# SYNOPSIS OF FRAILTY AND ANAESTHESIA

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## Acknowledgement

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Dr Krishna Prasad G V.

# CHAPTER – 1
# FRAILTY

## Introduction:

Though life expectancy has markedly increased due to improved health-care facilities, a global burden of aging population is also on the rise. Frailty is an inexorablepath of old age that ultimately escorts an individual to death. Aristotle described this phase as a period when the heatdispels from the body resulting in loss of coordination, balance and energy; illness,diminished strength, and ultimately the human capitulate to death (1). Frailty is an age-linked syndrome that is exemplified by increased vulnerabilityand reduced capability to perform physical activity (2). But it has to be remembered that ageing is allied with a ploddingdecline in the physical functioning, but there is difference in the rate of deterioration. Therefore, ageing cannot be essentially coupled with the process of frailty. Co-habitation of many chronic diseases and comorbidities that can negatively influence the normal functioning is generic midst older individuals. Nonetheless,it must be differentiated from the concept of frailty as the treatment approaches, outcome, and prognosisare different for both the cases.

The observations on frailty reinforce the prerequisite of improved understandingregarding the disparity in the capacity to perform tasks, resilience, and adverse outcomeamongst individuals of the same chronological age.An individual with this syndrome hasmoderated strength, enduranceand physiologic function. Furthermore, the condition isexacerbated by various stressors and leads to an increasing dependency oncaregivers to perform daily activities (3). The key features of frailty are cognitive impairment and physical unsteadiness, with

impreciselimitations between social and medical demands. This leads to falls,hospitalization, institutionalization, dependency andeventually death (4).

**Background**:

The Almagest, an ancient Mathematical Systematic Treatise, describes the humans at the end stage of life as "dispirited,weak, easily offended, and hard to please."Eli Metchnikoff, fondly called as the "father of gerontology", in 1908 had a question on how to transform in to old age under normal physiological condition without any pathological conditions (5). This question lead to various researches onaging and longevity; however, even almost a century later geriatriciansstruggle to define frailty.

Contradicting acommon belief that all elderly are weak,frailty syndrome is more often an age-related pathologic transformation (6).The rimsto differentiate age and frailty seem to be imprecise that it is commonlypresumed that at a particular age, everyone becomes frail. Physicians have frequently related the term frailty to label the feeblest andmost vulnerable subgroup of older adults. Conversely,'frail' is not an alternative term to describe the oldest of old adults nor any disability or comorbidity.Contemporaryresearches have attempted to describe the clinicaland physiological traits of frailty and to focus on the etiology for vulnerability of the frail, older adults.

In 1990s, the prevalence was 9.2% which is expected to surge up to 21.3% amongst the people of the global population, aged 60 years or older (7). The incidence of frailty increases with age,reaching more than 32% in those aged more than 90 years (8). Besides,if an individual is pre-frail, it indicates the downward spiral of the condition and they tend to become moreliable to develop frailty syndrome.

**Definition:**

Frailty can beequated to reduced functional reserves of multiple organ systems. This could be attributed to various factors such as any systemic disease, physicalinactivity, insufficient nutrient supplementation or stress.Precisely, frailty is an outcome of"excess demand imposed upon reduced capacity" (9).Frailty, once initiated, causes a rapid and progressive decline in physical and mental health,ultimately leading towards failure tothrive and death.

The WHO defined frailty as "a clinically recognizable state in which the ability of older people tocope with everyday or acute stressors is compromised by anincreased vulnerability brought by age-associated declinesin physiological reserve and function across multiple organsystems" (10).

Clinically, Fried et al defined frailty as "meetingthree out of five phenotypic criteria indicating compromised energetics (table 1): low grip strength,low energy, slowed waking speed, low physical activity, and/or unintentional weight loss" (11). He also proposed certain criteria to define this condition that encompassed the following factors:

- Walk time, as delineated by a 15-foot walk test.
- Grip strength, estimated by a dynamometer.
- Physical activity, measured by the MinnesotaLeisure Time Activity (MTLA) Questionnaire
- Exhaustion, measured by the Center for EpidemiologicStudies Depression Scale (CES-D Scale).
- Weight loss up to 10 pounds or 5% of total weight in the past1 year.

These criteria tactfully compute the manifestations of frailty, vitally the signs of sarcopenia, malnutrition by assessing the grip strength, and weight lossrespectively.

An individual must possess at least 3 among the 5 criteria to be diagnosed as frail.

Table 1: Criteria Used to Define Frailty

| Criteria | Male | | Female | |
|---|---|---|---|---|
| Weight Loss | Greater than 10 lbs or 5% of weight loss in the last year | | Greater than 10 lbs or 5% of weight loss in the last year | |
| 15-Foot Walk Time | Height ≤173 cm<br>Height >173 cm | ≥7 seconds<br>≥6 seconds | Height ≤159 cm<br>Height >159 cm | ≥7 seconds<br>≥6 seconds |
| Grip Strength | BMI ≤24<br>BMI 24.1-26<br>BMI 26.1-28<br>BMI >28 | ≤29<br>≤30<br>≤30<br>≤32 | BMI≤ 23<br>BMI 23.1-26 BMI<br>26.1-29<br>BMI >29 | 1≤7<br>≤17.3<br>≤18<br>≤21 |
| Physical Activity (MLTA) | <383 kcal/wk | | <270 kcal/wk | |
| Exhaustion | A score of 2 or 3 on either question on the CES-D* | | | |

*How often in the last week did you feel this way?

(a) I felt that everything I did was an effort.

(b) I could not get going.

0 =1 day; 1 =1-2 days; 2 =3-4 days; 3 =more than 4 days.BMI= body mass index

Adopted from: Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. JGerontolA BiolSciMedSci 2001;56(3):M146–M156

**Natural history:**

The idea of frailty is continuouslyadvancing, and there is an increasing deliberation regarding the etiology and progression of the disease.For over two decades, four importantfactors remained consistent while attempting to define the concept of frailty (12).

1. Frailty is multidimensional, with physical and psychosocial factors playing a vital role in its

pathogenesis.

2. Frailty is an extreme consequence of the normal ageing process and its prevalence increases with increase in age. However, the notion is not purely age-related, signifying on the negative and conventional opinion regarding the ageing process.
3. It is important to consider a frail individual's context, and therefore incorporate subjective perceptions. A frail individual can fluctuate between different states of severity of the condition.
4. The concept must credit the influence of both individual and environmental factors.

Interpreting theideas on thecommencement of frailty is essential to detect the individuals at high risk and to enable early intervention of those affected, at a stage where turning-around the condition is still feasible. Preclinical identification ofinitial manifestations of the frailty syndromenecessitates awareness and clear understanding regarding the natural history of frailty development and progression.

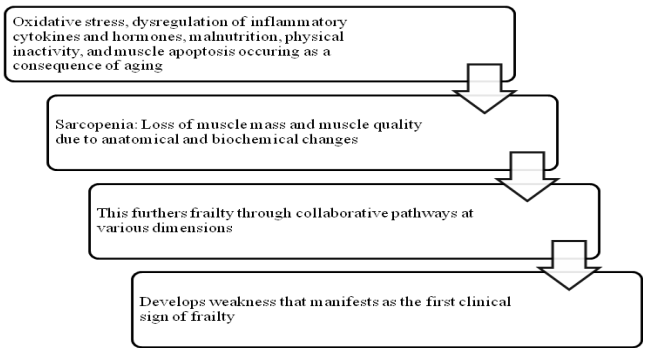
Xue QL in 2011 suggested two hypotheses to elaborate the natural history of frailty syndrome. The hypotheses are as follows (13):

1. The process of frailty might be instigatedby means of any of the clinical manifestations that can possiblyhasten a "vicious cycle" terminating in an amassed syndrome; and
2. Distinctearly manifestations couldpilot to varied rates of disease progression.

A 7.5-year longitudinal study comprising 420 WHAS II participants who were classified as non-frail at baseline based on Fried's phenotype suggested that weakness occupied the topmost position on the hierarchy of symptoms (Figure 1).Incidence of weakness, sluggishness,

andreduced activity headedtiredness and weight loss in 76% of the women who were non-frail at baseline (14).

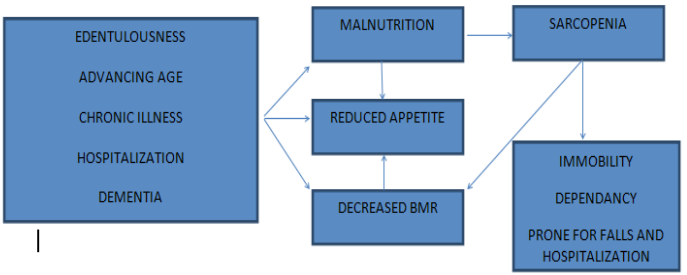
**Figure 1: Explanation for weakness experienced by a frail individual**




**Factors influencing frailty:**

Since it has already been established that frailty is multifactorial in etiology, many hypotheses emerged to find the various factorsassociated with the disease. Early researches revealed that the individuals lacked strength and balance, and this was considered to be the forecasters offrailty. But, during old age, many factorssuch asidleness, lessened appetite, malnutrition, and long-standing illness can lead to frailty. This preceded the development of the "frailty cycle" concept. This concept includes a systematic link between chronic malnutrituion, reduced apetitie, sarcopenia, and thus overall reduction in basal metabolic rate (BMR). All the above-mentioned factors are inter-related to each other and the end result will be a frail individual (Figure 2).

**Figure 2: The frailty cycle**




**Association between frailty, disability and comorbidities:**

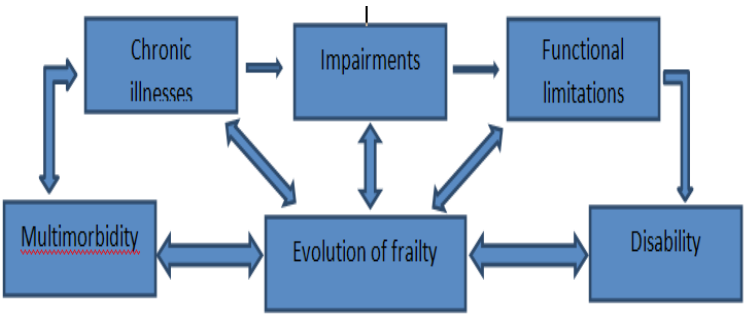
Most of the developed countries face a challenge of increasingolder adult population. It is considered as a challenge because older individuals fall prey to chronic illnesses, co-morbidities, various disabilities, and frailty. All these terminologies are very different from each other and yet possess certain similarities; therefore, these terms are often employed interchangeably.

The term multimorbidity can broadly be described as the "co-existence of two or more chronic conditions, where one is not necessarily more dominant than the other chronic conditions" (15). Comorbidity is defined as the "co-existence of certain medical conditions occurring in one individual in which an index disease occurs first" (16).Disabilitydenotes inconvenience and complexity whilecarrying out day-to-day activities that are obligatory to uphold an individual's life, such as eating, bathing, and toileting.

Nagi in the year 1991 developed the Disablement Process Model (DPM) that highlighted the similarities, differences and inter-relationship between the four above-mentioned terminologies. It encompasses a disease-disability pathway that includes four successive stages from 1) disease to

2) impairment to 3) functional limitation to 4) disability, all of which can contribute towards developing frailty in an individual (Figure 3). This framework implies that a disease process will cause impairments and this in turn leads to functional limitations. The limited functional movements of an individual will be succeeded by varying degree of disability. All of these factors, individually as well as sequentially will lead to evolution of frailty.

**Figure 3: Association between multimorbidity, disability, and frailty**




**Epidemiology, prevalence and incidence:**

Currently, frailty is thought to inhabit millions of older individuals globally, but the worldwide prevalence of this disease is not known up till now. This paradox can partially be contributed to the lack of research incorporating the population all over the world and the use of diversefunctional definitions of frailty in the various studies. Collard RM et al in 2012 estimated the prevalence of frailty to range anywhere between 4% and 59%. This vast range could mainly be due lack of standardisation of concepts or measures. The prevalence of frailty was computed to be 53% among long-term care residents, 5% to 29% among individuals with HIV infection, and 37% in patients with end-stage renal disease(18, 19, 20). Likewise, patients suffering from certain haematological malignancies

showed a prevalence rate of 42% (21).Furthermore, frailty was seen to be more prevalent in people of lower socio-economic groups, certain ethnic minorities such as African-American race and females (22, 23).

**Predictors of frailty:**

Old age, chronic illnesses, excessive alcohol consumption, allostatic load, sedentary lifestyle with reduced physical activity,obesity, excessive stress and depression, cognitive impairment, and lack ofsocial support are the predictors of developing frailty in future.Thechronic diseasesrelated tofrailty are cardiovascular diseases (CVD), pulmonary diseases, rheumatoid arthritis, and uncontrolled diabetes.

Except age, all the other predictors are modifiable and can be converted into signs of vitality if detected and treated at the initial stage. Early diagnosis and intervention of these predictors can reduce the risk of developing the disease.

**Frailty scores/index:**

Frailty index was given by Rockwood and Mitnitski in the year 2007 (24). The index scores were constructed on a comprehensive geriatric assessment by including the number of deficits accrued. The deficits were basically the predictors of frailty, and common geriatric syndromes other than frailty. The index comprises oftotalling the various signs, symptoms, disabilities, anddiseases to arrive at a score. The index scoring pattern is described below (24).

- Frailty index (deficit accumulation)
- Counts health deficits (at least 30), such as:
    - Signs
    - Symptoms
    - Diseases
    - Disabilities
    - Abnormal test results (example: laboratory, imaging, electrocardiogram)

**Health deficits should meet these criteria:**

- Represent multiple domains of functioning or multiple organ systems
- The prevalence must increase with age
- Not be too common before the age of 65 (early saturation)
- The prevalence should not be lower than 1%

Frailty score=sum of health deficits present divided by total number of deficits measured.

The scoring is rated between 0 and 1, where in higher scores indicate higher degree of frailty.

**Prevention:**

The measures to prevent frailty can be categorized into primary, secondary, and tertiary prevention.

- **Primary prevention:**

Identifying a pre-frail older individual with modifiable predictors of frailtysuch as sedentary lifestyle, malnutrition, and uncontrolled diabetes mellituscan essentially aid in preventing the disease at an early stage. Recognition of an older individual's gradualwaning of physical function and sarcopenic conditioncan aid aphysician to highlight on the necessity to change the lifestyle by practising regular exercise, and consuming healthy foods that have high nutritional value.

- **Secondary prevention:**

Identification of factors leading to frailty in an individual before developing severe problems such as unstable angina due to CVD canhelp a clinician to investigate about the aforesaid deficits. This will improve thepatient's compliance towards the medical treatments and health maintenance visits. When a clinician contemplates regarding the treatment options for various diseases or conditions,frailty plays a key role in predicting if the

patient will benefit from the treatment, and withstand the iatrogenic stress caused bythe procedures.

- **Tertiary prevention:**

Recognition of frailty in advance will aid the clinician to conscript the help of a comprehensive geriatric assessment team to amplify the possibility of functional recovery after any surgical procedure in an individual susceptible to frailty.

**Summary:**

Frailty is vastly prevalent and is related toaugmented health-care expenses. The worldwideinfluence of frailty is predicted to upsurge due to progressive increase in ageing population. Therefore, frailty should be focussed as a publichealth problem that needs immediate attention. Substantial development has been made in understanding the etiology, risk factors and methods of prevention of frailty in the pastdecades. Nevertheless, the conversion of these concepts from researchto clinical practice remains a challenge.Introduction more assessment tools and improvement in facilities to early diagnosis and primary prevention of the disease is mandated.

**References:**

1. Cole T. The Journal of Life. New York: Cambridge University Press; 1997.

2. Ahmed N, Mandel R, Fain MJ. Frailty: an emerging geriatric syndrome. Am J Med 2007: 120: 748–753

3. Morley JE, Anker SD, von Haehling S. Prevalence, incidence, and clinical impact of sarcopenia: facts, numbers, and epidemiology- update 2014. J Cachexia Sarcopenia Muscle 2014: 5: 253–259

4. Rockwood K, Hogan D, MacKnight C. Conceptualisation and measurement of frailty in elderly people. Drugs Aging 2000: 17: 295–302.

5. Achenbaum WA. Crossing Frontiers: Gerontology Emerges as a Science. New York: Cambridge University Press; 1995

6. Wilson JF. Frailty—and its dangerous effects—might be preventable. Ann Intern Med. 2004;141:489-492.

7. Ofori-Asenso R, Chin KL, Mazidi M, Zomer E, Ilomaki J, Zullo AR, Gasevic D, Ademi Z, Korhonen MJ, LoGiudice D, Bell JS. Global incidence of frailty and prefrailty among community-dwelling older adults: a systematic review and meta-analysis. JAMA network open. 2019 Aug 2;2(8):e198398-.

8. Walston J, McBurnie MA, Newman A, et al. Frailty and activation of the inflammation and coagulation systems with and without clinical comorbidities: results from the Cardiovascular Health Study. ArchIntern Med. 2002;162(20):2333-2342

9. Powell C. Frailty: help or hindrance. J R Soc Med. 1997;90:23-26

10. World Health Organization. WHO Clinical Consortium on Healthy Ageing: Topic Focus: Frailty and Intrinsic Capacity: Report of Consortium Meeting, 1–2 December 2016 in Geneva, Switzerland. Geneva,Switzerland: World Health Organization; 2017

11. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. JGerontolA BiolSciMedSci 2001;56(3):M146–M156

12. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003; 44: 58–68.

13. Xue QL. The frailty syndrome: definition and natural history. Clinics in geriatric medicine. 2011 Feb;27(1):1.

14. Xue QL, Bandeen-Roche K, Varadhan R, et al. Initial manifestations of frailty criteria and the development of frailty phenotype in the Women's Health and Aging Study II. The journals of gerontology Sep;2008 63(9):984–990

15. Boyd CM, Fortin M. Future of multimorbidity research: how should understanding of multimorbidity inform health system design? Public Health Reviews. 2010;32(2):451

16. van den Akker M, Buntinx F, Knottnerus JA. Comorbidity or multimorbidity: what's in a name? A review of literature. The European

Journal of General Practice. 1996;2(2):65–70.

17. Nagi SZ. Disability concepts revisited: Implications for prevention In: Pope AMT AR, editor. Disability in America: Toward a National Agenda for Prevention. Washington, D.C.: National Academy Press; 1991 p. 309–27

18. Kojima G. Prevalence of frailty in nursing homes: a systematic review and meta-analysis. J Am Med Dir Assoc 2015; 16: 940–45.

19. Levett TJ, Cresswell FV, Malik MA, Fisher M, Wright J. Systematic review of prevalence and predictors of frailty in individuals with human immunodeficiency virus. J Am Geriatr Soc 2016; 64: 1006–14.

20 Kojima G. Prevalence of frailty in end-stage renal disease: a systematic review and meta-analysis. Int Urol Nephrol 2017; 49: 1989–97.

21. Bandeen-Roche K, Seplaki CL, Huang J, et al. Frailty in older adults: a nationally representative profile in the United States. J Gerontol A Biol Sci Med Sci 2015; 70: 1427–34.

22 Santos-Eggimann B, Cuenoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. J Gerontol A Biol Sci Med Sci 2009; 64: 675–81.

23 Hoogendijk EO, van Hout HP, Heymans MW, et al. Explaining the association between educational level and frailty in older adults: results from a 13-year longitudinal study in the Netherlands. Ann Epidemiol 2014; 24: 538–44.

24. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J Gerontol A Biol Sci Med Sci 2007; 62: 722–27

# CHAPTER – 2

## Frailty- Implications for clinical practice and public health

**Background:**

Frailty syndrome is abstracted as a helpless or vulnerable conditionallied with increased risk of morbidity and mortality when the individual is imperilled to various stressors.This syndrome is contemplated as a handy tool for clinical risk classificationamong the elderly population. The developed countries such as the U.S, and U.K has a rapidly growing population of those aged more than 85 years, which is considered as a global burden. Whilst theelderly population endures to rise, the influence of frailty will be sensed throughout families of the affected individuals. Moreover, this burdensome situation will saturate the countries' economy, and affect the healthcare,and social systems.

**Important consensus points on physical frailty: (1)**

1. Physical frailty is a significant medical syndrome that is defined as "a medical syndrome with multiple causes and contributors that is characterized by diminished strength, endurance, and reduced physiologic function that increases an individual's vulnerability for developing increased dependency and/or death" (1).

2. It can be prevented or treated by early diagnosis and prompt management with precise treatment strategies such as routine exercise, nutrition rich diet (specifically proteins and vitamin D), and reduction of polypharmacy.

3. Easy,swift screening tests have been devised and authenticated, such as Frailty index (Chapter 1), Frailty scale, and simple 'FRAIL' questionnaire (Table 1). This permits the clinicians to diagnose the frail individuals at

the earliest.

4. In order to preciselymanage the affectedpersons with this syndrome, every individual above the age of 70 years and individuals with significant weight loss (≥5% of total body weight) due to any debilitating disease must beassessed for any signs of frailty.

**Table 1: The Simple "FRAIL" Questionnaire Screening Tool (1)**

| |
|---|
| 3 or greater = Frailty; 1 or 2 = Prefrail |
| Fatigue: Are you fatigued? |
| Resistance: Cannot walk up 1 flight of stairs? |
| Aerobic: Cannot walk 1 block? |
| Illnesses: Do you have more than 5 illnesses? |
| Loss of weight: Have you lost more than 5% of your weight in the past 6 months? |

**Clinical implication:**

Ahmed N in 2007 highlighted the clinical significance of the frailty during practice: (2)

1. A patient who is in pre-frail state has an increased risk for falls, hospitalization, institutionalization, and mortality, when compared to non-frail individual of the same age (Figure 1). However, the risk is not as high as an individual previously diagnosed with frailty syndrome.

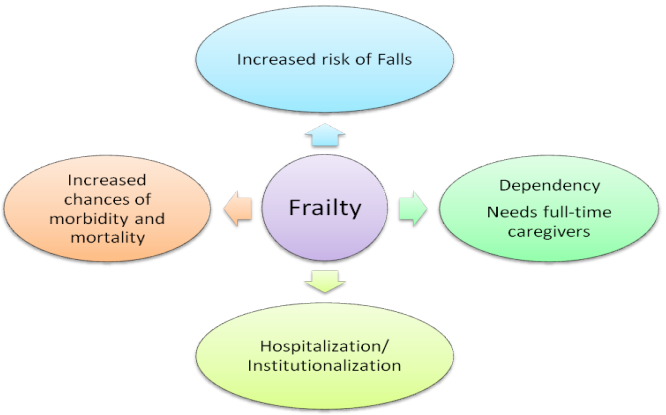
2.The pre-frail stage can still be reversed when diagnosed at an early stage.

3. Various studies have established that regular exercising, stretching, and resistance training can improve the condition remarkably. Reduction in the level of frailty markers are seeneven after 30 to60 minutes of routine

exercise that is performed at leastthrice a week.

4. A physician can prevent the comorbidities or reduce the severity of the syndrome by identifying the signs of frailty and recommending certain lifestyle changes before the condition reaches the next stages.

**Figure 1: Risks due to frailty**




**Clinical application of frailty (Figure 2):**

Research evidencessignify that frailty can be considered as an essential tool to assess the risk of developing post-surgical complications in elderly patients.The Frailty index (FI) and Frailty Phenotype (FP)aids in predictingthe possible postoperative complications in susceptible individuals (3, 4).

Frailty can also be employed for evaluating the risk in older patients with cardiovascular disorders, since it forecaststhe morbidity and mortality rates amongst the elderly population, including the patients enduring cardiac surgery (5, 6).Moreover, frailty can be considered as a clinical marker to assess the decline in the overall immune status of the older adults. FP has been suggested to recognize the people who fail to showpassable immune responses to common infection, andimmunization shots

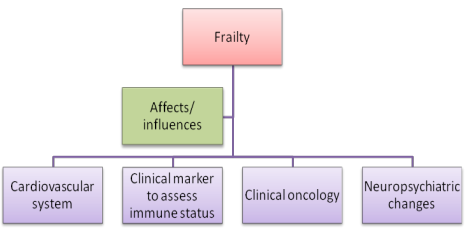
(vaccines against influenza and pneumococcal infections) (7, 8).

Evaluating the risk of frailty can also enable in predicting risk and vulnerability of older patients suffering from cancer (9, 10).Hence, assessment of frailty holds a critical position in geriatric oncology as it aids in foreseeing the mortality rate in older patients who receive chemotherapy for advanced tumors such as colorectal cancer (11). Furthermore, it also enables in predicting the post-operative complications of the patients who undergo treatment for tumours of gynecologic origin (12).

Effect of human immunodeficiency virus (HIV) infection and aging seem to be inter-related. Various studies have showed thatHIV infection and individuals with frailty or frailty-related phenotype have significant influence on mortality and decelerated immune-function (13, 14).

Most importantly, a frail individual are more prevalent to developimpairment of cognitive function and dementia. Though cognitive dysfunction is primarily due to chronic inflammatory state within the brain cortex, adverse effects of aging of the brain cells, i.e., "the frail brain" or "cognitive frailty" can be contributory factors to loss/reduction of cognitive function. But this association is still in the early stages of research and needs more long-term studies to substantiate this statement (15).

**Figure 2: Clinical application of frailty**



**Chiefelements of health status in elderly population:**

The three main components that have to be considered before assessing the overall health of the elderly population are:

1. Frailty
2. Disability
3. Comorbidity

(Refer chapter 1 for the details regarding each component).

Though each component is clinically different from each other, the prevalence and clinical signs and symptoms overlap to a certain extent (figure 3).

**The major healthcare implication for patientswith these 3 components:**

**Frailty:**

The patients are more vulnerable to frequent falls, hospitalization, and other related stressors. There is need to minimize these vulnerabilities and to treat the underlying conditions such as vitamin deficiency, generalized weakness, obesity, etc. However, it has to be kept in mind that this condition is progressive in nature that might demand primary and secondary preventive measures.

**Disability:**

The affected individuals require rehabilitative and supportive services. They are prone for partial or complete dependency, social isolation, and varying level of mortality. Therefore measures to reduce the risks for the above mentioned factors needs to be planned and implemented. When the degree of disability progresses, the patients will be either hospitalized or institutionalized and will require long-term care. However, in disabled patients, there is

scope for primary, secondary and tertiary prevention.

