has been reported to be associated with an increased perioperative complication rate in older adults undergoing elective and emergency surgeries[4–7] and mortality rates are higher among frail patients undergoing surgery.[8–11] Total Hip Arthroplasty (THA) and Total Knee Arthroplasty (TKA) surgeries are specifically associated with increased morbidity and mortality in the frail population[12,13],

As a direct consequence of the growing aging population, the demand for orthopedic surgical procedures is increasing. A recent study predicted the demand for THA to increase by 174%–572,000 procedures per year and the demand for TKA to increase by 673% to 3.48 million procedures per year by the year 2030. The growing number of orthopedic procedures in the older adult population, high prevalence of frailty in the surgical population, and increased risk for morbidity and mortality in frail older adult surgical patients all highlight the importance of increased focus on frailty in the orthopedic space. Accordingly, in this review we seek to summarize the current research and recommendations on frailty in patients undergoing orthopedic surgery. We incorporate the classical biomedical approach to disease that will include a discussion of risk factors, outcomes, diagnosis and management of frailty in this patient population.

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Table 1
Percent Increase in 30-Day Mortality, Re-Operation, Readmission, Clavien-Dindo Class IV Complications and Any Complications with Increase in mFI Score by Type of Orthopedic Surgery.

Orthopedic Surgery Type	30-Day Mortality (% increase)	Re-operation (% increase)	Readmission (% increase)	Clavien-Dindo Class IV Complications (% increase)	Any Complications (% increase)
Spine	9.7%	10%	N/A	N/A	25%
Orthopedic Trauma	10.5%	1.3%	13.3%	9.6%	8.5%
THA	4.08%	3.19%	11.28%	N/A	14.8%
TKA	1.49%	N/A	9.45%	N/A	11.27%
HA	11%	N/A	N/A	4.9%	N/A

THA = total hip arthroplasty; TKA = total knee arthroplasty, HA = hemiarthroplasty, N/A = not assessed; mFI = modified frailty index.

2. How to diagnose and screen frailty?

Unfortunately, there is not one single and simple way to diagnose frailty. Rather, there have been at least 27 frailty scales developed to date[14] and the screening tools that exist are either scoring systems based on physical, mental, and functional abilities or single measures of frailty based on functional capabilities.[2,15–19] Each screening tool has its own advantages and disadvantages; therefore, caution must be used in selecting the optimal screening tool based on both the patient and the context.

Fried developed an early standardized phenotype for frailty using data from over 5300 adults over age 65 in the Cardiovascular Heart Study.[2] This screening method is called the Frailty Phenotype (FP) and predicts falls, disability, worsening mobility, future hospitalization, and death, but it fails to account for changes in cognition and mood,[20] which are crucial components to frailty (Appendix A). However, this measure has methodological flaws as diagnosis of frailty via detection of two or more characteristics has limited theoretical grounds and there is no reliability or validity data.[21]

Since the development of the Frailty Phenotype, researchers developed the Frailty Index (FI),[22] which consists of 44 items. The FI has been found to be an effective measure for frail patients undergoing major elective orthopedic surgeries including total hip and knee replacement and lumbar, sacral, or cervical laminectomy.[23] After the FI was first developed, it was revised to become the Modified Frailty Index (mFI).[24] This modified scale provides an even simpler measure of frailty, as the mFI consists of only 11 items along with information about functional status from the medical record to stratify patients into risk categories and predict post-operative outcomes (Appendix B).