**Comorbidity:**

There is increased complexity in treating patients with diseases occurring concurrently. Handling comorbidity necessitates minimizing the risk for frailty and disability. There is potential for prevention of specific diseases, and minimizing the severity of the diseases.

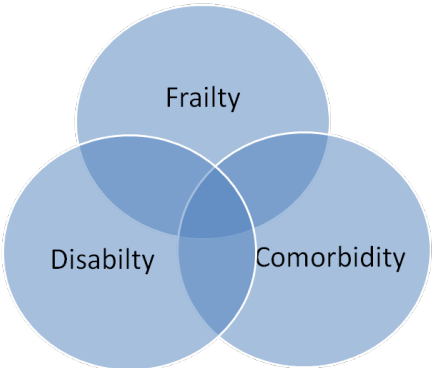
**Cost of frailty:**

Each of these components has critical prognostic insinuations that are not dependent on the other components. They are also independently related to the intensified need for healthcare assistance and amplified costs, including the risk of hospitalization. The researches on influence of frailty on health-care expenditure clearly suggested that there is a clear and evident pattern of augmented healthcare costs (16, 17). This pattern involves vaster practice in in-patient, and outpatient healthcare segments.

**Summary:**

The prognosis and treatment of other diseases such as cardiovascular diseases, tumors, and cognitive disorders are also significantly affected by frailty. Therefore, a clear understanding of the clinical implication of frailty and the associated components such as disability, and comorbidity is essential.

Figure 3: Interrelationship of disability, frailty, and comorbidity




**References:**

1. Morley JE, Vellas B, Van Kan GA, Anker SD, Bauer JM, Bernabei R, Cesari M, Chumlea WC, Doehner W, Evans J, Fried LP. Frailty consensus: a call to action. Journal of the American Medical Directors Association. 2013 Jun 1;14(6):392-7.

2. Ahmed N, Mandel R, Fain MJ. Frailty: an emerging geriatric syndrome. Am J Med 2007: 120: 748–753

3. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210: 901–908.

4. Ronning B, Wyller TB, Seljeflot I, et al. Frailty measures, inflammatory biomarkers and post-operative complications in older surgical patients. Age Ageing. 2010;39:758–761.

5. Afilalo J, Karunananthan S, Eisenberg MJ, Alexander KP, Bergman H. Role of frailty in patients with cardiovascular disease. Am J Cardiol. 2009;103:1616–1621.

6. Iqbal J, Denvir M, Gunn J. Frailty assessment in elderly people. Lancet. 2013;381:1985–1986.

7. Yao X, Hamilton RG, Weng NP, et al. Frailty is associated with impairment of vaccine-induced antibody response and increase in post-vaccination influenza infection in community-dwelling older adults.

Vaccine. 2011;29:5015–5021.

8. Ridda I, MacIntyre CR, Lindley R, et al. Immunological responses to pneumococcal vaccine in frail older people. Vaccine. 2009;27: 1628–1636.

9. Hamaker ME, Jonker JM, de Rooij SE, Vos AG, Smorenburg CH, van Munster BC. Frailty screening methods for predicting outcome of a comprehensive geriatric assessment in elderly patients with cancer: a systematic review. Lancet Oncol. 2012;13:e437–e444.

10. Audisio RA, van LB. When reporting on older patients with cancer, frailty information is needed. Ann Surg Oncol. 2011;18:4–5.

11. Aaldriks AA, van der Geest LG, Giltay EJ, et al. Frailty and malnutrition predictive of mortality risk in older patients with advanced colorectal cancer receiving chemotherapy. J Geriatr Oncol. 2013;4:218–226.

12. Courtney-Brooks M, Tellawi AR, Scalici J, et al. Frailty: an outcome predictor for elderly gynecologic oncology patients. Gynecol Oncol. 2012;126:20–24.

13. Desquilbet L, Jacobson LP, Fried LP, et al. HIV-1 infection is associated with an earlier occurrence of a phenotype related to frailty. J Gerontol A Biol Sci Med Sci. 2007;62:1279–1286.

14. Desquilbet L, Margolick JB, Fried LP, et al. Relationship between a frailty-related phenotype and progressive deterioration of the immune system in HIV-infected men. J Acquir Immune Defic Syndr. 2009;50: 299–306.

15. Boyle PA, Buchman AS, Wilson RS, Leurgans SE, Bennett DA. Physical frailty is associated with incident mild cognitive impairment in community-based older persons. J Am Geriatr Soc. 2010;58: 248–255.

16. Ensrud KE, Kats AM, Schousboe JT, et al. Frailty phenotype and healthcare costs and utilization in older women. J Am Geriatr Soc 2018; 66: 1276–83.

17. Kim DH, Glynn RJ, Avorn J, et al. Validation of a claims-based frailty index against physical performance and adverse health outcomes in the Health and Retirement Study. J Gerontol A Biol Sci Med Sci 2019; 74: 1271–76.

# CHAPTER – 3

## Frailty and Anaesthesia

**Background:**

The elderly people, as mentioned earlier, are more prone for falls, increased risk of institutionalization, and hospitalization. Recently, the global burden of expanding population of individuals above the age of 85 years has concerned the healthcare providers. Due to their increase risk for injuries, there is an increasing need for surgeries and thus anaesthesia. To deliver anaesthesia for an older patient is a subject of personalizing care according to the patient's specific requirements, but certaincommon aspects are imperative to consider.

This chapter discusses the characteristics of elderly, and the challenges and probabilities of administering anaesthesia for this delicate patient group, the existing methods and pharmacological preferences.

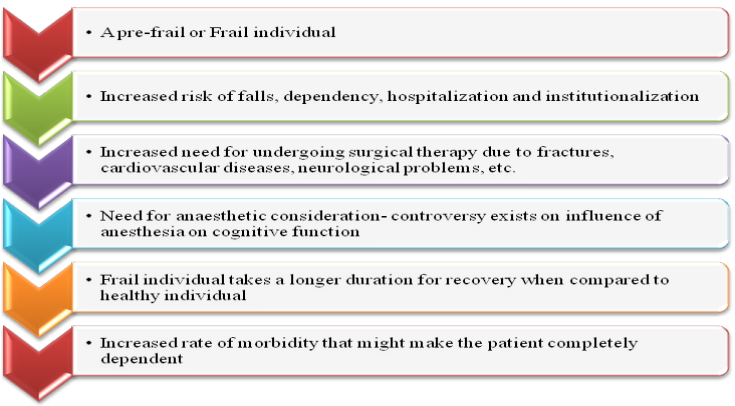
**Frailty and surgery (Figure 1):**

Since there is a considerable increase in the rate of surgical procedures amongst the elderly, the exigency for surgical proceduresunder anaesthesia is also expected to increase substantially (1, 2). An older individual who is hospitalized and requires a surgery experiences many challenges all through surgery and during the post-operative healing period. Most importantly, when frail individual is about to get operated, many factors should be considered as there is a multifacetedinteractionconcerning the process of aging, prevalence frailty, and anaesthetic procedure.A minor insult may be sufficient to lead to permanent functional decline post-surgery in a veryfrail patient,

whereas a robust older person may need majorsurgery and several postoperative complications to result ina decline in function.

For example, when a fit individual is injured or undergoes a minor surgery such as appendicectomy, he/she recovers quickly from the injury or the minor surgery and returns to perform daily activities with ease. In a similar situation, an individual with mild degree of frailty but functions independently takes a longer time to heal. Moreover, if they experience any major complication or undergo major surgeries, then functioning independently becomes almost impossible. Whereas an individual with moderate to severe degree of frailty and is already dependent on caretaker for day-to-day living takes the maximum duration of time to return to pre-surgical health status.

**Figure 1: Influence of frailty on surgical therapy**




**Frailty and pharmacologicalconsiderations for anaesthesia:**

Frailty is the accretion of discrepanciesamidst multiple organ systems resulting in deterioration of physiological functioning and subsequent pharmacological changes.

These concerns are additionallycomplicated by co-existence of co-morbidity, disability, organ malfunction, and polypharmacy.

The various pharmacological considerations in a frail individual are listed in table

Table 1: Pharmacological considerations in a frail individual (3, 4, 5)

1. Reduced muscle mass, total body water content and increase in adipose tissue. Therefore, drugs that are lipophilic drugs are distributed in large volumes all over the body resulting in longer duration of action. However, increased plasma concentration of hydrophilicdrugs is noted due to decrease in the central compartment.

2. The reduced musclemass usuallysuggests that the renal function is deterioratingbutit is not revealed specifically by the serum creatinine levels.Besides, aging condenses the renal mass, and lessens the rate of excretion of drugs.

3. The patientshave increased sensitivity to drugs with potential for renaltoxicity.

4. Frailty is associated with a reduction in estimatedglomerular filtration rate (GFR). This is suggested to be negative influence on prognosis of a frail individual after any surgical therapy.

5. Overall, there is considerable alteration in the drug metabolism inthe older population due to reduced hepatic blood flow anda reduction in the activity of the cytochrome P450 system.

Subsequently, drugs are less effectively cleared by Phase I reactions.

6. Frailty influences the cardiac functioning by reducing

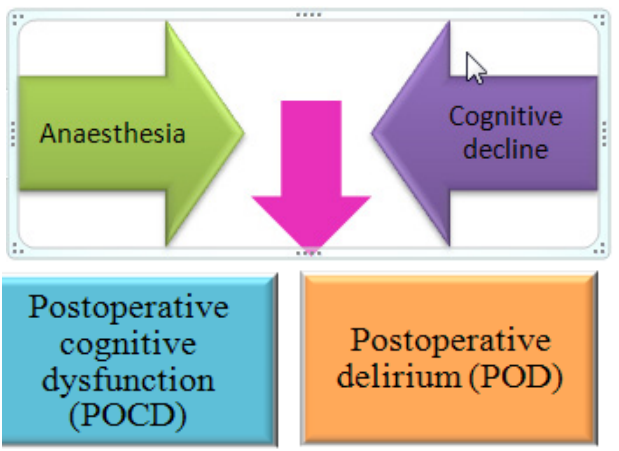
the cardiac muscle mass, thus decreasing the cardiac output. The resultant effect is hypotension and hypovolemia that has a significant influence while considering anaesthesia.

7. Aging causes progressive loss of lung parenchyma elasticity, a reduction in functionalalveolar surface area and reduced respiratory musclestrength. But frailty increases the severity these changes. Therefore, drugs such as neuromuscular blocking agents, opioids, or sedatives,may increase the risk of aspiratio

**Anaesthesia and cognition:**

A frequent finding in geriatric patients is decline in cognitive function. But the theory that is of particular interest is the instabilities in cognition during the perioperative phase of the older individuals who undergoes surgical treatment. These instabilities are termed as postoperative cognitive dysfunction (POCD) and postoperative delirium (POD). These two factors determine the prognosis of the patient post-surgically. An individual presenting with frailtytends to show impairment of the cognitive function with decreased cognitive reserve. Therefore, these patients aremore susceptible to POCD and POD.

**Figure 2: Anaesthesia and cognition**



**Frailty and anaesthesia:**

In general, the anaesthetic technique can be broadly classified into two categories, regional anaesthesia (RA) and general anaesthesia (GA), depending upon the requirement for a particular surgery. The method of anaesthesia preferred for the management of a patient rely upon the surgical needs, duration of the procedure as well as the prevailing comorbidities. There are various debates arguing about the influence of anaesthesia on cognitive function post-operatively, especially in pre-frail and frail patients. But before proceeding in detail into the topic of frailty and anaesthesia, it is important to remember certain points before administering anaesthesia to old patients in general (Table 2).

**Table 2: Points to consider before administering anaesthesia to the elderly**

1. Age is a predictor for increased mortality and morbidity
2. Biological age is more important than chronological age
3. Frailty denotes loss of function in all organs and is common
4. Cognitive changes are frequent and important
5. Preoperative assessment can be difficult and time consuming
6. Relatives may be crucial to obtain a reliable functional assessment and secure informed consent
7. Reduce doses of anaesthetic drugs, titrate to effect and evaluate responses repeatedly
8. Neuromuscular blocking agents have prolonged duration of action, so use neuromuscular monitoring
9. Assess pain with an appropriate pain score and secure pain relief
10. Facilitate early rehabilitation and minimise time in

hospital

Adopted from: Strøm C, Rasmussen LS, Steinmetz J. Practical management of anaesthesia in the elderly. Drugs & aging. 2016 Nov;33(11):765-77. (6)

A detailedassessment of the older patients prior to surgical procedure is essential to minimize poor clinical outcomes and to improve the prognosis. This is important because frailty is often an overlooked concept and in case a frail individual needs to undergo surgery, failure to adequately assess the patient before the procedure increases the morbidity and mortality rate. As a first step en-route this objective, Chow et al proposed certain guidelines for preoperative evaluation of older patients (Table 3).

**Table 3: Guidelines for preoperative evaluation of older patients**

- Assess the patient's cognitive ability
- Evaluate for depression or the tendency to develop depression
- Identify the risk factors for POD
- Present status of alcohol intake and substance abuse
- Estimation of cardiac and pulmonary function and output
- Assessment of the patient's general nutritional and functional status, history of falls, and social support

Influence of frailty on procedures requiring anaesthesia gained the importance anaesthetists come across frail patientsmore frequently. The National Joint Registry report from 2012 recorded nearly 166 000 cases of primary hip and knee arthroplasty surgeries. Approximately 51% and 43% of females and males, who underwent such surgeriesaged between a range 70 and 89 years,

respectively. This number became one of the concerns for anaesthetists because of the independent relationship of frailty with higher rate of postoperative morbidity, and the occurrence of postoperative complications, especially after procedures that required anaesthesia. Though this hypothesis has been explained by various studies retrospectively, more prospective studies are mandated to validate this association.

Mason SE and authors in 2010 in a meta-analysis considered the effect of anaesthetic technique on POCD and POD. The results suggested that GA was slightlybut non-significantly related to the incidence of POCD (8). Moreover, RA was expected to be favourable when administered as an analgesic agent, but the degree of analgesia depends uponthe type of block employed.

The intravenous agents utilized for GAseem to negatively affect the neuronal structures by altering the axonal growth and retarding the developments of neuronal networks. It can also derange the axonal growth, andproduce apoptosis of the brain cells. All of these changes combined together can result in alterations of critical areas that play a vital role in forming and retaining memory (9).

Apart from the effect of anaesthesia on frail patients, the influence of frailty on the choice of anaesthesia also needs to be discussed. All the above-mentioned information must be kept in mind before performing any surgical procedure on old as well as frail patients because, their organs take much longer time to heal than a healthy or pre-frail person. Therefore, the advantages and disadvantages of both RA and GA must be evaluated before choosing the method of anaesthesia.

**Summary:**

In general, an elderly person must be handled with utmost care both pre and perioperatively. The choice of anaesthesia depends on various factors and clinicians

must be thorough with the guidelines to reduce the risk of morbidity and mortality post-operatively. Some studies suggest that RA has an edge over GA for treating the frail patients. However, adequate and convincing evidence is lacking to substantiate this hypothesis.

**References:**

1. Dall TM, Gallo PD, Chakrabarti R, West T, Semilla AP, Storm MV. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health Aff (Millwood).* 2013;32(11):2013–2020.

2. Etzioni DA, Liu JH, Maggard MA, Ko CY. The aging population and its impact on the surgery workforce. *Ann Surg.* 2003;238(2): 170–177.

3. Rana MV, Bonasera LK, Bordelon GJ. Pharmacologic considerations of anesthetic agents in geriatric patients. *Anesthesiol Clin.* 2017;35(2):259–271

4. Strom C, Rasmussen LS, Steinmetz J. Practical management of anaesthesia in the elderly. *Drugs Aging.* 2016;33(11):765–777.

5. Chowdhury R, Peel NM, Krosch M, Hubbard RE. Frailty and chronic kidney disease: a systematic review. *Arch Gerontol Geriatr.* 2017;68:135–142.

6. Strøm C, Rasmussen LS, Steinmetz J. Practical management of anaesthesia in the elderly. Drugs & aging. 2016 Nov;33(11):765-77.

7. Chow, W.B., Rosenthal, R.A., Merkow, R.P., Ko, C.Y. and Esnaola, N.F., 2012. Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society. *Journal of the American College of Surgeons*, *215*(4), pp.453-466.

8. Mason SE, Noel-Storr A, Ritchie CW. The impact of general and regional anesthesia on the incidence of post-operative cognitive dysfunction and post-operative delirium: a systematic review with

metaanalysis. *J Alzheimers Dis.* 2010;22(Suppl 3):67–79.

9. Jevtovic-Todorovic V, Absalom AR, Blomgren K, Brambrink A, Crosby G, Culley DJ, et al. Anaesthetic neurotoxicity and neuroplasticity: an expert group report and statement based on the BJA Salzburg Seminar. Br J Anaesth. 2013;111:143–51.

## CHAPTER – 4

### Frailty and Pre-op Optimization, Prehabiltation, and Informed consent

**Background:**

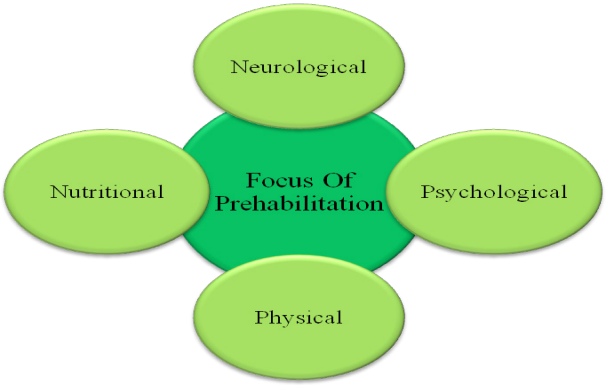
Frailty meansdecreasedcompetence to maintain the homeostasis and to react to any stressors and is related to poor clinical outcomes and amplified need for healthcare admissions. During perioperative care in the hospitals, frailty assessment seems to be an indispensable part of risk profiling, primarily because it is independentlyassociated with increased morbidity and mortality followingsurgery. Hubbard and Story refer frailty as the "elephant in the operating room: easy to spot but often ignored" (1). This phrase was suggested because many anaesthetists do not explicitly ponder frailty during their pre-operative evaluation or consider interventions intended to reduce the level of frailty in the pre-operative phase. Therefore, analysis of frailty in patients before they undergo any surgical procedure should be carried outto strategize the risk reduction and to enrol the diagnosed patients in prehabilitation programs.

**Prehabilitation of frail patients:**

Prehabilitation isa concerted term that describes the methods of interventions that reduces the extent of frailty by fuelling the patients' physiological reserve before the commencement of any surgical procedure. Prehabilitation programcapriciouslycomprises of various interventions such as neurological, psychological, physical andnutritional concerns of the patients, thereby reduces postoperativecomplications, curtails the duration of hospital stay and enhances the overall quality of life

(Figure 1) (2, 3, 4).

**Figure 1: Frailty and concerns of prehabilitation**




**Significance of frailty:**

When a patient enters the operating theatre with better physical health, the post-operative complications, the duration of hospital stay, and chances of morbidity are potentially reduced as the patient will be able to withstand the surgical insult and heals faster.

In order to achieve the better pre-surgical physical health of a frail patient, certain prehabilitating methods have been adopted (5):

1. Enhancingthe aerobic and functional capacity of the patient by advising specific exercises
2. By treating the ailments that are known to augment the perioperative risk
3. Creating awareness amongst the patients by educating them andencouraging them to involve actively in the process

This chapter will focus on each component of prehabilitating

a frail patient pre-operatively

**Prehabilitation and exercise:**

Exercise mandates a multifaceted interaction of the muscles and the multi-organ systems thereby modifying and promoting the functional status of these systems. Exercising hasnumerous advantages such as improved muscle strength and coordination, thus achieving enhanced physiological reserve.

The recommended exercises are (5, 6, 7):

- Robust exercising for at least 75 minutes or moderate level of exercising for a minimum of 150 minutes per week
- 10 sessions of aerobic exercises, the duration being evenly distributed throughout the week
- Resistance training, (for example, leg presses in both concentric and eccentric movements) to increase the muscle function and flexibility
- Balance training exercises at least 3 times a week
- 3 sessions of respiratory exercises that includes inspiratory/expiratory cycles per day to improve the lung capacity

A well planned programme is crucial forexercise prehabilitation (Table 1).

**Table 1: Scales and devices to plan the exercise programme**

| | | |
|---|---|---|
| Percentage of heart rate reserve (HRR) | Karvonen formula<br><br>Target Heart rate (HR) = [(maximum HR – resting HR) × %intensity] + resting heart rate). | Precaution:<br><br>In patients with low physical fitness, it is recommended to commence exercise at 55% heart rate reserve. |
| Assessment of intensity | Borg Scale (8)<br><br>The scale values ranges from 6 to 20 and the scores denote the HR ranging from 60 to 200 beats/ minute | 7 Very, very light<br><br>8 Very light<br><br>9 Fairly light<br><br>10 Somewhat hard<br><br>11 Hard<br><br>12 Very hard<br><br>13 Very, very hard |

| | | |
|---|---|---|
| Step counting devices | Accelerometers and pedometers | These are used to monitor and encourage ambulatory activity |

**Prehabilitation and nutrition:**

The term malnutrition and under-nutrition are terminologies referring to inadequate quantity of food intake or consuming food that lacks nutrition. Though malnutrition is distinct from frailty, both conditions overlap and co-exist.Similar to frailty, malnutrition is also associated with frequent hospitalizations, increased duration of stay in hospitals,and dependency on others (9). Malnutrition presents with generalized weakness, reduced ability to perform daily activities and hence can be a contributor for frailty in older individuals.

On the other hand, over-nutrition or metabolic syndrome due to excessive consumption of food can also lead to numerous health problems such as cardiovascular diseases, obesity, chronic inflammatory processes, etc. So both the ends of the nutrition spectrum can place the patients at the risk of developing frailty due to sarcopenia, inflammatory process, and oxidative stress. Therefore, adapting healthy eating habits is of prime concern. Prehabilitating and optimizing the frail individuals on the importance of eating clean and healthy will hasten their recovery post-operatively.

The inter-relationship of frailty and nutrition is described in the forthcoming sections.

**i. Diet quality:**

Healthier diets comprising fruits, vegetables, whole

grains, foods rich in proteins and less of carbohydrates are considered to be of higher quality and are linked with lower risk of frailty. Various cross-sectional, longitudinal studies, and meta-analyses suggest that frailty is associated with unhealthy food habits and reversal of frailty can be achieved by adapting healthy dietary pattern (10).

**ii. Inflammatory potential of diet:**

A healthy diet is said to have a balanced proportion of pro-inflammatory and anti-inflammatory components. Nutrition rich diets comprising of vitamins and minerals, poly- unsaturated fatty acids, Omega-3 fatty acids, and increased quantity of proteins and fibres with adequate quantity of carbohydrates are said to maintain and enhance someone's health. However, consuming sugary foods, foods containing saturated fats, fried and processed foods tend to increase the oxidative stress in the body and hence promoting the process of inflammation.

Any discrepancy in this balanceisanticipated to cause frailty because a number of studies have proved that pro-inflammatory diets (assessed by Dietary Inflammatory Index (DII) scores) are accompanied withincreased levels of circulating inflammatory markers such as C-reactive protein (CRP) and interleukin-6(IL-6) (11, 12).

**iii. Other influences on frailty risk:**

- Appetite

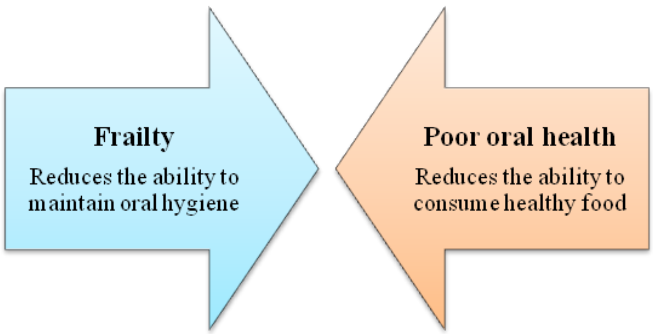
Appetite is generally low in older adults. However, loss of appetite leads to reduced intake of nutrition rich foods and further contributes to anorexia of aging. This in turn leads to developing or worsening of frailty and increases the risk of hospitalization and duration of hospital stays post-operatively.

- Oral health:

Advancing age is also associated with oral health problems such as gingival and periodontal disease, extensive caries,

and tooth loss. Xerostomia and loss of taste are also other features commonly noted in older adults. Poor oral health and frailty co-exist (Figure 2)

**Figure 2: Oral health and frailty**




Older adults with frailty are more susceptible to oral disease and have poorer access to dental treatment. Dental diseases will further aggravate frailty, therefore stressing upon theprerequisite for primary and secondary prevention of dental diseases, andenhanced management of oral health in pre-frail and frail individuals is vital.

Prospective studies and few case series provided exercise programs and nutritional modifications and optimizations prior to surgical therapy. The results of the studies suggested that modifying the diet and functional capacity reduced the duration of hospital stay and hastened their recovery post-surgically (7, 13). More emphasis was made on consuming diets rich in micro-nutrients, anti-oxidants and vitamin D (14, 15).

**Prehabilitation and respiration:**

Inspiratory muscle training (IMT) increases the respiratory musclestrength and improves the endurance by gradually

raising the intensity,starting at 20% to 30% of maximal inspiratory pressure and progressing to 60% of maximal inspiratory pressure (16). Emphasizing on prehabilitation programs to improve the respiratory muscle strength and function has been proved to be effective in reducing post-operative pulmonary complications, duration of stay in hospital, and necessity for re-intubation (17).

**Pharmacological optimization:**

A systematic review and meta-analysis evaluated the drug therapy for the betterment inphysical performance, increased muscle strength (18). To assess this, single-drug regimen to achieve positive impact on physicalperformance comprised of the following drugs were evaluated in various studies:

- alfacalcidol (a vitamin D analog),
- teriparatide (an anabolic parathyroid hormone fragment),
- piroxicam (a nonsteroidal anti-inflammatory drug),
- testosterone (an anabolic steroid) or
- capromorelin (a growth hormone secretagogue).

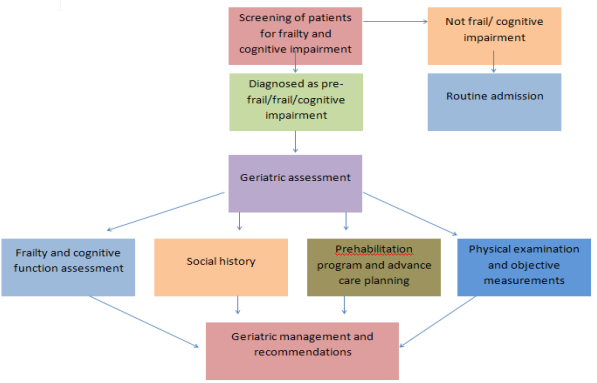
However, the results of the studies trying to establish the causal relationship amongst these above-mentioned drugs and frailty were inconclusive and recommended the need for randomized controlled clinical trials on pharmacological optimization of patients prior to surgical procedures (18).

**Recommendation for prehabilitation:**

Though it is mostly approved that prehabilitation of the older adult patientsmustinvolve physical, nutritional and psychological modifications, there is an increasing need for evidence-based recommendations. The Society

from Perioperative Assessmentand Quality Improvement (SPAQI) hasstipulated an outline for the geriatric centres that includes comprehensive frailty assessment and management of susceptible older adults (Figure 3) (19)

**Figure 3: Recommended preoperative evaluation pathway for older adults**




[Adapted from Cooper L, Abbett SK, Feng A, Bernacki RE, Cooper Z, Urman RD, Frain LN, Edwards AF, Blitz JD, Javedan H, Bader AM. Launching a geriatric surgery center: recommendations from the Society for Perioperative Assessment and Quality Improvement. Journal of the American Geriatrics Society. 2020 Sep;68(9):1941-6 (19)]

Currently, itis considered that prehabilitation through unimodel and multimodel approaches comprising of proactive care of older people undergoing surgery (POPS) and preoperative comprehensive geriatric assessment (CGA) should be planned for duration of at least 4 weeks before planning the surgical procedureand the plan must be tailored according to individual patient's condition. The baseline factors such as functional andcognitive status, medical and psychologicalcomorbidities must be evaluated before planning the programme (20). Geriatric

co-management has showed enhanced clinical outcomes by interdisciplinary approaches of the geriatric,anaesthetic, and surgical specialities.

**Summary:**

Prehabilitation and optimization of patients prior to planning surgical therapy has been proved to be effective in improved post-operative clinical outcomes, hastened healing, reduced post-operative complications and morbidity rate. It must be carried out sequentially involving all the aspects of therapy focusing on physical, nutritional and psychological aspects of the older patients. Frailty assessments tools and multimodel approaches must be employed to achieve prehabilitation and pre-operative optimization.

**References:**

1. Hubbard RE, Story DA. Patient frailty: the elephant in the operating room. *Anaesthesia*. 2014; 69 (Suppl. 1):26□34.

2. Vlisides PE, Das AR, Thompson, AM et al. Home-based cognitive prehabilitation in older surgical patients: a Feasibility Study. *J Neurosurg Anesthesiol*. 2019;31:212–217.

3. O'Gara BP, Mueller A, Gasangwa DVI, et al. Prevention of early postoperative decline: a randomized, controlled feasibility trial of perioperative cognitive training. *Anesth Analg*. 2020;130:586–595.

4. van Rooijen SJ, Molenaar CJL, Schep G, et al. Making patients fit for surgery: introducing a four pillar multimodal prehabilitation program in colorectal cancer. *Am J Phys MedRehabil*. 2019;98:888–896.

5. Milder DA, Pillinger NL, Kam PC. The role of prehabilitation in frail surgical patients: a systematic review. Acta Anaesthesiologica Scandinavica. 2018 Nov;62(10):1356-66.

6. Hoogeboom TJ, Dronkers JJ, van den Ende CH, Oosting E, van Meeteren NL. Pre□operative therapeutic exercise in frail elderly

scheduled for total hip replacement: a randomised pilot trial. *ClinRehabil*. 2010;24:901□910.

7. Mazzola M, Bertoglio C, Boniardi M, et al. Frailty in major oncologic surgery of upper gastrointestinal tract: how to improve postoperative outcomes. *Eur J Surg Oncol*. 2017;43:1566□1571.

8. Borg GA. Psychophysical bases of perceived exertion. Medicine & science in sports & exercise. 1982.

9. Elia, M. The Cost of Malnutrition in England and Potential Cost Savings from Nutritional Interventions (Short Version), A Report on the Cost of Disease-Related Malnutrition in England and a Budget Impact Analysis of Implementing the NICE Clinical Guidelines/Quality. 2015.

10. Ni Lochlainn M, Cox NJ, Wilson T, Hayhoe RP, Ramsay SE, Granic A, Isanejad M, Roberts HC, Wilson D, Welch C, Hurst C. Nutrition and frailty: Opportunities for prevention and treatment. Nutrients. 2021 Jul;13(7):2349.

11. Shivappa, N.; Hebert, J.R.; Marcos, A.; Diaz, L.E.; Gomez, S.; Nova, E.; Michels, N.; Arouca, A.; Gonzalez-Gil, E.; Frederic, G.; et al. Association between dietary inflammatory index and inflammatory markers in the HELENA study. Mol. Nutr. Food Res. 2017, 61.

12. Shivappa, N.; Wirth, M.D.; Hurley, T.G.; Hebert, J.R. Association between the dietary inflammatory index (DII) and telomere length and C-reactive protein from the National Health and Nutrition Examination Survey-1999–2002. Mol. Nutr. Food Res. 2017, 61, 1600630

13. Chia CL, Mantoo SK, Tan KY. 'Start to finish trans□institutional transdisciplinary care: a novel approach improves colorectal surgical results in frail elderly patients. *Colorectal Dis*. 2016;18:43□50.

14. Das, A.; Cumming, R.G.; Naganathan, V.; Blyth, F.; Ribeiro, R.V.; Le Couteur, D.G.; Handelsman, D.J.; Waite, L.M.; Simpson, S.J.; Hirani, V. Prospective Associations Between Dietary Antioxidant Intake and Frailty in Older Australian Men: The Concord Health and Ageing in Men Project. J. Gerontol. A Biol. Sci. Med. Sci. 2020, 75, 348–356

15. Marcos-Pérez, D.; Sánchez-Flores, M.; Proietti, S.; Bonassi, S.; Costa, S.; Teixeira, J.P.; Fernández-Tajes, J.; Pásaro, E.; Valdiglesias, V.; Laffon, B.; et al. Low Vitamin D Levels and Frailty Status in Older Adults: A Systematic Review and Meta-Analysis. Nutrients 2020, 12, 2286.

16. Tew GA, Ayyash R, Durrand J, Danjoux GR. Clinical guideline and recommendations on pre□operative exercise training in patients awaiting major non□cardiac surgery ePub ahead of print. *Anaesthesia*. 2018;73:750□768.

17. van Adrichem EJ, Meulenbroek RL, Plukker JT, Groen H, van Weert E. Comparison of two pre□operative inspiratory muscle training programs to prevent pulmonary complications in patients undergoing esophagectomy: a randomised controlled pilot study. *Ann Surg Oncol*. 2014;21:2353□2360.

18. Pazan F, Petrovic M, Cherubini A, Onder G, Cruz-Jentoft AJ, Denkinger M, van der Cammen TJ, Stevenson JM, Ibrahim K, Rajkumar C, Bakken MS. Current evidence on the impact of medication optimization or pharmacological interventions on frailty or aspects of frailty: a systematic review of randomized controlled trials. European journal of clinical pharmacology. 2021 Jan;77(1):1-2.

19. Cooper L, Abbett SK, Feng A, Bernacki RE, Cooper Z, Urman RD, Frain LN, Edwards AF, Blitz JD, Javedan H, Bader AM. Launching a geriatric surgery center: recommendations from the Society for Perioperative Assessment and Quality Improvement. Journal of the American Geriatrics Society. 2020 Sep;68(9):1941-6.

20. Alvarez-Nebreda ML, Bentov N, Urman RD, et al. Recommendations for preoperative management of frailty from the Society for Perioperative Assessment and Quality Improvement (SPAQI). J Clin Anesth 2018; 47(February): 33–42.

# CHAPTER – 5

## Frailty and Intra-operative Management

**Background:**

Frailty, a term used to describe generalized weakness, progressive loss of weight, and unsteadiness, possess lot of clinical implications. Pre-frail and frail individuals are at an increased risk for intra-operative and post-operative complications resulting in amplified morbidity and mortality rates. Moreover, frailty has been abstractlyidentified to portray a condition of augmented vulnerability, diminished physiologic reserve and inability to defy the stressors.

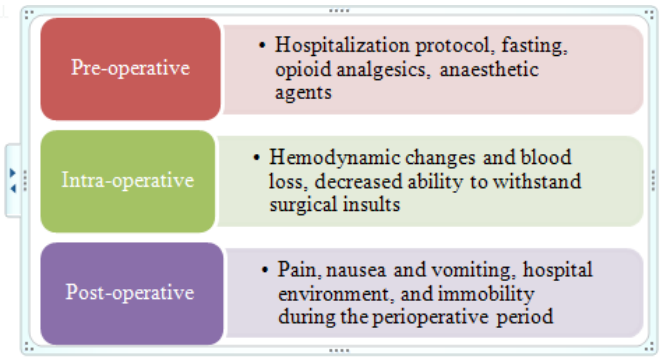
**Frailty and surgery:**

A hospitalized elder individual about to undergo surgical has to encounter many hardships all through their surgical expedition and the post-operative recoveryperiod. The following are the challenges faced by a frail patient during each phase of the surgery (Figure 1):

1. Pre-operatively: Hospitalization protocol, fasting, opioid analgesics, and anaesthetic agents
2. Intra-operatively: Hemodynamic changes and blood loss, decreased ability to withstand surgical insults
3. Post-operatively: Pain, nausea and vomiting, hospital environment,and immobility during the perioperative period

These factors canall be the sparks that results in failure of a formerlystable but frail body.

**Figure 1: Challenges phased by a frail patientduring each phase of the surgery**




The extent of insult required to initiate decompensationand consequentundesirable clinicaloutcome is inversely linked to the intensity of frailty (Figure 2).[2]A very frail patient may succumb to a minor insult whereas a pre-frail patient may successfully recover from major surgery and its post-operative complications.

**Figure 2: Frailty and surgical insults [2]**

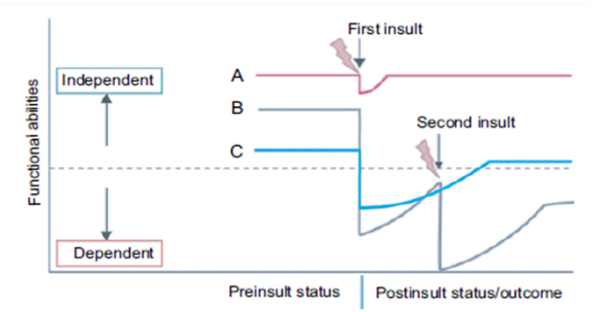



**Figure 1** Role of frailty in recovery from surgery.
**Source:** Copyright ©1999–2018 John Wiley & Sons, Inc. Reproduced from Desserud KF, Veen T, Soreide K. Emergency general surgery in the geriatric patient. *Br J Surg*. 2016; 103(2):e52–61.[15] from Desserud et al.[15]

Patient "A" is a fit individual who is completely independent for his normal function. Therefore the patientshows hastened recovery after a minor insult.

Patient "B" is someone with mild degree of frailty. Any major insult results in the patient becoming dependent. If this person suffers a second injury, then it will result in further decline of the functioning ability or even in death. Furthermore, second insult will make the individual completely dependent for life.

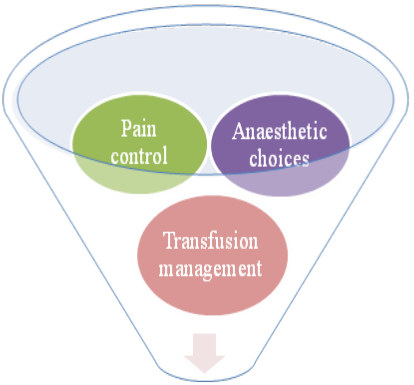
Patient "C" is a functionallyindependent but presents with a moderate degree of frailty. Therefore after an insult, the patient might become dependent on their caretaker for a certain period of time until complete recovery. The patient ultimatelyresumes to living independently after complete recovery, but at a decreasedlong-term function when contrasted with the functioning ability before surgery.

**Frailty and intra-operative implications:**

Clinically, intraoperative remedial decisions and treatment planning have anenduring and pensiveconsequence on the success of any surgical procedure as well as the post-operative morbidity and mortality rate, and the quality of life. It is noteworthy that the surgical aftereffects are intensified in a frail patient when compared to a fit individual. Figure 3 highlights the potential areas of intra-operative care that a surgeon must be heedful off. [3]

The choice of anaesthetic drug, methods adopted to control intra- and post-operative pain, and the usage of outcome-oriented transfusion careareacknowledged as prospective areas to recuperate the surgicaloutcomes. It is noteworthy that the post-operative complications such as protracted intubation, delirium, and pneumonia; eventually leading to increased duration of hospital stay can be handled explicitly if these three aspects are effectively considered intra-operatively.[4, 5]

**Figure 3: Potential areas to improve the intra-operative management of frail patients**




- **Anaesthetic choices:**

Anaesthetic choices have been recognized to have a profound effect on cognitive function post-surgically.[6] As mentioned in Chapter 3, elder patients are more prone to show higher global scores on cognitive impairmenteven a year after their critical illness. Furthermore, such individuals encounter postoperative delirium with significantly higher risk of getting institutionalized.[7] In order to avoid such eventful incidences, practising neuraxial anaesthesia and evasion of benzodiazepines can be applied to the patients.[8]

- **Pain control:**

Most of the older patients suffer from moderate to severe pain post-operatively, especially if it is a major surgery such as cardiothoracic or colorectal surgeries. The intensity of pain is increased by many folds in a frail patient. Taking adequate intra-operative measures to minimize pain, blood loss an intra-operative time will aid in reducing the

post-operative morbidity and mortality of such patients.

- **Transfusion management:**

Likewise, goal-directed fluid or outcome-oriented transfusionmanagement with least invasive monitoring devices and prudent practice of transfusion have major effect on older patients on both short- and long-term basis.[9, 10]

Even though most of these intercessions have been employed in the intraoperative care of geriatric patients, adequate prospective data is not available that has recorded the advantages of these methods on frail older population.[3]

Advanced programs such as "EnhancedRecovery After Surgery" have stemmed in the recent years. These programs employ thedemonstrated evidenceto regularize the care provided in hospitals, decrease the incidence of intra- as well as post-operative complications, and hasten the recovery of the frail patients after any surgical procedure. These programs stipulate anuprightagenda to enhance care throughout the intraoperative phase.[11, 12]

**Frailty and operative stress:**

Patients with frailty syndrome tend to show high mortality rates at high mortality rates at 30, 90, and 180 days even for surgeries that are considered to be least stressful.Moreover, it was found that the mortality rates were high for both elective as well as emergency surgeries. In fact, emergency surgeries showed very high death rate post-operatively. The level of operative stress can be assessed using a scale called as operative stress score (OSS). This OSS ranges from a score of 1 to 5 degree, rating that is based on the extent of physiologic stress applied to the patients.[13] The higher scores indicate higher degree of stress applied. This scale is encompassed in Veterans Affairs Surgical Quality Improvement Program.

Preoperatively, the patients should be assessed and categorized as normal, pre-frail, frail and very frail patients. With the help of this scale, the extent of intra- and post-operative stress the patients can withstand must be evaluated, and the decision on elective or emergency surgery must be made.

**Intraoperative hemodynamic variations:**

Homeostenosis is defined as physiologically impaired response to stress. A frail individual exhibits varying degree of homeostenosis. Levin et al hypothesized that the preoperative frailty and the extent of homeostenosis is linked to reducederraticism of mean arterial blood pressure (MAP) under anaesthesia. He also found that occurrences of blood pressure erraticism are essentiallydefensive but the phenotype of the patients must be taken into consideration.[14] The "reserve capacity" of patients can be identified if the phenotype of frailty is associated to hemodynamic variations pre-operatively.

In order to conferif intraoperative hemodynamic variability is part of the mechanistic pathway between frailty and mortality, James LA and co-authors conducted a retrospective cohort study. The study concluded that frailty is related with less intraoperative blood pressure changes, and the association of frailty with 30-day mortality is partlyarbitrated by incidents of absolute change >15% in fractional MAP.[15]

Thorough estimation of the above-mentioned factors will enable the physicians to determine the prognosis and thus reduce the post-operative mortality rate.

**Summary:**

A proper preoperative assessment will enable physicians in avoiding post-operative complications in a frail patient.

Intra-operatively, the factors that should be considered are the methods of pain control, anaesthetic choices and transfusion management, because proper choices associated with these factors will prevent the unsolicited post-operative complications such as total dependence, delirium, cognitive impairment, and in worst case scenario, the death of the patient. Another important factor to be considered intra-operatively is the operator stress. Assessing the extent of stress the procedure will impart of the patient and evaluating the capacity of the patient to withstand the stress is essential to prevent the adverse clinical outcomes.

**References:**

1. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56(3):M146–M156.

2. Desserud KF, Veen T, Soreide K. Emergency general surgery in the geriatric patient. *Br J Surg*. 2016;103(2):e52–61.

3. Anaya DA, Johanning J, Spector SA, Katlic MR, Perrino AC, Feinleib J, Rosenthal RA. Summary of the panel session at the 38th Annual Surgical Symposium of the Association of VA Surgeons: what is the big deal about frailty? JAMA surgery. 2014 Nov 1;149(11):1191-7.

4. Griffiths R, Beech F, Brown A, et al; Association of Anesthetists of Great Britain and Ireland. Peri-operative care of the elderly 2014: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia*. 2014;69(suppl 1):81-98

5. Dodds C, Foo I, Jones K, Singh SK, Waldmann C. Peri-operative care of elderly patients—an urgent need for change: a consensus statement to provide guidance for specialist and non-specialist anaesthetists. *Perioper Med (Lond)*. 2013;2(1):6.

6. Pandharipande PP, Girard TD, Jackson JC, et al; BRAIN-ICU Study Investigators. Long-term cognitive impairment after critical

illness. *N Engl JMed*. 2013;369(14):1306-1316.

7. Neufeld KJ, Leoutsakos JM, Sieber FE, et al. Outcomes of early delirium diagnosis after general anesthesia in the elderly. *Anesth Analg*. 2013;117(2): 471-478.

8. Pandharipande PP, Pun BT, Herr DL, et al. Effect of sedation with dexmedetomidine vs lorazepam on acute brain dysfunction in mechanically

9. Abbas SM, Hill AG. Systematic review of the literature for the use of oesophageal Doppler monitor for fluid replacement in major abdominal surgery. *Anaesthesia*. 2008;63(1):44-51.

10. Amato A, PescatoriM. Perioperative blood transfusions for the recurrence of colorectal cancer. *Cochrane Database Syst Rev*. 2006;(1):CD005033.

11. GrocottMP, Martin DS,Mythen MG. Enhanced recovery pathways as a way to reduce surgical morbidity. *Curr Opin Crit Care*. 2012;18(4):385-392.

12. Enhanced Recovery After Surgery (UK). ERAS Society (UK) website. http://www.erasuk.net. Accessed August 14, 2014.

13.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. doi:10.1001/jamasurg.2019.4620

14. Levin MA, Fischer GW, Lin HM, McCormick PJ, Krol M, Reich DL. Intraoperative arterial blood pressure lability is associated with improved 30 day survival. Br J Anaesth. 2015;115:716–726.

15. James LA, Levin MA, Lin HM, Deiner SG. Association of preoperative frailty with intraoperative hemodynamic instability and postoperative mortality. Anesthesia & Analgesia. 2019 Jun 1;128(6):1279-85.

## CHAPTER – 6

## Frailty and Post-operative Management

**Background:**

Older patients are at increased risk of developing post-operative complications, longer hospital stays and at increased risk of mortality after undergoing any major surgical procedure. This complication occurs in spite of technological and biomedical advances in the field of anaesthesia and surgery. Age is predicted to be the vital factor that determines the post-operative outcome. Even after regulating the comorbidities, age relics as an unfettered risk factor for undesirable postoperative outcome.

Various researches and studies amidst a vastscale of surgical fieldssteadilycorrelate poor surgical outcomes to preoperative frailty (Figure 1). This post-operative outcome in older adults is linked to factors such as poor nutritional status, lack of fitness and exercise, decline of cognitive function, and functional limitations.

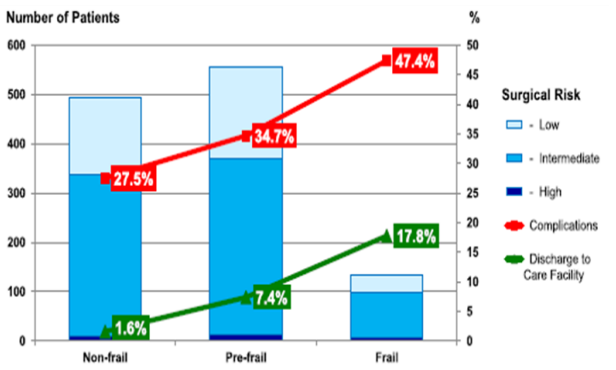



**Figure 1: Incidence of postoperative complications and discharge to care facility by frailty status and according to surgical risk[1]**

Image adapted from: Birkelbach O, Mörgeli R, Spies C, Olbert M, Weiss B, Brauner M, et al. Routine frailty assessment predicts postoperative complications in elderly patients across surgical disciplines–a retrospective observational study. BMC anesthesiology. 2019;19(1):1-10.

**Frailty and surgery:**

Older patients often present with complex health related conditions such as comorbidities, and low reserve energy and capacity. The extent and rate at which these changes transpire determines the degree of frailty in these older patients. The core characteristicsof frailty embrace the impairmentof various interrelated systems, especially the functions of musculoskeletal system, cognitive function and nutritional status. Along with these factors, presence or absence of stressors and the individual's ability to tolerate these stressors plays a vital role in determine the surgical prognosis.

Reckoning frailty in older patientsenduring surgical treatmentmust be examined thoroughly in milieu of altering the patient care protocols based on the assessment of frailty status. The primary goal of intervention for such frail individuals should focus on improving the quality of life, preventingthe deterioration of health due to chronicdiseases, reducing the risk of disastrous treatment outcome, and providing proper risk assessment to guide the patient in making decisions regarding the treatment.

Approaches for integrating the assessment of degree of frailty and the method of surgical intervention must include the following aspects (Table 1) [2]:

**Table 1: Various approaches to manage a frail patient postoperatively and to prevent post-operative morbidity [2]**

1. Preoperative risk assessment
   - Modify the surgical technique to reduce the invasiveness
   - Adopt appropriate methods of counseling the patient regarding the outcome
2. Trauma triage
   - Older patients are more prone for trauma; therefore frailty assessment is mandatory prior to admission
3. Prehabilitation to modify risk
   - Improving the nutritional status
   - Physical therapy and regular exercise
   - Increasing the physiologic reserve
4. Tailor anesthesia approach
   - Prefer regional anesthesia over general anesthesia whenever possible
   - Will enable in reducing the chances of post-operative delirium and cognitive impairment
5. Implement team-based care pathways
6. Delirium prevention
7. Palliative care approaches

**Preoperative Risk Assessment:**

Pre-operative frailty assessment is a well-recognized method to predict the surgical outcomes such as risk of developing post-operative complications, duration of hospital stay, need for institutionalization, and mortality rate. Quantifying frailty enables the surgeon to forecastif there is an increased surgical risk and the methods to modify care. This can be achieved in two ways. Firstly, by modifying the surgical technique in such a way

that the invasiveness of the surgery decreases. For example, preferring endovascular valve replacement over opensurgery. Secondly, by adopting appropriate methods of counseling the patient regarding the projected surgical outcome. Furthermore, adequate knowledge onprerequisite for institutionalization or prolonged stay in nursing homes along with a caregiver is mandated.[3,4]Informing the patient regarding the augmented risk of complications concocts the patients and their families for their postoperative course.Identifying and addressing the families about the need for co-dependence of the frail patient's partner preceding hospitalization alleviates the concern and encumbrance of the family.