In terms of orthopedic surgeries, the mFI has also been proven to be an effective risk assessment tool for both THA and TKA in addition to being easier to implement.[17,18,25,26] It has been shown to be a stronger predictor for readmission, post-operative complications, re-operation, and post-operative mortality.[16] Throughout the past few years, the mFI has been shrunk to a 5-factor mFI (mFI-5).[27] A recent study comparing the credibility of the mFI-5 compared to the original 11 factor mFI has found it an equally credible predictor of frailty in all surgical subspecialties with a correlation coefficient of above 0.9 for all surgical subspecialties except cardiac and vascular surgery.[27] Several recent studies have found the 5-mFI a strong predictor of frailty and post-operative morbidity and mortality in a wide variety of surgeries including primary hip and knee arthroplasty, kyphoplasty vertebral augmentation, posterior lumbar fusion, distal radius fractures repair.[28–31]

The Frailty Phenotype has five domains and all domains have to be collected specifically for the purpose of the phenotype. Some domains also require the use of specialized equipment and training for the collection of data such as weakness and slow gait domains, which require the measurement of grip strength and gait speed, for example. Furthermore, the FI has its own challenges as it has 42 variables and thus requires the use of an algorithm to extract information from individual electronic medical records and administrative databases.[32]

Ultimately, the FP, FI, and the 5 factor mFI are all useful for assessing and screening for frailty pre-operatively for patients undergoing major elective orthopedic surgery[32] but differ in the level of complicity. The mFI-5 has the benefit of simplicity with only 5 variables to measure and without the need for specialized equipment and therefore may be the most clinically useful. In the research setting, the original FI may have the most utility as it is more detailed in its inclusion of 70 clinical deficits in a wide variety of domains to more precisely stratify individuals into risk categories. However, both the mFI and mFI-5 have been proven useful in identifying frailty before surgery; therefore, selection of the optimal measure for pre-operative frailty will depend upon feasibility considerations such as available data, logistical constraints, and provider preference32.

3. What are the outcomes for frailty?

Previous research has reported that frailty is highly associated with post-operative mortality[12,25,26,33,34]. Frailty is associated with *post-operative mortality* in patients undergoing surgery for pelvis and lower extremity fractures, adult spinal deformity, femoral neck fracture, primary hip arthroplasty, and primary knee arthroplasty[12,25,26,33,34]. Higher mFI scores are associated with increased post-operative mortality and are shown to be a stronger predictor of post-operative mortality compared to age, obesity class, and ASA class[12,25,26,33,34]. Various studies have shown different results as to increased post-operative mortality for spine surgery, orthopedic trauma, THA, TKA, and HA (Table 1).

There is also an increased risk of post-operative complications, length of stay, and readmission in frail patients undergoing orthopedic surgery.[12] Specifically, as can be seen in Table 1, there are a significant number of *post-operative complications* that are associated with frailty. There is an increased risk of Clavien-Dindo Class IV complications and hospital acquired conditions (surgical-site infections, pneumonia, venous thromboembolism, and urinary tract infections) with increased mFI score[12,13,25,26,33–37] for patients undergoing spine surgery, orthopedic trauma, THA, TKA, and HA (Table 1).

Several recent studies have found an association with frailty with the occurrence of post-operative delirium.[38–40] Frailty is also associated with higher delirium severity as measured by the Confusion Assessment Method (CAM).[41] Furthermore, for post-operative delirium in frail patients, it has been shown that there is an association with delirium and longer length of hospitalization, lower baseline functional status, and pre-operative cognitive impairment.[42–44]

4. How to manage the orthopedic frail patient?

Excellent pain control, optimizing sleep environment, minimizing tethers, cognitive reorientation with clocks, clear communication, early mobilization, and good nutrition have been reported to improve the outcome in this group of patients.[45,46] Identification and management of triggering factors such as sepsis, dehydration, electrolyte imbalance, and substance withdrawal is paramount.[47] The European Society of Anesthesiology recommends implementing fast-track surgery to prevent post-operative delirium in high-risk patients such as those who are

frail.[45,46] Specific suggestions for anesthesia management include avoiding potentially inappropriate medications such as benzodiazepines for pre-medication and monitoring of anesthesia depth to avoid excessive depth.[45,46]