**Trauma Triage:**

Elderly patients tend to have increased incidence of trauma presentations, predominantly due to fall from height. Frailty assessment explicit to trauma must beexecuted duringpreliminary presentation.[5] It should beexpounded to support trauma physicians and surgeons in their decision-making regarding the treatment plan. The prior assessment of frailty ahead of hospital admission will enable in forecasting the prognosis post-operatively.[6,7]

**Prehabilitation to Modify Risk:**

Superseding prior to operations to increase the physiologic reserve enables a frail patient to endure and tolerate the surgical stress. This can be achieved by two modalities of prehabilitation, i.e., proper exercise and good nutrition. Physical therapy aiming at improving the pulmonary function as well as muscle activity is essential to reduce the post-operative complications and the duration of hospital stay after cardiac surgeries.[8] Multi-modalpreoperative approaches that include physical therapy in the form of exercises, proper nutritional supplements rich in protein

and vitamins, and measures to reduce anxiety are also being researched to prepare patients to enhance the surgical outcomes.[9]

**Tailor Anesthesia Regimen:**

Choice of anesthesia for frail elderly patientsmust compriseoptimized regional anesthetic techniques and minimizedusage of sedation. An ideal regimen for administering anesthesia for frail patients is yet to be established. Amongst the anesthetic choices, regional anesthetic technique is suggested over general anesthesia to aid in controlling the perioperative pain.[10] Apart from pain management, regional anesthesia is also proven to reduce postoperative delirium. Recent evidencesrecommend that mild sedation couldlessen postoperative delirium in older patientsenduring surgery for hip bone fracture under spinal anesthesia.[11]

**Implement Team-Based Care Pathways:**

Team based care methodologies are verified to befavourable for frail older patients in both the inpatient and outpatient settings (Figure 2). Acute Carefor Elders (ACE) model is applied for the inpatients and it is recognized to enable in maintaining the functional status of frail patients during their hospital stay.[12] Program of All-inclusive Care for the Elderly (PACE) is employed for the outpatients to deliver adequate health, social, recreational, and nutritional support. Moreover it will also aid in preserving the functional ability of those patients.[13]

**Delirium Prevention:**

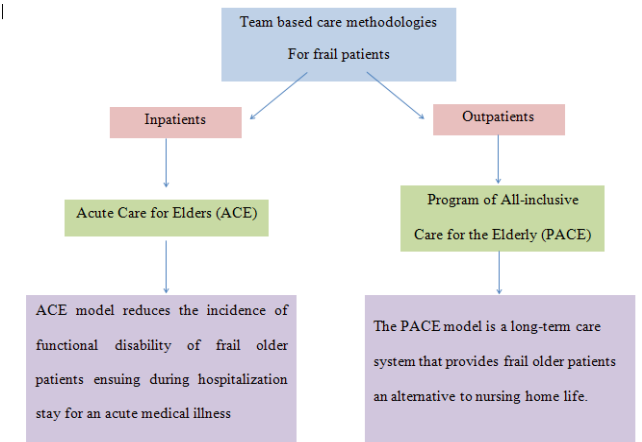
Frailty is connected to the incidence of postoperative delirium. Delirium is a significantlypertinent surgical outcome for older individuals due to its intimate association

to adverse postoperative outcomes such as increased risk of developing complications, protracted hospital stays, increased admissions atnursing homes, and in worst cases, leads to death of the patient. Nearly 40% of post-operative delirium can be prevented if necessary precautions are adopted pre- and peri-operatively.[14]Ascertaining baseline frailty can elicit immediate collation of evidence based postoperative delirium prevention programs.

**Palliative Care Approaches:**

Palliative care is an essential approach that must be employed even during the preoperative period to aid the physicians and the patients to define their care goals.[15] To ascertain whether surgical procedure is necessary, the physicians, anesthetists and surgeons mustevaluate the "need value" of the planned surgery for a frail patient. Significant decisions are supportedto help in achieving patient oriented expectations and outcomes. However, this must be deliberated ahead of major surgical interventions.

**Figure 2: Team- based care for inpatients and outpatients**



**Postoperative Management:**

Postoperative management mustincorporate an improved recoveryprogram, ample analgesia, early mobilization and discharge from hospital. Once the patient is discharged from the hospital, they must be in a condition to accommodate in a step-down facility. This is succeeded by effective and improved rehabilitation approaches, supportive modalities to tackle certain geriatric matters such as postoperativedelirium and its effective prevention.

A Cochrane collaboration review of literatureonrehabilitation of elderly patients in long-term care was conducted by Crocker T et al in 2012.[16]The primary objective of this study was to evaluate the benefits and harms of rehabilitation interventions aimed at maintaining, or improving, physical function for older people in long-term care. The review included various randomized and cluster randomised controlled trials. This study concludedthat rehabilitation attempts may be advantageous in moderatingthe chances of disability in a frail patient post-surgically. Furthermore, it will also enable in reducing the incidence of adverse events such as frequent hospitalization, infections and need for institutionalization. However, further long-term studies are required to make decisionsconcerning the most suitable and favourable interventions that provideamended sustainability, and cost-effectiveness.

Likewise, a systematic review byMcIsaac DI and co-authors in 2017 compiled the articles that evaluated the efficacy of interventions that aimed to improve the outcome of frailpatients after undergoing surgical procedures under anesthesia.[17] The results of this systematic review suggested that that prehabilitation of the individuals by physical therapy in the form of routine exercise paradedenhancement in functional status and quality of lifeof the patients.However, the conclusion also highlighted

the need for higher quality studies to test whether these interventions improve the outcomes of these frail patients undergoing surgery on a long-term basis.

**Frailty and adverse outcomes**

Frailty has long been exposedas a front-runner of adverse outcomes in surgical patients. The connection between frailty and adverse surgical events postoperatively has gained recognition in the past decade. Lin HS and co-authors in 2016 conducted a systematic review by assessing 23 studies that evaluated the association between frailty and surgical outcomes.[18] The study synopsizedvarious adverse outcomes seen in frail patients with a mean age of 75 years and above (Table 2). Amongst these adverse outcomes, the extent of mortality and post-operative complications where of particular interest and were largely focusedon.

**Table 2: Various adverse outcomes seen in frail patients postoperatively**

1. Mortality
   - Increased rate of 30-day, 90-day, and 1 year mortality
2. Post-operative complication
   - Non-routine recovery
   - Need for resuscitation
   - Postoperative delirium
3. Discharge
   - Increased duration of hospital stay
   - Discharge to institution
   - Functional and cognitive decline
4. Post-discharge
   - Increased rate of readmission within the next 1 year
   - Functional decline
5. Quality of life
   - Reduced quality of life and increased rate of dependance

**Mortality:** For example, 10 out of 10 studies evaluatingthe relationship between frailty and increased 12-monthmortality found a significant relationship with frailty, withodds ratios ranging from 1.1 to 4.97.[18] Likewise, frailty was realized to be linked with increased shorter (30 days and 90 days) andlonger-term (2 and 5 years) mortality rates post-surgically. This relationship was uncoveredirrespective of the instruments exercised to quantify frailtyand regardless of the type of surgery performed.

**Postoperative complications**: The complications evaluated were the length of stay, quality of life, delirium, functional decline, anddischarge to a residential care facility. It was studied that the risk of developing these complications had a significant associations to frailty. However, this risk cannot be generalized to all types of surgical procedures and the type of surgery and expected post-operative complications must be categorized in future to develop an understanding regarding this topic. This is a gap that future researchesmust explore.

**Discharge:** Ideally, a healthy individual is expected to be discharge once the patient is reviewed by the physician and considered fit. However, frail individuals whose physiological reserve is normally low, tend to have an increased duration of hospital stays. This is further complicated if the frail older patient develops any postsurgical complication. Certain patient might experience severe decline in functional ability and even require institutionalization.

**Post discharge and quality of life:** Adverse outcomes that are significant to frail older adultsare reduced quality of life, functional decline, amplified dependency, and postsurgical delirium. But these aspects must beexplored and validated through randomized controlled clinical trials. Nevertheless, various studies also recommended

that frailty is a superior predictor of mortality and morbiditythan age and associated comorbidities.

**Summary:**

Postoperatively, frail individuals are expected to develop many complications such as altered quality of life, increased hospital stay, risk of institutionalization, etc. However, these adverse outcomes can be modified if proper preoperative assessment of frailty is done before planning any surgical procedure. Additionally, consideration about anesthetic technique is also essential to reduce certain postoperative outcomes such as delirium and cognitive decline. Prehabilitating the patients to achieve satisfactory nutritional status, ability to perform exercise and improved physiological reserve enhances the surgical outcomes.

**References:**

1. Birkelbach O, Mörgeli R, Spies C, Olbert M, Weiss B, Brauner M, et al. Routine frailty assessment predicts postoperative complications in elderly patients across surgical disciplines–a retrospective observational study. BMC anesthesiology 2019; 19(1): 1-10.

2. Robinson TN, Walston JD, Brummel NE, Deiner S, Brown CH, Kennedy M, Hurria A. Frailty for surgeons: review of a national institute on aging conference on frailty for specialists. Journal of the American College of Surgeons. 2015;221(6):1083-92.

3. Dasgupta M, Rolfson DB, Stolee P, et al. Frailty is associated with postoperative complications in older adults with medical problems. Arch Gerontol Geriatr 2009;48:78- 83.

4. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg 2010;210:901-908.

5. Joseph B, Pandit V, Zangbar B, et al. Superiority of frailty over age in predicting outcomes among geriatric trauma patients: a prospective analysis. JAMA Surg 2014;149:766-772.

6. Joseph B, Pandit V, Zangbar B, et al. Validating trauma-specific frailty index for geriatric trauma patients: a prospective analysis. J Am Coll Surg 2014;219:10-17

7. Joseph B, Pandit V, Khalil M, et al. Managing older adults with ground-level falls admitted to a trauma service: the effect of frailty. J Am Geriatr Soc 2015;63:745-749.

8. Hulzebos EH, Smit Y, Helders PP, van Meeteren NL. Preoperative physical therapy for elective cardiac surgery patients. Cochrane Database Syst Rev 2012;11:CD010118.

9 Li C, Carli F, Lee L, et al. Impact of a trimodal prehabilitation program on functional recovery after colorectal cancer surgery: a pilot study. Surg Endosc 2013;27:1072-1082.

10. American Geriatrics Society Expert Panel on Postoperative Delirium in Older, A. Postoperative delirium in older adults: best practice statement from the American Geriatrics Society. J Am Coll Surg 2015;220:136-148

11. Sieber FE, Zakriya KJ, Gottschalk A, et al. Sedation depth during spinal anesthesia and the development of postoperative delirium in elderly patients undergoing hip fracture repair. Mayo Clin Proc 2010;85:18-26.

12. Landefeld CS, Palmer RM, Kresevic DM, et al. A randomized trial of care in a hospital medical unit especially designed to improve the functional outcomes of acutely ill older patients. N Engl J Med 1995;332:1338-1344.

13. Eng C, Pedulla J, Eleazer GP, et al. Program of All-inclusive Care for the Elderly (PACE): an innovative model of integrated geriatric care and financing. J Am Geriatr Soc 1997;45:223-232.

14. Inouye SK, Bogardus ST Jr, Charpentier PA, et al. A multicomponent intervention to prevent delirium in hospitalized older patients. N Engl J Med 1999;340:669-676.

15. Statement of Principles of Palliative Care. American College of Surgeons Task Force on Surgical Palliative Care and the Committee on Ethics: American College of Surgeons, 2005.

16. Crocker T, Forster A, Young J, Brown L, Ozer S, Smith J, et al.

Physical rehabilitation for older people in long-term care. Cochrane Database Syst Rev. 2013;2:CD004294.

17. McIsaac DI, Jen T, Mookerji N, Patel A, LaluMM. Interventions to improve the outcomes of frail people having surgery: a systematic review. PLoS One 2017;12(12):e0190071.

18. Lin HS, Watts JN, Peel NM, Hubbard RE. Frailty and post-operative outcomes in older surgical patients: a systematic review. *BMC* Geriatr 2016;16(1):157.

# CHAPTER – 7

## Frailty and perioperative outcomes

**Background:**

Improved healthcare facilities have increased the life expectancy of humans and thus an increase in the number of elderly population. However, this growing number of elderly patients has also witnessed a hike in patients undergoing surgery due to various compromising medical comorbidities.This older patient population has an increased risk ofpostoperative complications compared to younger patients. Various frailty tests have been demonstrated to predict whether a patient's health may deteriorate as a result of medical or surgical stress. Despite this, the numerous definitions and scoring systems for frailty have made it difficult for healthcare providers to implement a uniform assessment pattern into clinical therapy.

In all sickness contexts, frail people have poor prognosisand are unlikely to cope well with a severe stressor like surgery when compared to healthy older patients. It has long been established that advanced age is a risk factor for poor surgical results. [1, 2] The fact that frailty is linked to both age and reduction in physiological reserve has led to the belief that frailty can be assessed before surgery in order to anticipate the probability of adverse outcomes. Frailty is a systemic measure of general health and physiological status, whereas current preoperative examinations tend to focus on end-organ dysfunction. [1] This could make assessing frailty a helpful tool for predicting mortality and functional outcomes after surgery.[3]

**Prevalence of frailty before surgery:**

For a variety of reasons, risk factors may be considered significant for prognostication and care planning. [4] Typically, a risk factor is considered to be of significant importance if

1) There is presence of a risk factor,

2) It is substantially predictive of outcome (e.g., >50% increase in relative risk), and/or

3) It is potentially modifiable.

The projected prevalence of frailty in surgical patients is discussed below, followed by sections on the strength of the link and probable modifiability of frailty.

**Frailty in surgical patients:** [5]

According to predictions, one-fifth of surgical procedures will be performed on patients over the age of 75 by 2030.[6] The surgical population is ageing due to the nature of surgical pathology, which is often degenerative (eg, osteoarthritis), neoplastic (eg, bladder cancer), or metabolic (eg, vascular illness). While frailty is linked to ageing, it is not just seen in the elderly, nor are all elderly persons feeble. The frequency of frailty has been shown in numerous research, with rates varying between surgical specialties. In elective orthopaedic surgery, 23% of patients were fragile, compared to 53% in emergency hip fracture surgery. [7, 8] When it comes to cancer surgery, studies show that 25% of patients receiving elective cystectomy are frail, with a similar high prevalence rate of frailty in emergency general surgical patients (39%), where the underlying pathology is frequently neoplastic. [9, 10, 11]

**Identifying frailty in the perioperative setting:**

Because frailty is frequent and has important perioperative implications, but it is not specific to or universal in older persons, it is critical to correctly identify frailty in the

context of other overlapping illnesses and syndromes. While comprehensive geriatric assessment (CGA) and optimization are considered as the gold standard methods for screening, diagnosing, and managing frailty, it is time consuming and requires specialised knowledge. As a result, a number of frailty instruments have been developed that can be used in a variety of clinical settings and delivered by non-specialists. Few such examples of these tools are: [12-17]

- Single surrogate markers of frailty (e.g., gait velocity),
- Simple infographic tools (e/g., clinical frailty scale (CFS)),
- Scales or scores such as Edmonton frailty scale
- Electronic frailty index,
- Biomarkers like interleukin 6,
- Disease specific scores such as comprehensive assessment of frailty,
- surgery specific scores (e.g., comprehensive assessment of frailty)

Furthermore, the use of cross-sectional imaging for the opportunistic examination of associated diseases, such as sarcopenia, has grown in prominence, with claims that it could serve as a surrogate marker for frailty.[18] Surrogate markers' brevity and ease of use are appealing, but their use risks losing authenticity to the multidomain nature of frailty definition and models.

Accurately quantifying frailty in the perioperative context is difficult, especially in case of emergency surgeries. It can be difficult to separate acute pathology from underlying frailty status, and it may require a detailed history and adequate primary care. Because there is no consensus on which frailty instrument should be used to screen for or diagnose frailty in the perioperative context, many doctors

have chosen CFS as a pragmatic approach.[19]

In both elective and emergency surgical settings, CFS can be employed even by non-specialists. The assessments made using this tool has been linked to 30- and 90-day mortality, risk of complications, length of stay in the critical care unit, and overall hospital stay after emergency laparotomy. Even patients who are categorised as vulnerable or pre-frail rather than frail have outcomes that indicate they are at high risk while utilising CFS. The National Emergency Laparotomy Audit has now included the CFS. [20]

**Table 1: Frailty Instrument Composition Commonly Studied in the Perioperative Setting[4]**

| Frailty Index<br>Variable | Fried Phenotype | Clinical Frailty Scale | Edmonton Frail Scale |
|---|---|---|---|
| Anemia<br>Albumin<br>Sodium<br>Low body mass index<br>Obstructive sleep apnea<br>Cerebrovascular disease<br>Cancer<br>Diabetes mellitus<br>Cognitive impairment | Weight loss: >10 lbs unintentionally in the previous year<br>Grip strength: lowest 20% (by sex and body mass index)<br>Exhaustion: self-report | 1. Very fit: People who are robust, very active, and motivated. These people commonly exercise regularly. They are among the fittest of their age<br>2. Well: People who have no active disease symptoms but are less fit than category 1. Often, they exercise or are very active occasionally<br>3. Managing well: People whose medical problems are well controlled, but they are rarely active beyond walking. | Cognition: Clock draw test<br>General health: Number of hospital admissions in the past year<br>Functional independence: Number of activities of daily living requiring assistance |
| Alcohol abuse<br>Falls history<br>Heart failure<br>Insulin use<br>Liver disease<br>Coronary artery disease | Slowness: 15-foot walking speed (by sex and height)<br>Low activity: Kilocalories per week (males <383, females <270) | 4. Vulnerable: While not dependent on others for daily help, often symptoms limit activities. A common complaint is being "slowed up," and/or being tired during the day<br>5. Mildly frail: These people often have more evident slowing and need help in high order IADLs. Typically, this impairs shopping and walking outside alone, meal preparation, and housework | Social support: Availability of reliable help<br>Medication use: Presence of polypharmacy |
| Peptic ulcer disease<br>Peripheral vascular disease<br>Renal disease<br>Rheumatic disease<br>Smoker<br>Visual impairment<br>Hearing impairment | | 6. Moderately frail: People need help with all outside activities and with keeping house. Inside, they often have problems with stairs and need help with bathing and might need minimal help with dressing<br>7. Severely frail: Completely dependent for all personal care from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~6 mo)<br>9. Terminally ill: Approaching the end of life. This category applies to people with a life expectancy <6 mo, who are not evidently frail | Medication use: Forgetting to take prescribed medications<br>Nutrition: Unintentional weight loss<br>Mood: Feelings of sadness or depression<br>Continence: Presence of urinary incontinence<br>Functional performance: Timed up and go test |
| Assistance needed dressing<br>Assistance needed meals<br>Assistance needed shopping<br>Weight loss<br>Multimorbidity<br>Depression<br>Possibly inappropriate medication<br>Polypharmacy | | | |

AD8-Alzheimer's Disease in 8 questions questionnaire[17]; PHQ-2-Patient Health Questionnaire[16]; CAGE[18]; The Frailty Index is calculated as a number from 0 to 1 by dividing the number of deficits present by the number of deficits measured (ie, 30) as recommended by Searle et al.[20] One point is assigned for the presence of each feature of the phenotype, resulting in a score from 0 to 5. Following assessment, an individual is assigned a score on the scale. Zero to 2 points are assigned to each question, creating a score that ranges from 0 to 17.

Abbreviations: CAGE, cut down, annoyed, guilty, eye-opener; IADL, instrumental activities of daily living; PHQ-2, 2 question Personal Health Questionnaire.

Adopted from: McIsaac DI, MacDonald DB, Aucoin SD. Frailty for perioperative clinicians: a narrative review. Anesthesia & Analgesia. 2019; 130(6): 1450-60.

**The impact of frailty on perioperative outcomes:**

Even in healthy people, surgery causes significant physiologic stress. As a result, it's not surprising that the existence of frailty prior to surgery is closely linked to a higher risk of negative outcomes and a higher use of resources. Frailty is consistently associated with at least a 2-fold increase in the risk of major morbidity, mortality, and readmissions, according to an ever-growing epidemiologic literature that now includes large studies using administrative data, prospective registries, primary prospective observational studies, and systematic reviews. [21, 22, 23]

Furthermore, given the growing emphasis on patient-reported outcomes and the importance of functional measures for older surgical patients, it's critical to remember that frailty doubles the risk of new patient-reported disability, lowers quality of life, and fivefold increases the risk of non-home discharge among older people who previously lived in the community. Furthermore, duration of stay, expenses, and other indicators of resource consumption are consistently greater for older adults with frailty, ranging from 15% to 60% in various studies. [24, 25]

Whilst relative increases in risk, as well as risk estimates attuned for imperative confounders such as type of surgery, relative importance, urgency and indication of the surgery, are useful to clinicians in communicating expected outcomes to patients and their families, absolute risk estimates are particularly easier to understand and more evocative when delivering prognostic information prior to surgery. [26, 27] Fortunately, even for weak patients, the absolute risk of death in the month following surgery

is modest (usually 5% after major, elective non-cardiac surgery). [28] However, 1-year mortality rates after major elective cancer surgery are frequently high, exceeding 40% (which presumably reflects the interaction of surgery, frailty, and the underlying oncologic process). [29] A similar dose-response connection exists, with higher frailty scores (independent of instrument) associated with a higher chance of mortality.

Frailty is associated with a high rate of complications, which can reach 50%. [30] As a result, frailty was identified as the highest risk factor for the development of postoperative morbidity in older patients in a recent comprehensive study. Delirium is particularly prevalent in elderly surgical patients, with rates ranging from 10% to 50% depending on the type and urgency of the procedure. [31] Frailty is a high risk factor for developing delirium following major surgery (odds ratio = 4.1), and in a recent comprehensive review, it was only surpassed by a history of delirium in terms of its intensity of connection with delirium incidence.[32, 33]

While survival is important to older individuals, expected function and quality of life outcomes may be even more important in the event of an acute illness. [34] Unfortunately, perioperative frailty studies seldom investigate these patient-centered and patient-reported outcomes, and even fewer give clinically useful information. Evidence suggests that frailty is a powerful predictor of poor functional outcomes when these data are available. It was discovered that 3 months following major elective non-cardiac surgery, 1 in 5 older persons with frailty were having a new or markedly increased handicap in a multicenter cohort research with over 700 participants. It was also found that that 15%–50% of fragile elderly adults who lived independently in the community prior to surgery were unable to return home following elective treatments. [35]

In the 90 days following major, elective non-cardiac surgery, 29% of patients with frailty die, are institutionalised, or return home with a new handicap, according to a prospective research. These findings are consistent with the cardiac literature, which shows that older adults with frailty had a 20% higher absolute risk of dying or having a lower quality of life a year following surgery (when compared to people without frailty). [36]

Finally, while most research examining the link between frailty and poor surgical outcomes focus on major inpatient surgery, it's also crucial to note that frailty predicts poor outcomes even in low-risk procedures. These procedures include urgent and emergent appendectomy and cholecystectomy, where frailty has a greater influence on mortality than laparotomy or bowel resection. Frailty is also linked to a higher than 3-fold increase in the risk of complications following ambulatory hernia, breast, thyroid, or parathyroid surgery. [37]

**Frailty management in the perioperative setting:**

The intensity of the presentation, whether elective or emergency, influences how frailty is identified and managed in the perioperative setting. Early screening and identification of frailty is recommended in the elective situation. Frailty assessment at the outset of the process has several advantages such as: [5]

- Informing risk assessment
- Collaborative decision making
- Potential syndrome modification well before surgery.

An accurate diagnosis of frailty, together with understanding of the effects of frailty on morbidity and mortality during surgery, can lead to an informed

discussion of the potential benefits, risks, alternatives to surgery, and choices if nothing is done. In this case, some patients and healthcare professionals may decide not to pursue surgical treatment, and instead opting for conservative methods. In other circumstances, individuals who appear to be at high risk may engage with healthcare teams to modify their frailty syndrome, so changing their perioperative risk profile, allowing surgery to take place, and improving their postoperative results.

Furthermore, there are typically multiple surgical options available. For example, a patient with rectal cancer may have the option of undergoing local resection, radical resection with a stoma, or radical resection with bowel continuity restoration. Oncological benefits, perioperative risks, and quality-of-life outcomes are all varied. Frailty screening, preoperative optimization, multidisciplinary shared decision making, and targeted perioperative therapies mean that some fragile patients who would normally be regarded too high-risk for surgery can nonetheless benefit.

The same ideas apply in an emergency room, but the focus changes away from altering the patient's risk profile and toward customising the care pathway. High-risk frail patients undergoing emergency laparotomies, for example, will be treated by consultant level clinicians with planned level 3 care. The observation that the patient is weak with known unfavourable outcomes may also drive early discussions with patients and their families about care limits, avoiding the futility of surgery in certain cases and the futility of escalating therapies following difficulties in others. [38]

While frailty screening has gained popularity in perioperative pathways, interpreting the outcomes of frailty tools necessitates a qualified team. This necessitates a collaborative approach involving surgeons, anaesthesiologists, and those trained in the management

of frailty and multimorbidity, in keeping with the perioperative agenda. Such an approach should first focus on individual patient-level potential modifiers of the frailty syndrome, and then change the perioperative pathway to obtain optimal clinician-reported, patient-reported, and process-related outcomes. [5]

**Comprehensive geriatric assessment (CGA) and optimization:**

In a variety of therapeutic contexts, CGA and optimization is a well-established strategy for evaluating and managing older people. It entails a multidomain, interdisciplinary evaluation with the goal of describing recognised disease as well as previously undiscovered illnesses, as well as assessing functional, psychological, and social status. For all issues highlighted, this multidomain assessment encourages the design of a short- and long-term inquiry and management strategy (Table 2). Addressing a multisystem condition with a multidomain intervention has face validity and is increasingly supported by the perioperative literature in the context of frailty in the perioperative situation. [39, 40] These studies show that using preoperative CGA can improve postoperative outcomes in older surgical populations such as hip fracture, orthopaedic elective surgery, elective vascular surgery, and colorectal surgery. However, none of these trials particularly looked at the effect of CGA on the frailty syndrome during the perioperative period.[5]

**Conclusion:**

The surgical population is growing older, and fragility is becoming more common. New approaches to perioperative care are required now that it is recognised that this syndrome has a negative impact on postoperative outcome. Future research and implementation science should concentrate

on three areas. First and foremost, rather than inventing new frailty tests, reaching consensus on which frailty tool to employ for screening and diagnosis in emergency and elective surgical settings is critical. Second, the case for frailty as a predictor of poor postoperative outcomes has been made and no further research is required. In the perioperative environment, research should focus on both multicomponent therapies and single pharmacological modifiers of the frailty syndrome. Third, the outcomes of this research should be transferred into ordinary clinical care by creating collaborative perioperative pathways and evaluating them using implementation of scientific techniques.

**Table 2: A multidomain approach to modifying the frailty syndrome in the**

| Domain | Issue | History/examination | Screening or diagnostic tools | Investigation | Optimisation |
|---|---|---|---|---|---|
| Medical | Postural hypotension with visual hallucinations | History of falls.<br>Reports of slowing, falls, tremor, rigidity etc.<br>Proactive assessment for non-motor symptoms if Parkinson's disease likely.<br>Physical examination. | Unified Parkinson's disease rating scale. | DaTSCAN.<br>Cerebral imaging with computed tomography or magnetic resonance imaging (does not necessarily need to be preoperative). | In established cases, proactive plan around medications including timings and alternative drugs or routes of administration when nil by mouth.<br>Pre-emptive advice to ward teams about non-motor complications likely at time of surgery (constipation, delirium or falls).<br>In newly identified cases, consider starting medications preoperatively versus outpatient follow-up based on symptoms and urgency of surgery. |
| | Exertional dyspnoea and daily cough | Smoking history but no prior known chronic lung disease.<br>History of symptoms of chronic obstructive pulmonary disease. | Medical research council breathlessness scale.<br>6-minute walk test. | Spirometry.<br>CXR. | Smoking cessation advice.<br>Flu vaccination.<br>Inhaled therapy according to NICE / British Thoracic Society guidelines.<br>Pulmonary rehabilitation according to local guidelines. |
| Geriatric syndromes | Falls | Previous history.<br>History of 'near misses', suggestive underlying causes and injuries sustained.<br>Bone health screening. | Gait speed.<br>Timed up and go.<br>Fracture risk assessment tool. | Bone profile and vitamin D.<br>Suggestion to GP about DEXA and follow-up. | Medical management of bone health (eg bisphosphate and calcium-vitamin D supplementation).<br>Medical falls review.<br>Strength and balance training. |
| | Cognitive impairment | Self-reported history of cognitive issues.<br>Collateral history from relative/carer. | 4AT.<br>MoCA. | Cerebral imaging or recommendation to GP for this. | Delirium risk assessment and optimisation eg cessation of anticholinergic medications, ensuring normal electrolytes and treating constipation.<br>Signposting to standardised postoperative management of delirium.<br>Communication with patient and relatives.<br>Long-term vascular risk factor management.<br>Referral to memory services for long-term follow-up. |
| Psychological | Anxiety and depression | Self-reported history.<br>Collateral from family/carer.<br>Symptoms. | Hospital anxiety and depression score. | Thyroid function tests.<br>Exclusion of cognitive impairment. | Referral for psychological support (talking services).<br>Consider pharmacological treatment.<br>Explanation or counselling regarding surgery if this is prominent trigger for symptoms. |

## Table 2: A multidomain approach to modifying the frailty syndrome in the perioperative setting (Contiues)

| Domain | Issue | History/examination | Screening or diagnostic tools | Investigation | Optimisation |
|---|---|---|---|---|---|
| Functional and social | Functional dependency | Self-reported concerns.<br>Collateral from family/ carer.<br>Assessment of underlying cause. | Barthel.<br>Nottingham extended activities of daily living. | Physical examination and investigation of pathology causing disability eg proximal myopathy secondary to vitamin D deficiency.<br>Prescribe analgesia for osteoarthritis. | Preoperative physiotherapy.<br>Occupational therapy intervention (eg home adaptations).<br>Social worker intervention to proactively identify barriers to discharge.<br>Proactive communication regarding anticipated length of stay and access to rehabilitation or care at discharge. |
| | Non-adherence to prescribed medications | Self or family reported concerns.<br>Clinical evidence of non-adherence.<br>Assessment of understanding of medications. | STOPP/START. | Assessment of cognition and understanding of medications. | Liaising with community pharmacist to assist with dosette box and with care services or telecare to prompt medication. |

4AT = four 'A's test; CXR = chest X-ray; DaTscan = dopamine transporter single photon emission computed tomography; DEXA = dual-energy X-ray absorptiometry; GP = general practitioner; MoCA = Montreal cognitive assessment; NICE = National Institute for Health and Care Excellence; START = screening tool to alert doctors to right treatments; STOPP = screening tool of older people's potentially inappropriate prescriptions.

**References:**

1. Robinson TN, Wu DS, Pointer L, Dunn CL, Cleveland JC Jr, Moss M. Simple frailty score predicts postoperativecomplications across surgical specialties. Am J Surg 2013; 206: 544-50.

2. Cohen RR, Lagoo-Deenadayalan SA, Heflin MT, et al. Exploring predictors of complication in older surgical patients: a deficitaccumulation index and the Braden Scale. J Am Geriatr Soc2012; 60: 1609-15.

3. Beggs T, Sepehri A, Szwajcer A, Tangri N, Arora RC. Frailty and perioperative outcomes: a narrative review. Can J Anesth. 2015;62(2):143-57.

4. McIsaac DI, MacDonald DB, Aucoin SD. Frailty for perioperative clinicians: a narrative review. Anesthesia & Analgesia. 2019;130(6):1450-60.

5. Dhesi JK, Lees NP, Partridge JS. Frailty in the perioperative setting. Clin Med. 2019;19(6):485.

6. Fowler A, Abbott T, Prowle J et al. Age of patients undergoing surgery. Br J Surg 2019; 106: 1012 – 8.

7. van de Ree CLP, Landers MJF, Kruithof N et al. Effect of frailty on quality of life in elderly patients after hip fracture: a longitudinal study. BMJ Open 2019; 9: e025941.

8. Johnson RL, Abdel MP, Frank RD et al. Impact of Frailty onOutcomes After Primary and Revision Total Hip Arthroplasty . JArthroplasty 2019; 34: 56 – 64.

9. Khan M, Jehan F , Zeeshan M et al. Failure to rescue after emergency general surgery in geriatric patients: does frailty matter ? JSurg Res 2019; 233: 397 – 402.

10. Chappidi MR, Kates M, Patel HD et al. Frailty as a marker of adverseoutcomes in patients with bladder cancer undergoing radical cystectomy. Urol Oncol 2016; 34: 256,e1 – 6.

11. Partridge JS, Fuller M, Harari D et al. Frailty and poor functionalstatus are common in arterial vascular surgical patients and affectpostoperative outcomes . Int J Surg 2015; 18: 57 – 63.

12. Afilalo J, Eisenberg MJ, Morin JF et al. Gait speed as an incremental predictor of mortality and major morbidity in elderly patients undergoing cardiac surgery. J Am Coll Cardiol 2010; 56: 1668 – 76.

13. Rockwood K, Song X, MacKnight C et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005; 173: 489 – 95.

14. Rolfson DB , Majumdar SR , Tsuyuki RT et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006; 35: 526 – 9.

15. Clegg A, Bates C, Young J et al. Development and validation of an electronic frailty index using routine primary care electronic health record data. Age Ageing 2016; 45: 353 – 60.

16. Hubbard RE, Woodhouse KW. Frailty, inflammation and the elderly. Biogerontology 2010; 11: 635 – 41.

17. Sundermann S, Dademasch A, Praetorius J et al. Comprehensive assessment of frailty for elderly high-risk patients undergoing cardiac surgery. Eur J Cardiothorac Surg 2011; 39: 33 – 7.

18. Bentov I, Kaplan SJ, Pham TN et al. Frailty assessment: from clinical to radiological tools. Br J Anaesth 2019; 123: 37 – 50.

19. Buigues C, Juarros-Folgado P, Fernandez-Garrido J et al. Frailty syndrome and pre-operative risk evaluation: a systematic review. ArchGerontol Geriatr 2015; 61: 309 – 21.

20. The National Emergency Laparotomy Project Team. Fourth patient report of the National Emergency Laparotomy Audit. London:Royal College of Anaesthetists, 2018.

21. Lin HS, Watts JN, Peel NM, Hubbard RE. Frailty and postoperative outcomes in older surgical patients: a systematicreview. BMC Geriatr. 2016; 16: 157.

22. Kim DH, Kim CA, Placide S, Lipsitz LA, MarcantonioER. Preoperative frailty assessment and outcomes at 6months or later in older adults undergoing cardiac surgicalprocedures: a systematic review. *Ann Intern Med*.2016;165:650–660.

23. Beggs T, Sepehri A, Szwajcer A, Tangri N, Arora RC. Frailtyand perioperative outcomes: a narrative review. Can JAnaesth. 2015;62:143–157.

24. McIsaac DI, Beaulé PE, Bryson GL, Van Walraven C. Theimpact of frailty on outcomes and healthcare resourceusage after total joint arthroplasty: a population-basedcohort study. Bone Joint J. 2016;98-B:799–805.

25. Robinson TN, Wu DS, Stiegmann GV, Moss M. Frailtypredicts increased hospital and six-month healthcare costfollowing colorectal surgery in older adults. Am J Surg.2011;202:511–514.

26. Ahmed H, Naik G, Willoughby H, Edwards AG. Communicating risk. BMJ. 2012;344:e3996.

27. Trevena LJ, Davey HM, Barratt A, Butow P, Caldwell P. Asystematic review on communicating with patients aboutevidence. J Eval Clin Pract. 2006;12:13–23.

28. McIsaac DI, Wijeysundera DN, Huang A, Bryson GL, van

Walraven C. Association of the hospital volume of frail surgicalpatients cared for with outcomes after elective, majornoncardiac surgery: a Retrospective Population-basedCohort Study. *Anesthesiology*. 2017;126:602–613.

29. Shen Y, Hao Q, Zhou J, Dong B. The impact of frailty and sarcopenia on postoperative outcomes in older patientsundergoing gastrectomy surgery: a systematic review andmeta-analysis. BMC Geriatr. 2017;17: 188.

30. Watt J, Tricco AC, Talbot-Hamon C, et al. Identifying older adults at risk of harm following elective surgery: a systematicreview and meta-analysis. BMC Med. 2018;16: 2.

31. Scholz AF, Oldroyd C, McCarthy K, Quinn TJ, Hewitt J.Systematic review and meta-analysis of risk factors forpostoperative delirium among older patients undergoinggastrointestinal surgery. Br J Surg. 2016;103: e21–e28.

32. Brown CH IV, Max L, LaFlam A, et al. The associationbetween preoperative frailty and postoperative deliriumafter cardiac surgery. Anesth Analg. 2016;123: 430–435.

33. Watt J, Tricco AC, Talbot-Hamon C, et al. Identifying olderadults at risk of delirium following elective surgery: asystematic review and meta-analysis. J Gen Intern Med.2018;33:500–509.

34. Fried TR, Bradley EH, Towle VR, Allore H. Understanding the treatment preferences of seriously ill patients. N Engl JMed. 2002;346: 1061–1066.

35. McIsaac DI, Taljaard M, Bryson GL, Beaulé PE, Gagné S, Hamilton G, Hladkowicz E, Huang A, Joanisse JA, Lavallée LT, MacDonald D. Frailty as a predictor of death or new disability after surgery: a prospective cohort study. Ann Surg. 2020;271(2):283-9.

36. Green P, Arnold SV, Cohen DJ, et al. Relation of frailty tooutcomes after transcatheter aortic valve replacement (fromthe PARTNER trial). Am J Cardiol. 2015;116: 264–269.

37. Seib CD, Rochefort H, Chomsky-Higgins K, et al. Association of patient frailty with increased morbidity aftercommon ambulatory general surgery operations. JAMASurg. 2018;153: 160–168.

38. Lees NP, Peden CJ, Dhesi JK et al. The high-risk general surgery patient: Raising the standard. London: Royal College of Surgeonsof England, 2018.

39. Partridge JS, Harari D, Martin FC *et al*. Randomized clinical trial of comprehensive geriatric assessment and optimization in vascularsurgery. Br J Surg 2017; 104: 679 – 87.

40. Eamer G, Taheri A, Chen SS et al. Comprehensive geriatric assessment for older people admitted to a surgical service. CochraneDatabase Syst Rev 2018; 1: CD012485.

# CHAPTER – 8

## Frailty and neuraxial Anaesthesia

**Background:**

Frailty is described as a loss of homeostasis and stress resistance, which increases a person's vulnerability to negative changes (illness or mortality) disproportionately in relation to the occurrence.[1] In lieu of ambulatory surgical patients undergoing procedures lasting up to 60 to 90 minutes, such as knee arthroscopy, hernia repair, and extracorporeal shock wave lithotripsy, neuraxial mode of anaesthesia (spinal or epidural) can be considered as an excellent choice.[2]Longer ambulatory surgery cases or instances with an unknown duration may profit from epidural anaesthesia. Lower-extremity surgery, hernia repair, and lower-abdomen laparoscopy have all benefited from epidural anaesthesia.[3]The necessity to demonstrate the ability to void before discharge, lower backache, and other procedure-related adverse effects have all been mentioned as obstacles to administering epidural anaesthetic in an outpatient setting.

Spinal anaesthesia is a straightforward procedure that involves injecting modest doses of local anaesthetic solution into the subarachnoid region to create a deep and quick surgical block. It ispondered to be adequately safe, and severe complications are reasonably rare.Local anaesthetics injected into the cerebrospinal fluid (CSF) provide access to action sites in the spinal cord and peripheral nerve roots.[1] But, there is a complex interplay between aging, frailty, and anesthesia.

Functional decline, mobility impairment, polypharmacy,

psychosis, dementia, pressure ulcers, falls, malnutrition, and incontinence are all connected with frailty, all of which have an impact on postoperative recovery.[4]Individuals with pre-existing geriatric syndromes are more prone to post-surgical problems; nevertheless, non-elective and significant surgery increases the risk of developing geriatric syndromes during a patient's hospital stay. This chapter will elaborate on the interaction between frailty and neuraxial anesthesia.

**Important neural changes that occur in the body of elderly: [5]**

i. **Anatomical changes:**
   - Reduction in brain mass, number of neurons, neurotransmitters and receptors
   - Reduced number of pain transmitting peripheral nerve fibres

ii. **Functional changes:**
   - Decreased autonomic responsiveness (diminished central response to hypercapnia/hypoxemia, autoregulation, decreased parasympathetic function)
   - Slower and decreased pain perception and ability to report pain
   - Higher sensitivity to most anaesthetics

**Anaesthetic management necessary to handle these changes: [5]**

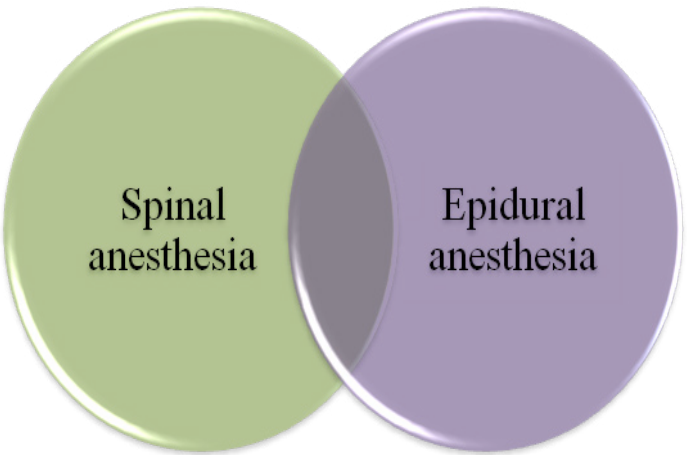
- Reduce doses of intravenous sedatives, hypnotics and analgesics; minimum alveolar concentration for volatile anaesthetics is lower
- Titrate dose of anaesthetics carefully; beprepared that onset of hypnotic effectsmay occur suddenly

- Consider pain score (VAS, NRS ifcognitively intact; VRS if mild cognitiveimpairment; behavioural pain scores ifsevere cognitive impairment)
- Prevent and screen for cognitive disorders;prevent postoperative delirium bypreferable non-pharmacologic efforts

**Role of regional anesthesia (RA):**

Neuraxial blockade with spinal or epidural anaesthesia, or a combination of the two, and peripheral nerve blocks are examples of regional anaesthesia procedures (Figure 1). A number of analgesics, sedatives, or general anesthesia (GA) can be used in conjunction with any of these approaches.[4]

**Figure 1: Methods of achieving neuraxial anesthesia**




Mulroy et al found identical operating room turnover times for epidural and general anaesthesia when the epidural was provided in an induction area outside the operating room in a comparison of epidural, spinal, and general anaesthesia.[6]When compared to a subarachnoid block,

the slower onset of action after epidural administration of a local anaesthetic actually makes it less dangerous for patients in terms of sudden hemodynamic changes, and the dose of anaesthetic can be gradually titrated to the desired dermatome and level of sensory and motor blockade.In that study, epidural and general anaesthesia had identical postanesthesia care unit (PACU) discharge periods, whereas spinal anaesthesia had a longer PACU discharge time and a higher incidence of adverse effects.

Although backache after epidural anaesthesia is not a typical occurrence, it appears to be linked to the local anaesthetic used and the patient's age, with young patients experiencing it more frequently. [7] In addition, the time from injection to voiding was shorter in the epidural group than in the spinal group. Mulroy et al determined that predischarge voiding after outpatient epidural anaesthesia with short-acting medications for low-risk procedures was not necessary in another recent study explicitly addressing the topic of bladder dysfunction after neuraxial blocking for outpatient surgery. [8]

**Common complications encountered following neuraxial anesthesia:**

Operating room turnover time, post-anesthesia recovery and time to discharge, the need to demonstrate ability to void before discharge due to fear of bladder dysfunction, lower backache, and other procedure-related complications are all common concerns about using epidural anaesthesia for day-case surgery.

**Frailty and anesthesia:**

It's uncertain whether anaesthetic method has a major impact on surgical outcomes in frail patients. The best

anaesthetic approach for performing surgery that is acceptable for either regional or GA is a hot topic of discussion. The anaesthetic approach used to manage a patient is determined by the surgical needs as well as the patient's comorbidities.

Disturbances in cognition in the perioperative period are the most researched of all the geriatric syndromes in older surgical patients. These cognitive impairments are known as postoperative cognitive dysfunction (POCD) and postoperative delirium (POD), and they are essential in predicting how well an older patient will recover from surgery. Frail patients are more susceptible to POCD and POD because they are more likely to have pre-existing cognitive impairment and lower cognitive reserve. These drawbacks can be overcome when preferring neuraxial anesthesia over general anesthesia. [4]

However, some people are not candidates for regional anaesthetic due to drugs, comorbidities, or personal preference. Similarly, the type of surgery or planned duration may preclude the use of regional anaesthetic, at least completely.Theoretically, regional anaesthesia has advantages such as avoiding GA exposure and lowering the risk of airway and pulmonary problems in frail patients.

**RA versus GA in frail patients:**

Several research on the incidence of postoperative neurological problems in older patients have found no differences in terms of the percentage of cases or the type of anaesthesia used. Some studies have found no changes in cardiovascular problems, use of the intensive care unit, or overall hospitalisation expenditures in older patients when one form of anaesthesia is used versus the other. [9, 10]

Bryson and co-authors found no significant differences

between the use of regional or general anaesthesia in a meta-analysis of 18 randomised studies on delirium and cognitive dysfunction, highlighting the difficulty of preventing these two events due to the difficulty of managing some of the patient-related risk factors.[11]

White and co-authors found no differences in mortality in patients undergoing hip fracture repair surgery under regional or general anaesthesia in an observational study of 65,535 patients, with the only difference in outcome being increased mortality within the first 24 hours associated with the use of cemented prostheses. [12]

However, a meta-analysis of the effects of anaesthetic technique on postoperative cognitive dysfunction and delirium found no statistically significant difference between regional and GA (odds ratio for POD/POCD in GA versus non-GA was 0.88, 95% CI 0.51–1.51), but GA was marginally non-significantly associated with POCD (odds ratio of 1.34, 95% CI 0.93–1.95). Furthermore, it suggested that regional anaesthetic is likely to be advantageous for analgesia, the level of which is dependent on the type of block utilised, and may potentially lessen systemic analgesia's negative effects.[13]

In a prospective cohort research, the incidence of frailty in patients receiving spinal anaesthetic was 25.8%, whereas another large-scale investigation found a prevalence rate of 21.5%. [14, 15] The greater rates of frailty in surgical patients getting neuraxial anaesthesia compared to general anaesthesia could simply indicate that anesthesiologists perceive regional blocks to be a safer alternative, given they are associated with less perioperative problems in sicker and elderly patients. [16, 17] The Mayo Clinic study group discovered that frail patients who had knee arthroplasties done under neuraxial blocks had considerably reduced mortality and wound complication rates than those who

got general anaesthesia in a recent cohort analysis. [15]

The above-mentioned studies suggest that it is vital to evaluate whether frail individuals are more sensitive to local anaesthetics during spinal nerve blocks, and if so, whether local anaesthetic dosages should be reduced for spinal anaesthesia while using neuraxial anaesthesia.

**Advantages of RA:**

- The avoidance of GA medications and opiates, which have been associated to postoperative delirium, is one possible primary benefit of RA. [18]
- In addition, RA allows for earlier oral intake and a faster return to mobility, as observed in the enhanced recovery programme. [19, 20]
- Excessive anaesthetic depth and perioperative hypotension under GA are linked to a greater mortality rate. This disadvantage is overcome when RA is preferred. [21]

**Drawbacks associated with RA:[22]**

- Hypotension is linked to neuraxial anaesthesia.
- There is increased risk of sequelae such epidural hematoma, infection, and post-dural puncture headache.
- In addition, the patient must also be willing to endure RA.
- Sedation strategies utilised in conjunction with regional anaesthetic are highly diverse, and their usage may reduce the benefits of GA avoidance.

Regional anaesthetic agents (spinal or regional blocking) caused greater perioperative problems than GA, according to a recent retrospective cohort study data from the

American College of Surgeons' NSQIP database. [23] Both RA and GA frequently cause hypotension, which is treated with fluid resuscitation and/or vasopressors. Perioperative hypotension is a condition that causes organ hypoperfusion, which can lead to myocardial infarction, psychosis, and renal failure. [24] The physiological cause of hypotension is unknown, however many anesthesiologists feel that it is caused by a drop in systemic vascular resistance, while others believe it is caused by a decrease in cardiac output. [25, 26]

**Clinical consideration:**

The analgesic options available are determined by whether the procedure is suitable for regional anaesthetic, the absence of contraindications, and the expected duration of substantial discomfort. Central neuraxial blockade with an epidural with a catheter or spinal anaesthesia, which is limited to a single dosage, or peripheral nerve blocks with a single shot or with the insertion of a catheter and the delivery of local anaesthetic via infusion or boluses are two choices. [4]

**Summary:**

Frailty is linked to increased surgical mortality and morbidity, and it may influence the anaesthetic approach and perioperative analgesics utilised. In the literature and in clinical practise, the use of GA versus RA is ardently contested, with no clear consensus. Individual deficits, probable complications, and surgical goals should all be addressed in the perioperative treatment plan for the frail patient. The advantages of RA for surgery and postoperative analgesia should be considered, and the anaesthetic technique used should be tailored according to the patient's need after thorough preoperative assessment.

**References:**

1. Le Guen M, Herr M, Bizard A, Bichon C, Boichut N, Chazot T, Liu N, Ankri J, Fischler M. Frailty Related to Anesthesia guided by the Index "bispectraL"(FRAIL) study: study protocol for a randomized controlled trial. Trials. 2017; 18(1): 1-9.

2. Begani MM, Mulchandani DV, Choudhary S, editors. Anesthesia in Day Care Surgery. Springer Singapore; 2019 Jan 4.

3. Oremus K, Safaric Z. The role of epidural anesthesia and analgesia in surgical practice. Ann Surg. 2004; 240(3): 561.

4. Lin HS, McBride RL, Hubbard RE. Frailty and anesthesia–risks during and post-surgery. Local and regional anesthesia. 2018;11:61.

5. Strøm C, Rasmussen LS, Steinmetz J. Practical management of anaesthesia in the elderly. Drugs & aging. 2016 Nov;33(11):765-77.

6. Mulroy MF, Larkin KL, Hodgson PS, et al. A comparison of spinal, epidural and general anesthesia for outpatient knee arthroscopy. Anesth Analg. 2000; 91: 860–864.

7. Seeberger MD, Lang ML, Drewe J, et al. Comparison of spinal and epidural anesthesia for patients younger than 50 years of age. Anesth Analg. 1994; 78: 667–673.

8. Mulroy MF, Salinas FV, Larkin KL, et al. Ambulatory surgery patients may be discharged before voiding after short-acting spinal and epidural anesthesia. Anesthesiology. 2002; 97: 315–319

9. Slor CJ, De Jonghe JF, Vreeswijk R, Groot E, Ploeg TV, Van Gool WA, et al. Anesthesia and postoperative delirium in older adults undergoing hip surgery. J Am Geriatr Soc. 2011; 59: 1313–9.

10. Le-Wendling L, Bihorac A, Baslanti TO, Lucas S, Sadasivan K, Wendling A, et al. Regional anesthesia as compared to general anesthesia for surgery in geriatric patients with hip fracture: does it decrease morbidity, mortality and healthcare costs? Results of a single centered study. Pain Med. 2012; 13: 948–56.

11. Bryson GL, Wyand A. Evidence-based clinical update: general anesthesia and the risk of delirium and postoperative cognitive dysfunction. Can J Anaesth. 2006; 53: 669–77.

12. White SM, Moppett IK, Griffiths R. Outcome by mode of anaesthesia for hip fracture surgery. An observational audit of 65 535 patients in a national dataset. Anaesthesia. 2014; 69: 224–30.

13. Mason SE, Noel-Storr A, Ritchie CW. The impact of general and regional anesthesia on the incidence of post-operative cognitive dysfunction and post-operative delirium: a systematic review with metaanalysis. J Alzheimers Dis. 2010; 22(3): 67–79.

14. Lee TL, Su YK, Chang YC, Chen TS, Lam CF. Spinal Nerve Block and Recovery after Spinal Anesthesia in Frail Patients-a Prospective Cohort Study. https://doi.org/10.21203/rs.3.rs-994589/v1

15. Johnson RL, Frank RD, Habermann EB, Chamberlain AM, Abdel MP, Schroeder DR, Mantilla CB. Neuraxial anesthesia is associated with improved survival after total joint arthroplasty depending on frailty: a cohort study. Reg Anesth Pain Med. 2020; 45: 405–11.

16. Lin HS, McBride RL, Hubbard RE. Frailty and anesthesia - risks during and post-surgery. Local Reg Anesth. 2018; 11: 61–73.

17. Lin C, Darling C, Tsui BCH. Practical Regional Anesthesia Guide for Elderly Patients. Drugs Aging. 2019; 36: 213–34.

18. Urwin SC, Parker MJ, Griffiths R. General versus regional anaesthesia for hip fracture surgery: a meta-analysis of randomized trials. Br J Anaesth. 2000; 84(4):450–5.

19. Wood RJ, White SM. Anaesthesia for 1131 patients undergoing proximal femoral fracture repair: a retrospective, observational study of effects on blood pressure, fluid administration and perioperative anaemia. Anaesthesia. 2011; 66(11):1017–22.

20. Sessler DI, Sigl JC, Kelley SD, et al. Hospital stay and mortality are increased in patients having a "triple low" of low blood pressure, low bispectral index, and low minimum alveolar concentration of volatile anesthesia. Anesthesiology. 2012; 116(6):1195–203.