Optimization strategies for functional status for frail patients include referring patients to obtain formal physical therapy evaluations, obtaining assistive devices, and planning for in-hospital and post discharge rehabilitative therapy. Pre-operative exercise programs often referred to as pre-habilitation to improve strength and mobility have shown minimal to no improvement in post-operative outcomes including reduced risk of discharge to a rehabilitation facility post-discharge, improved strength, and functional ability.[48] A recent systematic review by Wang et al. that included 33 studies found that only two studies reported a significant reduction in several different pain scores at 6 and 12 weeks post-operatively as a function of pre-habilitation.[48] Only 25% of the studies reported significant improvement of post-operative function which was measured by various ADL scales and various ranges of motion on the operated joint.[48,49] Furthermore, length of stay, cost, and quality of life were not significantly changed following these interventions.[48]

To prevent common post-operative infections including respiratory, wound, and urinary infections, antibiotics and standard infection protocols should be given and followed.[50] Frail patients are also at increased risk for opportunistic infections such as MRSA (methicillin-resistant staph aureus) or clostridium difficile and iatrogenic problems that arise from unnecessary medication as there is a high rate of unnecessary prescribing in hospitals.[50] Even when drugs are prescribed appropriately, polypharmacy and altered pharmacodynamics and kinetics can lead to systemic side effects including nausea, lethargy, confusion, anorexia, dizziness, constipation, and electrolyte imbalance. Therefore, regular drug chart review and rationalization of each medication is important.[50]

To prevent problems with fluid and electrolyte imbalance, regular monitoring of urea and electrolytes, weight and blood pressure (both standing and lying), and drug charts should be regularly reviewed.[50] Postoperative volume overload or volume depletion is common in frail patients especially in patients with poor oral intake which can lead to exertional dyspnea, fatigue, drowsiness, and postural hypotension.[50]

Ultimately, there is a lack of evidence that frailty can be attenuated or reversed once established. Nevertheless, some strategies including supervised exercise training programs before surgery, early identification of frailty, prophylactic antibiotics, regular drug chart review, regular monitoring of urea and electrolytes, and strategies to prevent post-operative delirium may be helpful in the management of the frail orthopedic patient.

5. Conclusion

As the world population ages, the demand for surgical care in older and frail patients will continue to increase. As such, it is crucial for clinicians and researchers to tailor the peri-operative pathway for these patients as they present unique challenges. Since there is currently a lack of evidence that frailty can be attenuated or reversed, it is important for anesthesiologists and surgeons to initiate preventative action in order to counter the development of this disease. These preventive strategies include pre-operative supervised exercise programs, early identification of frailty, prophylactic antibiotics, regular drug chart review, regular monitoring of urea and creatinine, and implementing strategies to prevent post-operative delirium. Ultimately, more research is needed to identify new strategies to prevent and reduce negative post-operative outcomes in frail patients as well as to evaluate whether pre-operative optimization can effectively mitigate post-operative outcomes in large-scale randomized controlled trials.

Appendix A. Frailty Phenotype Criteria

Frailty phenotype criteria	Measurement
Weakness	Grip strength (lowest 20% by sex, body mass index)
Slowness	Walking time per 15 feet (slowest 20% by sex, height)
Low level of physical activity	Kcal/week for lowest 20% Males 383 kcal/week Females: 270 kcal/week
Exhaustion/poor endurance	Self-reported exhaustion
Weight Loss	> 10 lbs. lost unintentionally in prior year

Appendix B. Modified Frailty Index Factors

1) Overall functional status (partial or total dependency)	+1
2) Impaired sensorium	+1
3) Diabetes mellitus (with or without insulin treatment)	+1
4) Chronic or acute lung disease (history of COPD, current pneumonia, etc.)	+1
5) Myocardial Infarction (history of myocardial infarction within 6 months)	+1
6) History of congestive heart failure	+1
7) History of angina, percutaneous coronary intervention, or prior cardiac surgery	+1
8) Hypertension requiring medications	+1
9) History of transient ischemic attacks	+1
10) History of cerebrovascular accidents/strokes with neurologic deficits	+1
11) Revascularization/amputation for peripheral vascular disease, rest pain, or gangrene	+1

COPD = chronic obstructive pulmonary disease; the Modified Frailty Index is graded on a Likert scale with a summative score out of 11.

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