21. Neuman MD, Silber JH, Elkassabany NM, et al. Comparative effectiveness of regional versus general anesthesia for hip fracture surgery in adults. Anesthesiology. 2012; 117(1):72–92.

22. Whiting PS, Molina CS, Greenberg SE, Thakore RV, Obremskey WT, Sethi MK. Regional anaesthesia for hip fracture surgery is associated

with significantly more peri-operative complications compared with general anaesthesia. Int Orthop. 2015; 39(7):1321–1327.

23. Hausman MS Jr, Jewell ES, Engoren M. Regional versus general anesthesia in surgical patients with chronic obstructive pulmonary disease: does avoiding general anesthesia reduce the risk of postoperative complications? Anesth Analg.2015; 120(6):1405–1412.

24. Beecham, G., Cusack, R., Vencken, S., Crilly, G., Buggy, D.J. Hypotension during hip fracture surgery and postoperative morbidity. Irish J Med Sci. 2020; (1971-): 1–10.

25. Nakasuji, M., Suh, S.H., Nomura, M., Nakamura, M., Imanaka, N., Tanaka, M., Nakasuji, K.: Hypotension from spinal anesthesia in patients aged greater than 80 years is due to a decrease in systemic vascular resistance. J Clin Anesthesia. 2012; 24(3): 201–206.

26. Jakobsson, J., Kalman, S., Lindeberg-Lindvet, M., Bartha, E.: Is postspinal hypotension a sign of impaired cardiac performance in the elderly? An observational mechanistic study. Br J Anaesthesia. 2017; 119(6): 1178–1185.

# CHAPTER – 9

## Frailty and General Anesthesia

**Background:**

Amnesia, unconsciousness, and immobility are all goals of general anesthesia (GA). GA, by definition, produces all three of these therapeutic effects in a reversible manner. Inhaled gases and intravenous agents are examples of general anesthetic medications. Anesthetists may use other medication types to achieve specific therapeutic aims during surgery. [1, 2]It's not just a matter of academic curiosity to distinguish between the clinical goals of general anesthesia.[3] Surgeons prefer an immobile patient for better exposure and precision, whereas patients prefer unconsciousness and amnesia during surgery, thus resulting in divergent goals.[4]

In major surgery, general anesthetics are frequently utilised. Patients are given a range of general anesthetics, either alone or in combination, to obtain the desired level of anesthesia for surgery. GA has long been thought to be completely reversible, with the central nervous system (CNS) returning to its original state once the anesthetic drug is removed from the active site. However, studies show that disrupting the regular functioning of these targets might have long-term beneficial or negative consequences.[5]

**Action of GA in the CNS:**

According various studies on the mechanism of Gas, it influences the neuronal activity through numerous receptor proteins,thereby exerting amnesic, analgesic,

sedative, and immobilising actions. GABA receptor (propofol, etomidate, isoflurane, sevoflurane), NMDA receptor (nitrous oxide, xenon, ketamine), glycine receptor, and two-pore potassium channel are the most well-known receptor targets.[6,7] Such inhibitory and activating receptors are widespread in the mammalian brain, and they may arbitrate GAs' undesirable, off-target effects, which can lead to long-term cognitive impairment. In this sense, the developing and elderly brains' exceptional plasticity/ connectivity and limited compensatory capacity, respectively, may make them sensitive to the widespread, undesirable effects of GA.[5]

In recent years, anesthesia-related problems and death rates have been dramatically reduced. However, anesthesia-related complications such postoperative nausea and vomiting (PONV) or delirium should not be overlooked.[8] Firstly, patients are concerned about anaesthetic side effects. Secondly, because these side effects can result in lengthy hospital stays and significant healthcare expenditures, they are both organizationally and economically burdensome.[9] These factors tend to further deteriorate the condition of a pre-frail or frail individual.

**Frailty and GA:**

Patients over the age of 60 make up 25% of the population and are at a higher risk of complications during surgery. As a result, medical research and practise are focused on lowering postoperative morbidity and mortality. Dependence on caretakers and cognitive impairment are two key risk factors in the elderly, particularly in frail patients following surgeries under GA.[10]

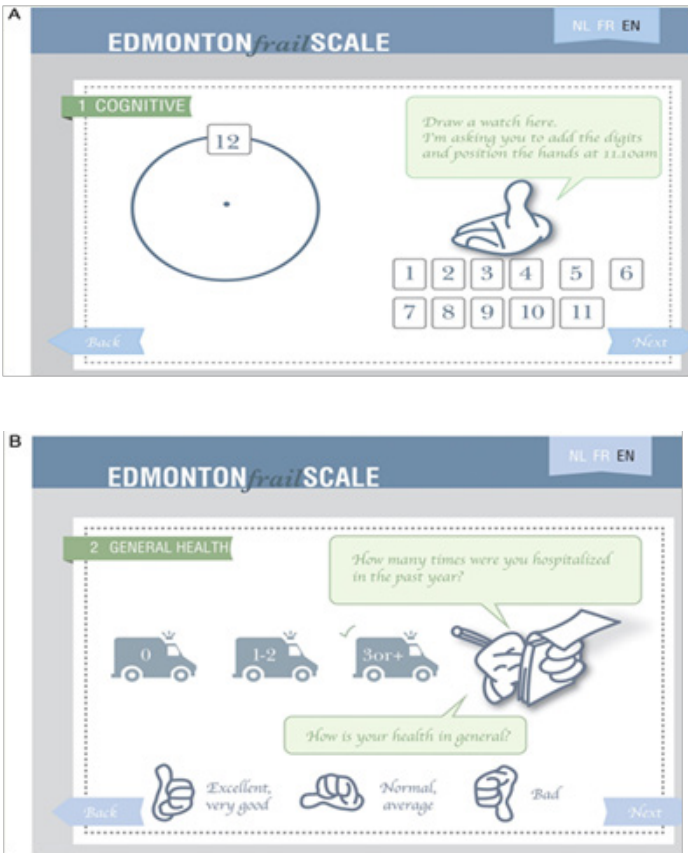
Frailty grows increasingly common as people get older, with up to 50% of those over the age of 85 being frail.[11] The frail older patient is a common occurrence for anaesthetists.

Despite the high frequency with which frailty is encountered, it is rarely formally tested, diagnosed, or discussed as part of a patient's risk profile. This is despite the fact that there is an independent link between frailty and higher postoperative morbidity, particularly the development of postoperative complications and the length of acute hospital stay, both of which should be of interest to doctors and healthcare executives. [12] Furthermore, recognising frailty and using it in conjunction with other risk factors, such as theAmerican Society of Anesthesiologists (ASA), enhances the predictability of postoperative complications. [13]

**Preoperative assessment of frailty before administering GA:**

In the medical literature, there is a large body of evidence that links frailty to outcome. The surgical and perioperative evidence is now being obtained, and a quick examination of the frailty assessment tools indicates the many ways used to acquire evidence of negative surgical outcomes. Over 60 assessment tools are currently in use for research and therapeutic purposes. Every method has its own set of advantages and disadvantages. The Fried Frailty Phenotype, for example, is time-efficient and straightforward, although it necessitates the use of specialised equipment. Nevertheless, the Edmonton Frail Scale (EFS) is a 17-point scale that can be given to each patient in a couple of minutes and has been validated for use by non-geriatricians to assess frailty. [14] The EFS is available as a free smartphone app in English, French, and Dutch, and takes about 5 minutes to complete in each patient (Figure 1).

**Figure 1: The Edmonton Frail Scale (EFS) for preoperative assessment of frailty**




(a) The Edmonton Frail Scale app screen shot. The first task is to draw a clock face, and then put on the hands at 10 past 11. The numbers from the app can be dragged onto the clock face. (b) Edmonton Frail Scale screen shot with question asking about how many times the patient was in hospital in the last year. The whole process takes about 3 min and gives a final score out of 17.

**Image adopted from:** Griffiths R, Mehta M. Frailty and anaesthesia: what we need to know. Continuing Education in Anaesthesia, Critical Care & Pain. 2014 Dec 1;14(6):273-7.[15]

The use of a single instrument in all clinical settings, by all disciplines, specialties, and grades, is ideal. The EFS 17-point scale takes about 5 minutes to complete. The EFS's 'get up and go' test has recently been found to predict morbidity and mortality in a variety of surgical specialties.[16] The test isn't useful in most emergency cases, but it's useful in anesthetic evaluation clinics, where this part of the scale can be evaluated when a patient gets up and enters the clinic or leaves at the conclusion.

A routine preoperative neurocognitive assessment is included in the current ACS-AGS Guidelines for Optimal Preoperative Assessment of the Geriatric Patient. "Mini-Cog" is a short, easy-to-use, and well-studied tool for patients who have no prior history of cognitive impairment.[17] For detecting and anticipating common postoperative problems such as postoperative delirium (POD) or cognitive dysfunction, meticulous documenting of the patient's preoperative cognitive condition is essential (POCD). [18, 19] POD is predicted by pre-existing cognitive impairment. Longer hospital stays, greater mortality, and functional deterioration are all linked to postoperative cognitive impairment. Patients with decreased cognition are less likely to participate in active pulmonary hygiene and ambulation following surgery, increasing the risk of postoperative complications such as pneumonia, deep vein thrombosis, stroke, and cerebrovascular accident with neurologic loss.

**Anesthetic management of a frail patient:**

Typical monitoring (electrocardiogram (EKG), pulse

oximetry, noninvasive blood pressure) or invasive monitoring (neuromuscular blockade, capnography, inspiratory oxygen fraction) with required BIS monitoring (Figure 2) must be set up for the patient for anaesthetic management. The usage and selection of a muscle relaxant, as well as intubation or the construction of a supraglottic device, should be at the anesthesiologist's discretion. The practitioner's judgement on fluid management and hemodynamic control is left to their discretion. Any perioperative events that affect the patient's prognosis, such as prolonged arterial hypotension, abrupt bleeding, or myocardial ischemia, may have an indirect impact.

During anaesthesia, all events must be meticulously recorded.[20]Postoperative nausea and vomiting prophylaxis should be given after recording the Apfel score (Figure 3a &3 b). [21] To avoid chronic drowsiness, it is particularly advised that the tube be removed as soon as the anaesthesia is stopped.

**Figure 2: Bispectral Index scores**

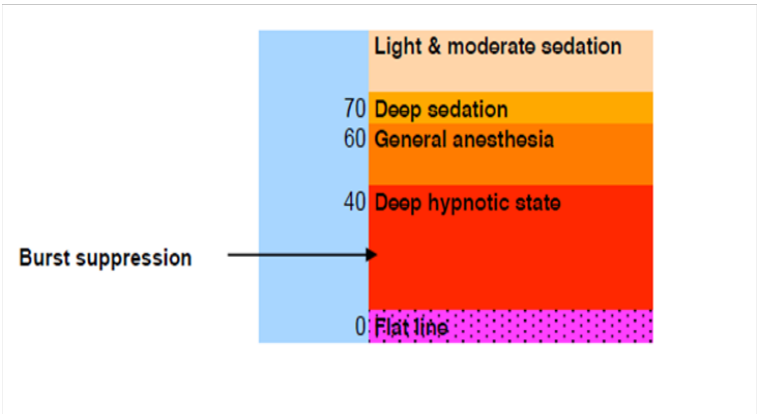


**Figure 3: a) risk factor for PONV b)Apfel score for PONV prophylaxis**

**a**

| Risk Factor | OR | 95% CI |
|---|---|---|
| Female gender | 2.57 | 2.32–2.84 |
| History of PONV/motion sickness | 2.09 | 1.90–2.29 |
| Nonsmoker | 1.82 | 1.68–1.98 |
| Age | 0.88 | 0.84–0.92 |
| Volatile anesthetics | 1.82 | 1.56–2.13 |
| Nitrous oxide | 1.45 | 1.06–1.98 |
| Postoperative opioids | 1.39 | 1.20–1.60 |
| Cholecystectomy | 1.90 | 1.36–2.68 |
| Laparoscopy | 1.37 | 1.07–1.77 |
| Gynecological | 1.29 | 1.02–1.52 |

OR, odds ratio; CI, confidence interval; PONV, postoperative nausea and vomiting.

**b**

| Risk Score | Prevalence PONV | Prophylaxis: No of Anti-emetics |
|---|---|---|
| 0 | 9% | 0-1 |
| 1 | 20% | 1 |
| 2 | 39% | 2 |
| 3 | 60% | 3 |
| 4 | 78% | 4 |

**Importance of BIS in frail patients:**

The BIS monitor was the first quantitative EEG index to be used as a monitor to determine the level of anaesthesia in clinical practise. Only the hypnotic component of anaesthesia is measured using BIS technology. The raw EEG data was reviewed during this process, and parts with artefacts were eliminated. As patients transitioned from an awake to a totally sedated state, several EEG characteristics were detected. The best mix of these features was determined using multivariate statistical models. This data was then converted to a linear scale ranging from 0 to 100.

A BIS score is not the same as a physiologic measurement like blood pressure in millimetres of mercury. BIS values measure changes in the brain's electrophysiologic condition

during anaesthesia. A typical BIS score for conscious patients is 90 to 100. A BIS score of 0 indicates complete suppression of cortical activity, sometimes known as a flat line. BIS scores drop during sleep, although not to the extent that large anaesthetic dosages do. The lower the number, the stronger the hypnotic effect. A BIS rating of less than 60 indicates a low likelihood of responding to commands. [22]

The state of the brain right before the reading is indicated by a BIS score, which is calculated from the preceding 15 to 30 seconds of EEG data. Furthermore, in response to severe stimulation, brain state as assessed by BIS may change fast.[23]

**Intraoperative neurologic monitoring devices:**

Over the last few years, devices for determining the degree of anesthesia have been created. The BIS index monitor, the entropy module, and the narcotrend monitors are all based on electroencephalographic changes and use Fourier's theorem to convert the electroencephalographic signal into an interpretable numerical readout. Although further research is needed to verify some of the benefits attributed to these devices, there is already evidence of their benefits, particularly in patients with neurological or critical risks, such as the elderly.

These devices allow for tighter control of anesthesia's effects on the brain from an anesthetic standpoint, as they allow observation of signals that appear to be related to patient outcomes. Most importantly, in frail patients, these devices allow the better control of the depth of anesthesia and thus aids in reducing the chances of post-operative anesthetic complications.

**Regional versus general anesthesia in frail patients:**

There is no clear-cut evidence to suggest that one technique to superior to other. Many systematic reviews and meta-analyses have given inconclusive results and have suggested long-term randomized clinical trials to arrive at a conclusion. To date, the available data recommends that both regional and anesthesia have their own advantages and disadvantages and post-operative cognitive decline is slightly more prevalent in cases administered with GA. But this increased prevalence is statistically and clinically non-significant. [24, 25, 26]

It has to be remembered that there is a dose–effect relationship of medications in the central or peripheral nervous system as a result of the deterioration of myelin bridges and reduced amount of cerebrospinal fluid.

Also, refer chapter 8 for studies comparing the regional and general anesthesia in frail patients.

**Summary:**

Due to age-related physiological deterioration, various comorbidities, and polypharmacy, older patients have a higher risk of negative surgical outcomes.[15] In the perioperative context, principles of care for older patients should include anaesthetic techniques that result in rapid recovery, drug dose according to individual pharmacokinetic variance, and appropriate pain management tactics. The European Society of Anesthesiology's consensus guideline on postoperative delirium recently concluded that there is insufficient evidence to recommend a specific type of anaesthetic technique, but it does recommend intraoperative monitoring to avoid blood pressure swings and anaesthesia depths that are too deep. [27]

## References:

1. Grasshoff C, Rudolph U, Antkowiak B. Molecular and systemic mechanisms of general anaesthesia: the 'multi-site and multiple mechanisms' concept. Curr Opin Anaesthesiol. 2005; 18: 386–391.

2. Mashour GA, Forman SA, Campagna JA. Mechanisms of general anesthesia: from molecules to mind. Best Pract Res Clin Anaesthesiol. 2005; 19:349–364.

3. Woodbridge PD. Changing concepts concerning depth of anesthesia. Anesthesiology. 1957; 18:536– 550.

4. Forman SA, Chin VA. General anesthetics and molecular mechanisms of unconsciousness. Int Anesthesiol. 2008;46(3):43.

5. Wu L, Zhao H, Weng H, Ma D. Lasting effects of general anesthetics on the brain in the young and elderly:"mixed picture" of neurotoxicity, neuroprotection and cognitive impairment. J Anesthesia. 2019;33(2):321-35.

6. Franks NP. Molecular targets underlying general anaesthesia. Br J Pharmacol. 2006;147(Suppl 1):72–817.

7. Chau PL. New insights into the molecular mechanisms of general anaesthetics. Br J Pharmacol. 2010;161:288–307.

8. Schiff JH, Welker A, Fohr B, et al. Major incidents and complications in otherwise healthy patients undergoing elective procedures: results based on 1.37 million anaesthetic procedures. Br J Anaesth 2014;113:109–21.

9. Rudolph JL, Marcantonio ER. Review articles: postoperative delirium: acute change with long-term implications. Anesth Analg 2011;112:1202–11

10. Le Guen M, Herr M, Bizard A, Bichon C, Boichut N, Chazot T, Liu N, Ankri J, Fischler M. Frailty Related to Anesthesia guided by the Index "bispectraL"(FRAIL) study: study protocol for a randomized controlled trial. Trials. 2017 Dec;18(1):1-9.

11. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-62.

12. Dasgupta M, Rolfson DB, Stolee P, Borrie MJ, Speechley M. Frailty is associated with postoperative complications in older adults with medical problems. Arch Gerontol Geriatr. 2009;48(1):78-83.

13. Makary MA, Segev DL, Pronovost PJ, Syin D, Bandeen-Roche K, Patel P, Takenaga R, Devgan L, Holzmueller CG, Tian J, Fried LP. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210(6):901-8.

14. Rolfson DB, Majumdar SR, Tsuyuki RT, Tahir A, Rockwood K. Validity and reliability of the Edmonton Frail Scale. Age and ageing. 2006;35(5):526-9.

15. Griffiths R, Mehta M. Frailty and anaesthesia: what we need to know. CEACCP. 2014;14(6):273-7.

16. Robinson TN, Wu DS, Sauaia A, Dunn CL, Stevens-Lapsley JE, Moss M, Stiegmann GV, Gajdos C, Cleveland Jr JC, Inouye SK. Slower walking speed forecasts increased postoperative morbidity and one-year mortality across surgical specialties. Ann Surg. 2013;258(4):582.

17. Borson S, Scanlan J, Brush M, Vitaliano P, Dokmak A. The mini-cog: a cognitive 'vital signs' measure for dementia screening in multi-lingual elderly. Int J Geriatr Psychiatry 2000; 15: 1021-7.

18. Ansaloni L, Catena F, Chattat R, Fortuna D, Franceschi C, Mascitti P, et al. Risk factors and incidence of postoperative delirium in elderly patients after elective and emergency surgery. Br J Surg 2010; 97: 273-80.

19. Rudolph JL, Jones RN, Levkoff SE, Rockett C, Inouye SK, Sellke FW, et al. Derivation and validation of a preoperative prediction rule for delirium after cardiac surgery. Circulation 2009; 119: 229-36.

20. Liumbruno GM, Bennardello F, Lattanzio A, Piccoli P, Rossetti G. Recommendations for the transfusion management of patients in the peri-operative period. II. The intra-operative period. Blood Transfus. 2011;9(2):189.

21. Apfel CC, Läärä E, Koivuranta M, Greim CA, Roewer N. A simplified risk score for predicting postoperative nausea and vomiting: conclusions from cross-validations between two centers. Anesthesiology. 1999;91(3):693-700.

22. Sleigh JW, Andrzejowski J, Steyn-Ross A, Steyn-Ross M.

The bispectral index: a measure of depth of sleep? Anesth Analg. 1999;88(3):659-61.

23. Rosow C, Manberg PJ. Bispectral index monitoring. Anesthesiol Clin North America. 2001;19(4): 947-66.

24. Neuman MD, Silber JH, Elkassabany NM, et al. Comparative effectiveness of regional versus general anesthesia for hip fracture surgery in adults. Anesthesiology. 2012; 117(1):72–92.

25. Whiting PS, Molina CS, Greenberg SE, Thakore RV, Obremskey WT, Sethi MK. Regional anaesthesia for hip fracture surgery is associated with significantly more peri-operative complications compared with general anaesthesia. Int Orthop. 2015; 39(7):1321–1327.

26. Hausman MS Jr, Jewell ES, Engoren M. Regional versus general anesthesia in surgical patients with chronic obstructive pulmonary disease: does avoiding general anesthesia reduce the risk of postoperative complications? Anesth Analg.2015; 120(6):1405–1412.

27. Aldecoa C, Bettelli G, Bilotta F, Sanders RD, Audisio R, Borozdina A,et al.European Society of Anaesthesiology evidence-based and consensus-based guideline on postoperative delirium. Eur J Anaesthesiol. 2017; 34(4):192-214.

# CHAPTER – 10

## Frailty and regional Anaesthesia/peripheral nerve blocks

**Background:**

As the number of older adults has continuously increased in recent years, healthcare practitioners have been increasingly focused on providing appropriate management of acute perioperative pain in all patients, but notably in older adults. [1] An improved understanding of the pathophysiology of pain, the development of new opioid and non-opioid analgesic drugs, the incorporation of regional techniques that reduce or eliminate reliance on traditional opioid analgesics, and novel methods of drug delivery have all contributed to an increase in the number of older patients undergoing major surgery. [2]

There are a slew of other concerns that could jeopardise the capacity to give older patients with optimal and effective acute pain management. The medications utilised in treating these sick conditions, as well as the increased danger of drug-to-drug and disease-to-drug interactions, are a result of the comorbid diseases that plague this patient population more frequently. Any acute pain management care strategy for older people must include a better understanding of age-related changes in physiology, pharmacodynamics, and pharmacokinetics. [3] Alterations in pain responses among the aged, as well as challenges in pain assessment for certain individuals with cognitive impairment, are potential issues that must be taken into account.

Several theories have been proposed to characterise the multifaceted characteristics and repercussions of ageing, emphasising the complexities and challenges of creating appropriate localised anaesthetic and analgesic choices for senior patients. As a result, the purpose of this chapter is to discuss the physiologic and pharmacologic effects of ageing on surgical anaesthetic and acute pain treatment in geriatric patients, as well as the risks and benefits of neuraxial blockade combined with peripheral nerve/nerve plexus blockade.

**Age-related physiological changes and considerations for regional anesthesia/analgesia:**

The homeostatic reserves of practically every organ system are gradually depleted as people age. Declining organ function, also known as homeostenosis, can be gradual or progressive, and by the third decade of life, it is noticeable. Each organ system's degraded function happens independently of changes in other organ systems and is impacted by a variety of factors such as nutrition, environment, behaviours, and genetic predisposition. [4] An understanding of normal age-related changes in anatomy, physiology, and sensitivity to pharmacologic drugs is required for optimal anaesthetic management employing regional approaches in older patients. It's also crucial to distinguish between normal physiologic changes in the central nervous system (CNS), cardiovascular, pulmonary, and hepatic systems and disease-related pathophysiologic changes.

**Nervous System Function:**

The brain, spinal cord, and peripheral nervous system (PNS) undergo structural and biochemical changes as people age, resulting in qualitative and quantitative changes in function[5, 6] (Table 1). Furthermore, senior age is

linked to decreased brain volume, which is a symptom of neuron loss, as well as a reduction in cerebral white matter nerve fibres. The number of cholinergic and dopaminergic neurons decreases, and neuronal fibre morphology changes, resulting in fewer synaptic connections and neuroreceptors.

**Table 1: CNS changes associated with aging and effects on pharmacokinetic variables** [7]

| Physiologic Process | Magnitude of Change | Variable Kinetic/ Dynamic Consequences | General Dosing Strategy |
|---|---|---|---|
| Cerebral blood flow, metabolism, and volume | ↓ 20%<br>↓ 20% | ↓ distribution to the CNS<br>↓ apparent volume in the CNS | Little net effect o |
| Active blood–brain barrier transport (efflux) | Drug-specific ↓ | ↑ apparent volume in the CNS | ↓ bolus dose during drug titration<br>↓ maintenance dose |
| Pain threshold sensitivity | Little change | ↑ apparent sensitivity of the CNS | Need for titration is unchanged |
| Concentration response (opioids) | ↑ 50% for some opioids | ↑ response to opioids | ↓ bolus dose during titration<br>↓ maintenance dose |

A decrease in acetylcholine, dopamine, and other neurotransmitters is also observed, as is an extraneuronal amyloid buildup, which is thought to be the cause of neurocognitive dysfunction. [8] In the elderly, alterations in brain phospholipid chemistry are connected with changes in second messengers such as diacylglycerol. [9] Overall, elderly people have lower brain electrical and metabolic

activity than younger people, which could be due to the myriad of anatomic, structural, and biochemical changes that come with ageing. Alterations in nerve conduction velocity and disruption of normal neuronal circuit timing may occur as a result of degenerative changes in the myelin sheaths of nerve fibres in the CNS and PNS.Reduced spinal cord volume and deterioration of the bony spinal canal are two further morphological alterations that impair nervous system function.

**Changes noted in the somatic nervous system of the PNS associated with ageing are:**[7]

- Peripheral nerve deterioration
- Dysfunction of genes responsible for myelin sheath protein components
- Decreased myelinated nerve fibre conduction velocity
- Motor and sensory discriminatory changes in the feet, and
- Changes in sensation such as pain, touch, etc.

The autonomic nervous system (ANS) of the PNS, which controls most of the body's involuntary physiological activities via the parasympathetic and sympathetic divisions, also undergoes age-related alterations.

**Signs of ageing of the ANS are:**[7]

- Reduced stress adaptation;
- Decreased parasympathetic nervous system basal activity and overall net sympathetic nervous system activation;
- Decreased baroreflex sensitivity; and
- Slowing and weakening of homeostatic functions are all.

When choosing a sympathomimetic anaesthetic, take into account the rise in sympathetic tone in older patients, as sympathomimetic anaesthetics may be poorly tolerated by some people with cardiovascular disease.

Changes in the PNS and CNS may have an impact on functional outcomes throughout the recovery phase after surgery and anaesthesia, and should be taken into account during the preoperative evaluation. [10] Aging can cause changed pharmacodynamics, resulting in increased sensitivity to anaesthetic drugs, as well as signs and symptoms such as altered reflexes, degradation of gait and mobility, altered sleep patterns, memory and cognition impairment, and sensory decrements. [4]

**Considerations for the Use of Peripheral Regional and Neural Blockade in Elderly Patients:**

Due to a variety of secondary concerns, such as patient age, comorbidities, safety profile issues, and concurrent medications, there are few evidence-based guidelines for the use of specific regional analgesic modalities in older patients.[11] Elderly patients are frequently excluded from clinical trials. Many of these variables, as well as several additional concerns connected to old age, must be considered when selecting a procedure-specific analgesic regimen that may be more beneficial than more traditional pain management choices like unimodal opioid analgesics. The health status of the older patient, the surgery being performed, and the competence of the perioperative pain management healthcare providers should all be considered when making decisions about regional alternatives and peripheral nerve blocks.

To ensure safe use of regional and peripheral nerve blockade techniques in the elderly and undertake evidence-based research, needs should be addressed on a patient-by-patient basis and focused toward regional

pain medication alternatives that target the surgical site. [12] In recent years, the number of elderly patients seeking anaesthesia and surgery has increased dramatically, and neuraxial and peripheral nerve blocking procedures are routinely used in this patient population. [13] Regional modalities of perioperative pain treatment can help elderly patients.

One important clinical observation that has emerged from the literature on regional anesthesia/analgesia is evidence that the use of regional techniques allows for the minimization or elimination of the negative side effect profiles of other systemic pain management options, such as bowel and bladder dysfunction, hemodynamic derangements, and cognitive effects commonly experienced with opiates and other analgesic adjuncts, as well as sedative/hypnotics, to which older patients are exposed. [14] Surgical results in older patients are influenced by a variety of factors, including the nature, duration, and invasiveness of the procedure, underlying medical or mental status disorders, and the ability and expertise of both the anesthesiologist and the surgeon.

These and other considerations make determining whether or not one localised analgesic treatment is unequivocally better than another challenging. As a result, until evidence-based research can provide definitive guidelines on regional anesthesia/analgesia in the elderly, it's critical to concentrate on improving overall perioperative pain management options for elderly patients by implementing patient- and procedure-specific modes of regional anaesthesia.[15]

In the senior population, anatomic changes associated with age may make neuraxial and regional peripheral nerve anesthesia/analgesia more technically challenging. Because of osteoarthritic changes, decreased range of motion in the limbs, difficulties associated with severe

osteoporosis and rheumatoid arthritis, and cartilage calcification, elderly people may develop dorsal kyphosis, a propensity to flex their hips and knees. [16]

All of these concerns could complicate situating older individuals for regional block implantation. Neuraxial procedures can be challenged not only by patient positioning issues, but also by degenerative disc and vertebral joint alterations, as well as the aging-related distortion and compression of intervertebral and epidural spaces. With age, the ligamentum flavum gets more calcified, making an epidural block or dural puncture more difficult to perform due to difficult needle placement and progress through such dense, calcified ligaments.[17] Osteophytes can also reduce the size of the intervertebral gap, making access to the subarachnoid region more difficult.

A lateral (paramedian) needle approach to the epidural or subarachnoid area can help avoid problems including calcification of the vertebral midline ligament and dorsal vertebrae deformation.[18] In addition, reaching the L5–S1 interspace, which is often the biggest intervertebral space, may make entry to the epidural or subarachnoid space easier in patients with severe osteoarthritis and ossified ligaments. [19]

**Regional Anesthesia and Analgesia Using Peripheral Nerve and Nerve Plexus Blockade:**

Consider the postoperative problems usually associated with regular surgical procedures and then analyse how peripheral nerve and nerve plexus blocking could lessen these difficulties in geriatric patients as one method to perioperative pain management.[21] In any surgical setting, elderly patients are more likely to have underlying neurologic, pulmonary, and cardiovascular disease, all of which can lead to catastrophic consequences. While there are established clinical practises and theoretical indications

for using safe and effective regional techniques for elderly patients, a lack of consistency among studies has prevented the development of firm recommendations to guide which regional anaesthetics and analgesia techniques offer the most benefits for elderly patients undergoing specific surgical procedures.

Peripheral nerve blockade can be used as a supplemental analgesic for medical operations and can provide enough analgesia for a variety of surgical procedures involving the upper and lower extremities, abdomen, groin, and chest wall. The definitions and descriptions of regional peripheral nerve block procedures, as well as the definitions of other analgesia and anaesthetic techniques, are all different (Table 2).[7] In clinical studies, neuraxial anaesthesia (with or without analgesia) is frequently used to define regional anaesthesia.[7] Other researches, on the other hand, define localised anaesthesia as simply peripheral nerve and nerve plexus blocking, local anaesthetic infiltration, and local anaesthetic injection.[7]

**Table 2: Analgesia and anesthesia techniques[7]**

| **Local Monitored Anesthesia Care (LMAC) (LMAC)** | **LMAC with or without Intravenous and Oral Sedatives, Hypnotics, Analgesics (Opioid and Nonopioid)** |
|---|---|
| **General Anesthesia and analgesia**<br>Anesthesia<br>Analgesia | With or without perioperative medicationsInhalation agents, intravenous agents, and/or total intravenous anesthesia (TIVA)<br>Systemically administered analgesia with opioids, nonopioids, and other adjuncts<br>• Intramuscular injections<br>• Intravenous boluses<br>• Patient-controlled analgesia (PCA)<br>• Transdermal, mucous membrane, and oral routes |

| | |
|---|---|
| **Regional Anesthesia and Analgesia**<br>Neuraxial<br>Peripheral nerve/ nerve plexus blockade<br>Infiltration/field block | With or without other intravenous perioperative medications (analgesics, sedation)Spinal (subarachnoid) and/or epidural anesthesia and/or analgesia<br>• Single injection, with or without catheters<br>• Local anesthetic (type, concentration) with or without opioids and other adjuncts<br>• Vertebral level of block placement/ initiation<br>• Level of blockade achieved<br>• Length or duration of postoperative anesthesia and analgesia<br><br>Peripheral nerve block<br>• Local anesthetic with or without additives<br>• Single injection or continuous catheter technique<br><br>Brachial plexus blockade<br>• Femoral block<br>• Sciatic/popliteal blockade<br>• Paravertebral block<br>• Transverse abdominis plane block, etc.<br><br>Local anesthetic infiltration/injection (diffusion blockade)<br>• With or without indwelling catheters |

**Peripheral anesthesia versus neuraxial anesthesia:**

Following total knee replacement surgery, Zaric et al compared epidural analgesia to a combination of femoral and sciatic peripheral nerve blocking.[21] The incidence of side effects, such as urine retention, moderate to severe dizziness, pruritus, drowsiness, nausea, and vomiting during the postoperative period, were the primary outcome measures. Three days following surgery, the intensity of motor blockage, discomfort at rest and on movement, and

rehabilitation indices were all recorded. In the epidural group, 87% of patients experienced side effects (one or more), but only 35% of individuals in the femoral and sciatic block group experienced side effects.[21]

Furthermore, in the epidural group, motor blockage was more acute (operated and non-operated limbs) on the day of surgery and the first postoperative day. The pain on mobilisation was well controlled in both groups, rehabilitation indices were identical, and the length of hospital stay was not different. In comparison to the epidural group, the femoral and sciatic nerve block group had a lower frequency of side effects. Similarly, epidural analgesia is thought to be a better way to relieve pain following major thoracic surgery. However, utilising a paravertebral blockade (PVB) catheter to implant a PVB can provide equivalent analgesic effectiveness and a better side effect profile than using an epidural catheter for neuraxial alternatives. [22]

Systematic reviews and meta-analyses of relevant randomised controlled clinical trials suggested that there was no significant difference in terms of pain relief, when comparing PVB with epidural analgesia for thoracic surgery. [23, 24] Additionally, it wasfound that hemodynamic variability, urinary retention, increased plasma cortisol concentrations, nausea, pruritus, respiratory depression, prolonged operative time, reports of incomplete/failed epidural, and paraplegia were recounted more frequently in the epidural groups when compared to those in the paravertebral groups. Thus, it is recommended that PVBs had less respiratory difficulties, nausea and vomiting, and hypotension, as well as a lower rate of failed blocks and a lower incidence of urine retention, which were all prevalent and often serious compromising side effects.[25]

As previously stated, there are several factors that influence the distribution of both local anaesthetics and adjuncts into the epidural area. But it has to be ascertained if a paravertebral approach, when inserted in the neuraxial area of elderly people, can provide effective anaesthesia or analgesia without the distribution of local anaesthetics. Patients over 65 years old who underwent urological surgery after receiving a paravertebral lumbar plexus blockade (using ropivacaine or bupivacaine) demonstrated improved pain levels, lower incidence of cognitive dysfunction, and stable heart rate and blood pressure in a research by Akin et al. [26] Patients receiving paravertebral nerve block treatments for the management of persistent pain were studied by Cheema et al. [27] Unlike the varying spread of local anaesthetics supplied for epidural analgesia, the age of the patient had no effect on the spread of bupivacaine when placed in the thoracic paravertebral region, according to the findings of this study.

The contraindication to regional anaesthesia in anaesthetized patients is another crucial element to consider in all patients. Unlike neuraxial anaesthesia, paravertebral blocks may be performed safely in profoundly sedated or anaesthetized individuals with no obvious risk of neurological harm. As a result, paravertebral blocks can be performed under severe sedation or general anaesthesia in older patients who experience pain or discomfort during placement for neuraxial or paravertebral blockade procedures without risking serious brain harm.

**Summary:**

When properly delivered (timed correctly and coupled with the appropriate sort of surgical intervention), proper patient selection and surgery-specific peripheral nerve and nerve plexus blockade can provide good perioperative pain control in all patient demographics. However, there

is some evidence that the effects of peripheral nerve blockade can be extended in some older individuals, lowering or eliminating the requirement for opioid drugs for breakthrough pain after discharge from the hospital. Furthermore, when considering the long-term effects of peripheral nerve blockade, elderly patients should be properly counselled about these effects prior to block placement, and care should be taken to ensure that older patients have adequate home assistance if peripheral nerve blocks are to be placed for outpatient surgery.

**References:**

1. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients, J Am Coll Surg.2010 Jun 1;210(6):901-8

2. Grape S, Tramèr MR. Do we need preemptive analgesia for the treatment of postoperative pain?. Best Pract Res Clin Anaesthesiol. 2007;21(1):51-63.

3. Falzone E, Hoffmann C, Keita H. Postoperative analgesia in elderly patients. Drugs Aging. 2013;30(2):81-90.

4. Dharmarajan TS. Physiology of Aging. Geriatric gastroenterology. 2021:101-53.

5. Canta A, Chiorazzi A, Carozzi VA, Meregalli C, Oggioni N, Bossi M, Rodriguez-Menendez V, Avezza F, Crippa L, Lombardi R, de Vito G. Age-related changes in the function and structure of the peripheral sensory pathway in mice. Neurobiol Aging. 2016;45:136-48.

6. Troncale JA. The aging process: physiologic changes and pharmacologic implications. Postgrad Med. 1996;99(5):111-22.

7. https://www.nysora.com/foundations-of-regional-anesthesia/sub-specialties/elderly/perioperative-regional-anesthesia-elderly/

8. Darvesh AS, Carroll RT, Geldenhuys WJ, Gudelsky GA, Klein J, Meshul CK, Van der Schyf CJ. In vivo brain microdialysis: advances

in neuropsychopharmacology and drug discovery. Expert Opin Drug Discov. 2011;6(2):109-27.

9. Giusto NM, Salvador GA, Castagnet PI, Pasquare SJ, De Boschero MI. Age-associated changes in central nervous system glycerolipid composition and metabolism. Neurochem Res. 2002;27(11):1513-23.

10. Nordquist D, Halaszynski TM. Perioperative multimodal anesthesia using regional techniques in the aging surgical patient. Pain Res Treat. 2014;2014.

11. Simon BJ, Cushman J, Barraco R, Lane V, Luchette FA, Miglietta M, Roccaforte DJ, Spector R, EAST Practice Management Guidelines Work Group. Pain management guidelines for blunt thoracic trauma. JTrauma Acute Care Surg. 2005;59(5):1256-67.

12. Jin Z, Lee C, Zhang K, Gan TJ, Bergese SD. Safety of treatment options available for postoperative pain. Expert OpinDrug Saf. 2021;20(5):549-59.

13. Cozowicz C, Poeran J, Zubizarreta N, Mazumdar M, Memtsoudis SG. Trends in the use of regional anesthesia: neuraxial and peripheral nerve blocks. Reg Anesth Pain Med. 2016;41(1):43-9.

14. White PF, Kehlet H, Neal JM, Schricker T, Carr DB, Carli F, Fast-Track Surgery Study Group. The role of the anesthesiologist in fast-track surgery: from multimodal analgesia to perioperative medical care. Anesth Analg. 2007;104(6):1380-96.

15. Rawal N. Current issues in postoperative pain management. Eur J Anaesthesiol. 2016; 33(3):160-71.

16. Lane NE, Wallace DJ. All about Osteoarthritis: The definitive resource for arthritis patients and their families. Oxford University Press; 2002 Mar 14.

17. Hameed F, Hunter DJ, Rainville J, Li L, Suri P. Prevalence of anatomic impediments to interlaminar lumbar epidural steroid injection. Arch Phys Med Rehabil. 2012;93(2):339-43.

18. EU DC. Comparison of Real-time Ultrasound Approach to Non Ultrasound-assissted Approach in Paramedian Lateral Spinal Anaesthesia for Lower Limb Surgery (Doctoral dissertation, Universiti Sains Malaysia).

19. Eisenberg RL. Clinical imaging: an atlas of differential diagnosis. Lippincott Williams & Wilkins; 2010.

20. Indelli PF, Grant SA, Nielsen K, Vail TP. Regional anesthesia in hip surgery. Clin Orthop Relat Res. 2005;441:250-5.

21. Zaric D, Boysen K, Christiansen C, Christiansen J, Stephensen S, Christensen B. A comparison of epidural analgesia with combined continuous femoral-sciatic nerve blocks after total knee replacement. AnesthAnalg. 2006;102(4):1240-6.

22. Fortier S, Hanna HA, Bernard A, Girard C. Comparison between systemic analgesia, continuous wound catheter analgesia and continuous thoracic paravertebral block: a randomised, controlled trial of postthoracotomy pain management. Eur J Anaesthesiol. 2012;29(11):524-30.

23. Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy—a systematic review and meta-analysis of randomized trials. Br J Anaesth. 2006;96(4):418-26.

24. Ding X, Jin S, Niu X, Ren H, Fu S, Li Q. A comparison of the analgesia efficacy and side effects of paravertebral compared with epidural blockade for thoracotomy: an updated meta-analysis. PloS one. 2014;9(5):e96233.

25. Elmore B, Nguyen V, Blank R, Yount K, Lau C. Pain management following thoracic surgery. Thorac Surg Clin. 2015;25(4):393-409.

26. Akin S, Aribogan A, Turunc T, Aridogan A: Lumbar plexus blockade with ropivacaine for postoperative pain management in elderly patients undergoing urologic surgeries. Urol Int 2005;75:345–349.

27. Cheema S, Richardson J, McGurgan P: Factors affecting the spread of bupivacaine in the adult thoracic paravertebral space. Anaesthesia 2003; 58:684–687.

# CHAPTER – 11

## Frailty and anesthesia outside operation theatre

**Background:**

Non-operating room anesthesia (NORA) refers to the delivery of sedation/anesthesia to patients undergoing painful or unpleasant procedures outside of the operating room.[1] Technological advancements in medical equipment, physician proficiency, and medically compromised patients, have all increased the need for these procedures and thus, are becoming more common. Radiology, gastrointestinal imaging, diagnostic/therapeutic interventions, paediatric cardiac catheterization, mental care, and dentistry are all common procedures. Anesthesiologists are regularly asked to give NORA at these remote areas, but they often overlook the necessity of maintaining safety standards for equipment, employees, and facilities. Despite the fact that there are several studies on anaesthetic use in remote places, high-quality studies are limited.

It is critical for anesthesiologists to build a systemic, uniform framework throughout an institute that encompasses all provisions of all categories of anesthetic treatment in order to deliver safe and quality anesthetic care in the NORA. Such standards must be implemented consistently throughout the hospital, not just to protect patients but also to protect health-care workers. Because anesthesiologists doing NORA are responsible for the patient's as well as their own safety, these guidelines should not be overlooked.

**Risks associated with NORA:**

NORA presents a number of specific obstacles, including those relating to the patient, technique, and surroundings.

Patients undergoing treatments utilizing new and complex technical equipment are at higher risk, if handled by physicians who are inexperienced with NORA. Pediatrics, geriatrics, and medically compromised patients who are too weak for surgical management but can benefit from a procedure are among these patients. [2]

Regardless of how simple the treatments (or surgeries) conducted by NORA are, each patient should be prepared for general anesthesia (GA) because sedation can be switched to general anesthesia at any time. The anesthesiologist must comprehend the process's nature, including the patient's position, the procedure's pain level, and the duration of the procedure. In addition, contingencies for emergencies and negative outcomes must be discussed with the proceduralist ahead of time. Other employees must be trained to help or do cardiopulmonary resuscitation.[3] Patients and anesthesiologists are both at danger in emergency scenarios due to unfamiliar surroundings, absence of monitoring devices, improperly trained or insufficient staff, and unavailable medication or equipment. To improve the quality of patient treatment, the American Society of Anesthesiology (ASA) has issued minimal recommendations for anaesthesia in the non-operating room. [4]

**Table 1: Guidelines for Non-operating Room Anesthesia** [4]

Each location should have

- Reliable source of oxygen adequate for the length of the procedure, with a backup supply
- Adequate and reliable source of suction
- Adequate and reliable system for scavenging waste anesthetic gases
- Self-inflating hand resuscitator bag capable of administering > 90% oxygen

- Adequate anesthesia drugs, supplies, and equipment for the intended anesthesia care
- Adequate monitoring equipment to allow adherence to the "Standards for Basic Anesthetic Monitoring"
- Sufficient electrical outlets to satisfy anesthesia machine and monitoring equipment requirements

Provision for adequate illumination

- The patient, anesthesia machine, and monitoring equipment
- Battery-powered illumination other than a laryngoscope immediately available

Sufficient space

- Accommodate necessary equipment and personnel
- Allow expeditious access to the patient, anesthesia machine, and monitoring equipment

Immediate availability of an emergency cart

- Defibrillator, emergency drugs, and other equipment to provide cardiopulmonary resuscitation

Staff

- Trained anesthesiologist

**NORA and frailty:**

NORA services have become common for frail patients as well as patients with serious comorbidities as the number of operations and interventional procedures performed in offices and ambulatory facilities has increased. According to registry data from the United States, the number of patients undergoing office-based procedures in ASA classes 4–5 grew from 19.3 to 32.8% between 2010 and 2014.[5]

NORA can be used on patients who are too sick to be considered for surgery as well as the general public undergoing diagnostic tests. According to NORA's closed claims study, the majority of the patients were elderly. [6]61% of individuals were classed as ASA 3 to 5, and 38%

were above the age of 70. It's worth noting that monitored anaesthetic care claims were more closely related with older and frail patients than GA claims. [7] Another closed claims analysis of 13 patients found that the anaesthetic risk increases significantly in patients with an ASA rating higher than 1, implying that patients desiring NORA should be thoroughly examined before receiving anesthesia/sedation. [8]

Anesthesiologists should be mindful that administering anaesthesia or sedation outside of the operating room raises the risk of complications. Operator error or lack of rescue systems is the most typical causes of near misses or critical occurrences. [9] In NORA settings, insufficient or inadequately trained workers can also pose serious difficulties. Even if an anesthesiologist is present, if workers in the radiology or endoscopy departments are unfamiliar with anaesthetic or cardiovascular resuscitation, the rate of morbidity and mortality will rise. The anesthesiologist must verify that all participants are properly trained in both anaesthesia and cardiopulmonary resuscitation before beginning NORA.

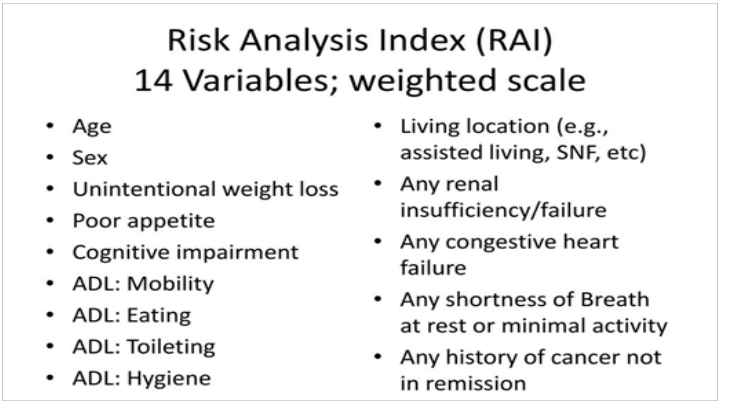
**Frailty index before NORA procedures:**

Frailty is a stress-related syndrome in which the body's physiological balance is disrupted and health is deteriorated. In many therapeutic settings, frail individuals have a higher risk of postoperative complications. However, more recent research has focused on the link between frailty and quality indicators like failure to rescue (death following a possibly preventable problem) and hospital readmissions, both of which are more common in frail people.[10, 11]

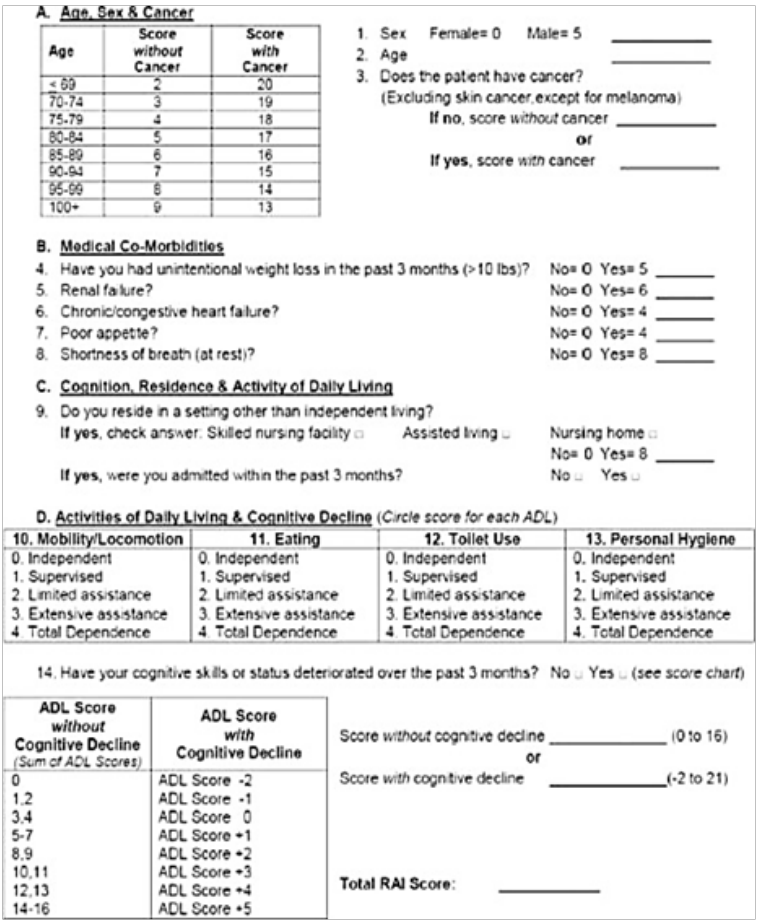
Frailty Index, Surgical Complexity Score and Revised Cardiac Risk and could be used together with ASA classification in preoperative risk assessment of comorbidities. [12, 13] Amongst the frailty indices, The Risk

Analysis Index (RAI) is a validated frailty assessment tool that can predict postoperative death at 30-, 180-, and 365 days that can be employed to evaluate the severity of frailty before commencing the NORA procedures.[13, 14]

**Table 2: Variables of Risk Analysis Index**



## Figure 1: Assessment of frailty using Risk Analysis Index (RAI)



**A. Age, Sex & Cancer**

| Age | Score *without* Cancer | Score *with* Cancer |
|---|---|---|
| < 69 | 2 | 20 |
| 70-74 | 3 | 19 |
| 75-79 | 4 | 18 |
| 80-84 | 5 | 17 |
| 85-89 | 6 | 16 |
| 90-94 | 7 | 15 |
| 95-99 | 8 | 14 |
| 100+ | 9 | 13 |

1. Sex Female= 0 Male= 5 _____
2. Age _____
3. Does the patient have cancer?
   (Excluding skin cancer,except for melanoma)
   **If no**, score *without* cancer _____
   **or**
   **If yes**, score *with* cancer _____

**B. Medical Co-Morbidities**

4. Have you had unintentional weight loss in the past 3 months (>10 lbs)? No= 0 Yes= 5 _____
5. Renal failure? No= 0 Yes= 6 _____
6. Chronic/congestive heart failure? No= 0 Yes= 4 _____
7. Poor appetite? No= 0 Yes= 4 _____
8. Shortness of breath (at rest)? No= 0 Yes= 8 _____

**C. Cognition, Residence & Activity of Daily Living**

9. Do you reside in a setting other than independent living?
   **If yes**, check answer: Skilled nursing facility ☐ Assisted living ☐ Nursing home ☐
   No= 0 Yes= 8 _____
   **If yes**, were you admitted within the past 3 months? No ☐ Yes ☐

**D. Activities of Daily Living & Cognitive Decline** (*Circle score for each ADL*)

| 10. Mobility/Locomotion | 11. Eating | 12. Toilet Use | 13. Personal Hygiene |
|---|---|---|---|
| 0. Independent | 0. Independent | 0. Independent | 0. Independent |
| 1. Supervised | 1. Supervised | 1. Supervised | 1. Supervised |
| 2. Limited assistance | 2. Limited assistance | 2. Limited assistance | 2. Limited assistance |
| 3. Extensive assistance | 3. Extensive assistance | 3. Extensive assistance | 3. Extensive assistance |
| 4 Total Dependence | 4. Total Dependence | 4. Total Dependence | 4. Total Dependence |

14. Have your cognitive skills or status deteriorated over the past 3 months? No ☐ Yes ☐ (*see score chart*)

| ADL Score *without* Cognitive Decline (*Sum of ADL Scores*) | ADL Score *with* Cognitive Decline |
|---|---|
| 0 | ADL Score -2 |
| 1,2 | ADL Score -1 |
| 3,4 | ADL Score 0 |
| 5-7 | ADL Score +1 |
| 8,9 | ADL Score +2 |
| 10,11 | ADL Score +3 |
| 12,13 | ADL Score +4 |
| 14-16 | ADL Score +5 |

Score *without* cognitive decline _____ (0 to 16)
**or**
Score *with* cognitive decline _____ (-2 to 21)

**Total RAI Score:** _____

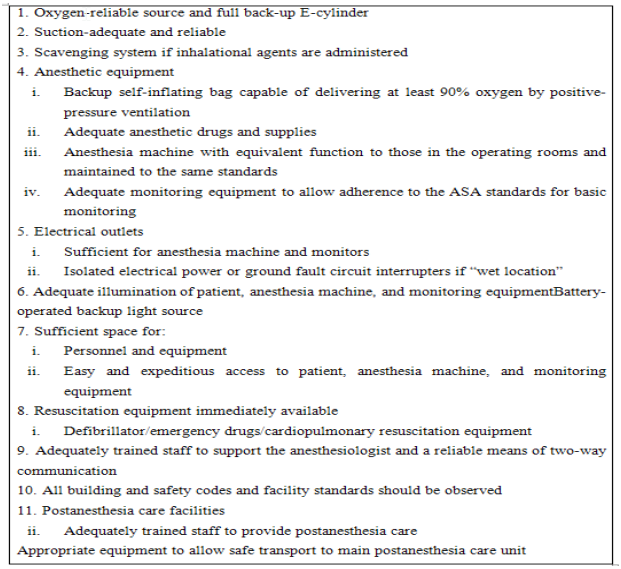
These metrics, unlike comorbidity indexes, take into account functioning, disease condition, past treatments and procedures, as well as anesthesia-related aspects. They can be simply generated and calculated electronically, even from medical records. It would be fascinating to see whether they could help with risk assessment prior to surgery. None of these tools, however, incorporates information on concomitant conditions, NORA settings, staff experience, and anaesthetic resources. Naturally, the location of NORA is important: a surgical unit in a downtown office, for example, is significantly different from one at a university hospital.[3]

**Preparing for non-operating room anesthesia:**

It is critical to emphasise that the necessary comorbidity care should be provided in NORA as well. Prior to NORA, it is critical to determine the number of comorbidities including frailty as well as their pathophysiological status. The team should be taught to keep key functions running smoothly, offer proper monitoring, and treat comorbidities as needed. In addition, the care should be extended to include a recovery period as well as transportation back to the patient's home. NORA-service providers must also be prepared to deal with potential comorbidity-related emergencies, such as intubation difficulties. Regrettably, there is relatively little evidence for disease-specific care in NORA. [13]

In order to achieve this, the triad of NORA must be kept in mind before starting the procedure (Figure 2). [15]

**Figure 2: Triad of NORA**


1. Oxygen-reliable source and full back-up E-cylinder
2. Suction-adequate and reliable
3. Scavenging system if inhalational agents are administered
4. Anesthetic equipment
   i. Backup self-inflating bag capable of delivering at least 90% oxygen by positive-pressure ventilation
   ii. Adequate anesthetic drugs and supplies
   iii. Anesthesia machine with equivalent function to those in the operating rooms and maintained to the same standards
   iv. Adequate monitoring equipment to allow adherence to the ASA standards for basic monitoring
5. Electrical outlets
   i. Sufficient for anesthesia machine and monitors
   ii. Isolated electrical power or ground fault circuit interrupters if "wet location"
6. Adequate illumination of patient, anesthesia machine, and monitoring equipmentBattery-operated backup light source
7. Sufficient space for:
   i. Personnel and equipment
   ii. Easy and expeditious access to patient, anesthesia machine, and monitoring equipment
8. Resuscitation equipment immediately available
   i. Defibrillator/emergency drugs/cardiopulmonary resuscitation equipment
9. Adequately trained staff to support the anesthesiologist and a reliable means of two-way communication
10. All building and safety codes and facility standards should be observed
11. Postanesthesia care facilities
   ii. Adequately trained staff to provide postanesthesia care

Appropriate equipment to allow safe transport to main postanesthesia care unit

**The patient:**

For a variety of reasons, patients may require sedation or anaesthesia to withstand NORAprocedures. Frail patients and patients who are too ill to tolerate a major surgical treatment but may be able to have a palliative, less invasive procedure are likewise a dilemma for the NOR anesthesiologist. All NORA patients require a thorough pre-anesthetic evaluation and the preparation of a competent anaesthetic plan with adequate monitoring levels.

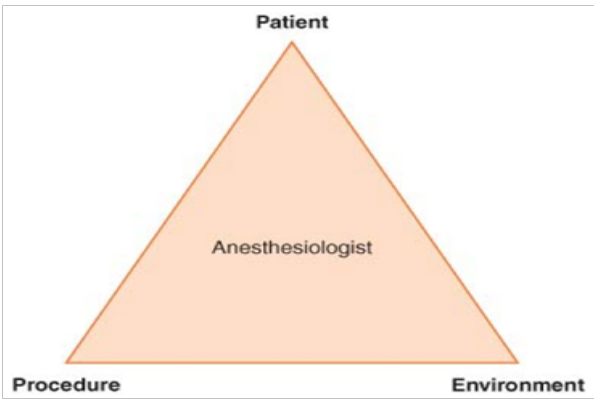
**The procedure:**

The following are some of the most common NORA procedures for which the patient may require anaesthesia or sedation. The anesthesiologist must comprehend the process's nature, including the patient's position, the

procedure's pain level, and the duration of the procedure. The best anaesthesia plan ensures that the patient is safe and that the process runs smoothly. Contingencies for crises and negative results must be discussed with the proceduralist.

- **Patient Factors Requiring Sedation or Anesthesia for Non-operating Room Procedures:**[15]
- Claustrophobia,
- Anxiety and panic disorders
- Cerebral palsy, developmental delay and learning difficulties
- Seizure disorders, movement disorders and muscular contractures
- Pain, both related to the procedure and other causes
- Acute trauma with unstable cardiovascular, respiratory, or neurologic function
- Raised intracranial pressure
- Significant comorbidity and patient frailty (ASA grades III, IV), child age, especially children <10 yrs

**Table 3: ASA Standards for NORA Locations** [16]



**Summary:**

Regardless of where the procedures will be performed, the pathophysiological conditions of various comorbidities including frailty should be carefully reviewed and a risk assessment completed prior to surgery. The amount of comorbidities as well as the patient's functionality is crucial. NORA guidelines for numerous comorbidities, such as frailty, COPD, diabetes, and so on, were recently published and are highly important tools, but they will not eliminate the necessity for institutional protocols. It is essential to assess the frailty score through RAI before starting the NORA procedures and exceptional post-procedural care is also mandated.

**References:**

1. Metzner J, Domino KB.Risks of anesthesia or sedation outside the operating room: the role of the anesthesia care provider.Curr Opin Anaesthesiol. 2010; 23(4):523-31.

2. Lai YC, Manninen PH.Anesthesia for cerebral aneurysms: a comparison between interventional neuroradiology and surgery.Can J Anaesth. 2001; 48(4):391-5.

3. Youn AM, Ko YK, Kim YH. Anesthesia and sedation outside of the operating room. Korean J Anesthesiol. 2015; 68(4):323.

4. Statement on nonoperating room anesthetizing location Edited by The American Society of Anesthesiologists. 2010.

5. Seligson E, Beutler SS, Urman RD. Office-based anesthesia: an update on safety and outcomes (2017-2019). Curr Opin Anesthesiol 2019; 32:756–761

6. Robbertze R, Posner KL, Domino KB.Closed claims review of anesthesia for procedures outside the operating room.Curr Opin Anaesthesiol. 2006; 19(4):436-42.

7. Bhananker SM, Posner KL, Cheney FW, Caplan RA, Lee LA,

Domino KB. Injury and liability associated with monitored anesthesia care: a closed claims analysis. Anesthesiology. 2006; 104(2):228-34.

8. Jastak JT, Peskin RM. Major morbidity or mortality from office anesthetic procedures: a closed-claim analysis of 13 cases.Anesth Prog. 1991; 38(2):39-44.

9. Bell C, Sequeira PM. Nonoperating room anesthesia for children. Curr Opin Anaesthesiol. 2005; 18(3):271-6.

10. Abellan van Kan G, Rolland YM, Morley JE, Vellas B. Frailty: toward a clinical definition. J Am Med Dir Assoc. 2008;9(2):71-72.

11. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-762.

12.Rothernberg KA, Stern JR, Goerge EL, et al. Association of frailty and postoperative complications with unplanned readmissions after elective outpatient surgery. JAMA Netw Open 2019; 2:e194330.

13.Pöyhiä R. Nonoperating room anesthesia for patients with serious comorbidities. Curr Opin Anesthesiol. 2020;33(4):594-600.

14. Hall DE, Arya S, Schmid KK, Blaser C, Carlson MA, Bailey TL, Purviance G, Bockman T, Lynch TG, Johanning J. Development and initial validation of the risk analysis index for measuring frailty in surgical populations. JAMA Surg. 2017;152(2):175-82.

15. KJ Souter,AJ Pittaway. Nonoperating Room Anesthesia (NORA). https://aneskey.com/nonoperating-room-anesthesia-nora-2/#R1-32

16. American Society of Anesthesiologists Statement on Nonoperating room Anesthetizing Locations. 2013.

# CHAPTER – 12

## Frailty and Orthopaedic Surgery

**Background:**

While frailty is a multidimensional concept, as reflected in the frailty index approach to measurement, clinical indicators, or phenotypic markers, such as reduced muscle strength, unintended weight loss, low physical activity, fatigue, and impairment of physical function, are frequently used to operationalize it.[1] Furthermore, frail elderly individuals have poorer bone mineral density and lean body mass than non-frail elderly patients. These and other mechanisms can lead to weakness, unsteady walking, and poor balance, making patients more vulnerable to falls, fragility fractures, and death.

Over the last fifteen years, best practise for the management of older and frail orthopaedic patients has vastly improved. The ageing population has resulted in increasingly complex comorbidities and weakness among orthopaedic patients. Prior to surgery, initiatives such as a full geriatric assessment and surgery within 36 hours of trauma have improved treatment and reduced mortality. There has been a growing awareness of poor outcomes in various orthopaedic trauma patient cohorts over the last decade. [2, 3] As a result, authorities have increasingly broadened their guidelines to incorporate more fracture patterns, demographic considerations, and treatment recommendations (Table 1).

**Table 1: Comparison of the Best Practice Tariff Criteria, National Institute of Health and Care Excellence (NICE) Guidelines and the Blue Book for the management of hip fractures [4]**

| | BPT 2020 | BOAST 2019 | NICE | Blue Book |
|---|---|---|---|---|
| **Inclusion Criteria** | Hip fracture or femoral fracture in aged 60 + + | Sustaining a fragility fracture OR Major trauma with CFS of 5 + | Hip fracture in adults (aged 18 + ). | All fragility fractures with Some recommen -dations for hip fractures only (∗= hip fracture specific) |
| **Time to surgery** | Within 36hrs of arrival in the emergency department. | Within 36 hours of admission. | Day of, or the day after admission. | Within 48 hours of admission (if medically fit) ∗. |
| **Orthogeriatric input** | Geriatrician assessment in preoperative period (within 72hrs of admission). Admitted under joint care of consultant geriatrician and consultant orthopaedic surgeon. Postoperative geriatrician-directed Multiprofessional rehabilitation team. | Comprehensive Geriatric Assessment within 72 hours of injury. | From admission, patients should be offered orthogeriatric assessment, optimisation for fitness for surgery, orthogeriatric and multidisciplinary review. | Should be managed on an orthopaedic ward with routine access to acute orthogeriatric medical support ∗. |
| **Physiotherapy input** | Assessed by physiotherapist the day of or day following surgery. | Should be seen by physiotherapist the day after surgery. | Offer appropriate mobilisation strategies e.g. physiotherapist assessment. | |
| **Fracture/falls prevention** | Fracture prevention assessments (falls and bone health). | Bone health review. Multifactorial falls risk assessment, referred to | Liaison with appropriate services e.g. falls prevention. | Offered MDT assessment and intervention to prevent future falls. Assessed for need for antiresorptive therapy |

| | | | | |
|---|---|---|---|---|
| | | falls prevention services if indicated. | | to prevent future osteoporotic fractures |
| **Other guidelines** | Admitted using an assessment protocol agreed by geriatric medicine, orthopaedic surgery and anaesthesia AMTS before surgery, with score recorded in the NHFD. Delirium assessment using the 4AT screening tool during admission. Nutritional assessment during admission. | Delirium assessment. Nutrition assessment. | | Should be admitted to an acute orthopaedic ward within 4 hours of presentation ∗ . Should be assessed and cared for to minimise risk of developing a pressure ulcer. |

BPT: Best Practice Tariff, BOAST: British Orthopaedic Association Standards for Trauma and Orthopaedics, NICE: National Institute of Health and Care, CFS: Clinical Frailty Scale, Excellence, MDT: Multidisciplinary Team, AMTS: Abbreviated Mental Test Score, NHFD: National Hip Fracture Database, 4AT: rapid assessment test for delirium.

Table source: Rogers MM, Brown R, Stanger MS. Frailty in orthopaedics: is age relevant?. Injury. 2020 Jul 15.

**Frailty and orthopaedics:**

Frailty has been linked to a higher rate of perioperative complications in older adults undergoing elective and emergency procedures, as well as a higher rate of mortality in frail patients undergoing surgery. [5, 6] Total Hip Arthroplasty (THA) and Total Knee Arthroplasty (TKA) procedures are linked to an increased risk of morbidity and mortality in the elderly. [7, 8] The need for orthopaedic surgical operations is rising as a result of the growing ageing population.

According to a recent study, demand for THA would rise by 174% to 572,000 treatments per year by 2030, while demand for TKA will rise by 673% to 3.48 million procedures per year. [9] The rising number of orthopaedic procedures performed on the elderly, the high incidence of frailty in the surgical population, and the increased risk of morbidity and death in frail older

adult surgical patients all point to the significance of a greater focus on frailty in the orthopaedic field.

**Diagnosis and screening of frailty prior to orthopaedic procedures:**

Researchers have developed the Frailty Index (FI), which consists of 44 elements, since the establishment of the Frailty Phenotype. For fragile patients undergoing major elective orthopaedic procedures such as total hip and knee replacement and lumbar, sacral, or cervical laminectomy, the FI has been demonstrated to be a beneficial metric. The FI was changed after its initial development to become the Modified Frailty Index (mFI). [10] The mFI consists of only 11 items plus information about functional status from the medical record of the patients (Figure 1). It helps to stratify patients into risk categories and predict post-operative outcomes, is an even simpler measure of frailty.

The mFI has also been shown to be an excellent risk assessment tool for both THA and TKA orthopaedic operations, as well as being easy to deploy. [11, 12] It has been demonstrated to be a better predictor of readmission, post-operative complications, re-operation, and post-operative death. The mFI has been reduced to a 5-factor mFI over the last few years (mFI-5).[13] A recent study comparing the mFI-5 to the original 11-factor mFI found it to be an equally credible predictor of frailty in all surgical subspecialties, with a correlation coefficient of above 0.9 in all cardiac and vascular surgery. [13, 14]

The 5-mFI has been demonstrated to be a powerful predictor of frailty, postoperative morbidity, and mortality in a range of operations, including primary hip and knee arthroplasty, kyphoplasty vertebral augmentation, posterior lumbar fusion, and distal radius fracture repair, in several recent investigations. Finally, while the Frailty Phenotype, FI, and 5 factor mFI are all effective for assessing and screening for frailty in patients undergoing major elective orthopaedic surgery, their levels of complicity differ. [13] The mFI-5 has the

advantage of being the most therapeutically helpful due to its simplicity (just 5 variables to measure and no need for specialist equipment).

**Figure 1: Modified frailty index [15]**

The 11-Item Modified Frailty Index[a]

| Variable, if Present in Patient History | Modified Frailty Index Variable |
|---|---|
| Diabetes mellitus—insulin and noninsulin dependent | 1 |
| Congestive heart failure | 2 |
| Hypertension requiring medication | 3 |
| History of myocardial infarction | 4 |
| Previous percutaneous coronary intervention or angina | 5 |
| History of transient ischemic attack or cerebrovascular accident without neurological deficit | 6 |
| Cerebrovascular accident with neurological deficit | 7 |
| Impaired sensorium | 8 |
| History of chronic obstructive pulmonary disease or pneumonia | 9 |
| History of peripheral vascular disease or rest pain | 10 |
| Functional health status before surgery—partially or totally dependent for activities of daily living | 11 |

[a]*Scores are calculated by adding 1 point for each variable present and then dividing this number by 11.*

Image source: Boissonneault A, Mener A, Schwartz A, Wilson J, Staley C, Schenker M. Impact of frailty on 30-day morbidity and mortality of patients with intertrochanteric femur fractures. Orthopedics. 2019 Nov 1;42(6):344-8.

**Figure 2: The 5 item modified Frailty Index [16]**

**Dis RF (Distal Radius Fracture)**

**+1 Diabetes mellitus**
**+1 Increased blood pressure requiring medication**
**+1 Status (nonindependent functional status)**
**+1 Respiratory pathology (history of COPD or pneumonia)**
**+1 Failure of heart (congestive heart failure within 30 days of surgery)**

Image source: Wilson JM, Holzgrefe RE, Staley CA, Schenker ML, Meals CG. Use of a 5-item modified frailty index for risk stratification in patients undergoing surgical management of distal radius fractures. J Hand Surg. 2018;43(8):701-9.

**Orthopaedic implications of frailty:**

Frailty has been linked to a high rate of postoperative death in previous studies. In patients undergoing surgery for pelvis and lower extremity fractures, adult spinal deformity, femoral neck fracture, primary hip arthroplasty, and primary knee arthroplasty, frailty is linked to postoperative mortality. Higher mFI scores are linked to a higher risk of post-operative death and have been proven to be a better predictor of post-operative mortality than age, obesity class, or ASA class. [17] Various studies have found a link between spine surgery, orthopaedic trauma, THA, TKA, and HA and increased post-operative mortality. In addition, fragile patients undergoing orthopaedic surgery have a higher risk of post-operative complications, duration of stay, and readmission. [18, 19]

As seen in Table 2, fragility is related with a considerable number of postoperative problems. Patients undergoing spine surgery, orthopaedic trauma, THA, TKA, and HA have a higher risk of Clavien-Dindo Class IV complications and hospital acquired diseases (surgical-site infections, pneumonia, venous thromboembolism, and urinary tract infections) when their mFI score is higher. [9]

**Table 2: 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 [9]**

| Orthopedic Surgery Type | 30-Day Mortality (% increase) | Reoperation (% 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

Source: Mamtora PH, Fortier MA, Barnett SR, Schmid LN, Kain ZN. Peri-operative management of frailty in the orthopedic patient. J Orthop. 2020;22:304-7.

**Management of frail orthopaedic patient:**

Excellent pain control, a decent sleep environment, limiting tethers, cognitive reorientation using clocks, clear communication, early mobilisation, and adequate diet have all been documented to help this group of patients improve their outcomes. It's critical to recognise and treat triggering conditions like sepsis, dehydration, electrolyte imbalance, and substance withdrawal. [17] Fast-track surgery is recommended by the European Society of Anesthesiology to prevent post-operative delirium in high-risk patients, such as the elderly. [20] Avoiding possibly inappropriate drugs such as benzodiazepines for pre-medication and monitoring anaesthesia depth to minimise excessive depth are two specific recommendations for anaesthesia management.

Referring frail patients for formal physical therapy exams, procuring assistive devices, and preparing for in-hospital and post-discharge rehabilitative therapy are all examples of functional status optimization techniques for frail patients. Pre-operative exercise programmes to promote strength and mobility, also known as pre-habilitation, have demonstrated considerable improvement in postoperative outcomes, such as decreased risk of discharge to a rehabilitation facility, improved strength, and functional capacity.

Antibiotics and routine infection control protocols should be provided and followed to prevent common post-operative infections such as respiratory, wound, and urinary tract infections. Frail patients are also more susceptible to opportunistic infections like MRSA (methicillin-resistant staph aureus) or Clostridium difficile, as well as iatrogenic disorders caused by excessive medicine, which are common in hospitals. [21] Polypharmacy and changed pharmacodynamics and kinetics can cause systemic adverse effects such as nausea, fatigue,

disorientation, anorexia, dizziness, constipation, and electrolyte imbalance, even when medicines are given appropriately. As a result, it is critical to evaluate and rationalise each medication's drug chart on a frequent basis. Regular monitoring of urea and electrolytes, weight and blood pressure, and drug charts should be monitored to avoid problems with fluid and electrolyte imbalance. [21]

**Summary:**

The demand for surgical care in older and frail patients will continue to rise as the global population ages. As a result, doctors and researchers must customise the perioperative pathway for these patients since they face distinct problems. Because there is currently no proof that frailty can be slowed or reversed, it is critical for anesthesiologists and surgeons to take prophylactic measures to halt the disease's progression. Preoperative supervised exercise programmes, early detection of frailty, prophylactic antibiotics, regular drug record review, regular monitoring of urea and creatinine, and implementing postoperative delirium prevention measures are among the preventive strategies.

Finally, more studies are needed to find innovative ways for preventing and reducing unfavourable surgical outcomes in frail patients, as well as to assess whether pre-operative optimization can effectively ameliorate postoperative outcomes through large-scale randomised controlled trials.

**References:**

1. Archibald MM, Lawless M, Gill TK, Chehade MJ. Orthopaedic surgeons' perceptions of frailty and frailty screening. BMC geriatrics. 2020; 20(1):1-1.

2. Shields E, others. Mortality and financial burden of periprosthetic fracture of the femur'. Geriatr Orthop Surg Rehabil 2014; 5.

3. Adams A, others. Physeal fractures of the distal femur. J Pediatr Orthop B 2020; 29.

4. Rogers MM, Brown R, Stanger MS. Frailty in orthopaedics: is age relevant? Injury. 2020

5. Joseph B, Zangbar B, Pandit V, Fain M, Mohler MJ, Kulvatunyou N, Jokar TO, O'Keeffe T, Friese RS, Rhee P. Emergency general surgery in the elderly: too old or too frail?. J Am Coll Surgeons. 2016; 222(5): 805-13.

6. Afilalo J, Mottillo S, Eisenberg MJ, Alexander KP, Noiseux N, Perrault LP, Morin JF, Langlois Y, Ohayon SM, Monette J, Boivin JF. Addition of frailty and disability to cardiac surgery risk scores identifies elderly patients at high risk of mortality or major morbidity. Circ Cardiovasc Qual Outcomes. 2012; 5(2): 222-8.

7. McIsaac DI, Beaule PE, Bryson GL, Van Walraven C. The impact of frailty on outcomes and healthcare resource usage after total joint arthroplasty: a population-based cohort study. Bone Jt J. 2016; 98(6): 799-805.

8. Dayama A, Olorunfemi O, Greenbaum S, Stone Jr ME, McNelis J. Impact of frailty on outcomes in geriatric femoral neck fracture management: An analysis of national surgical quality improvement program dataset. Int J Surg. 2016; 28: 185-90.

9. Mamtora PH, Fortier MA, Barnett SR, Schmid LN, Kain ZN. Peri-operative management of frailty in the orthopedic patient. J Orthop. 2020; 22:304-7.

10. Tsiouris A, Hammoud ZT, Velanovich V, Hodari A, Borgi J, Rubinfeld I. A modified frailty index to assess morbidity and mortality after lobectomy. J Surg Res. 2013; 183(1): 40-6.

11. Partridge JS, Harari D, Dhesi JK. Frailty in the older surgical patient: a review. Age Ageing. 2012; 41(2): 142-7.

12. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J. Gerontol. A Biol. Sci. Med. Sci. J. 2007; 62(7): 722-7.

13. Subramaniam S, Aalberg JJ, Soriano RP, Divino CM. New 5-factor modified frailty index using American College of Surgeons NSQIP data. J Am Coll Surgeons. 2018; 226(2): 173-81.

14. Segal DN, Wilson JM, Staley C, Michael KW. The 5-item modified frailty index is predictive of 30-day postoperative complications in patients undergoing kyphoplasty vertebral augmentation. World Neurosurg. 2018; 116: e225-31.

15. Boissonneault A, Mener A, Schwartz A, Wilson J, Staley C, Schenker M. Impact of frailty on 30-day morbidity and mortality of patients with intertrochanteric femur fractures. Orthopedics. 2019; 42(6):344-8.

16. Wilson JM, Holzgrefe RE, Staley CA, Schenker ML, Meals CG. Use of a 5-item modified frailty index for risk stratification in patients undergoing surgical management of distal radius fractures. J Hand Surg. 2018; 43(8): 701-9.

17. McIsaac DI, Beaule PE, Bryson GL, Van Walraven C. The impact of frailty on outcomes and healthcare resource usage after total joint arthroplasty: a population-based cohort study. Bone Jt J. 2016; 98(6): 799-805.

18. Runner RP, Bellamy JL, Vu CC, Erens GA, Schenker ML, Guild III GN. Modified frailty index is an effective risk assessment tool in primary total knee arthroplasty. J Arthroplasty. 2017; 32(9): S177-82.

19. JRunner RP, Bellamy JL, Vu CC, Erens GA, Schenker ML, Guild III GN. Modified frailty index is an effective risk assessment tool in primary total knee arthroplasty. J Arthroplasty. 2017; 32(9): S177-82.

20. Igwe EO, Nealon J, Mohammed M, Hickey B, Chou KR, Chen JK, Traynor V. Multi-disciplinary and pharmacological interventions to reduce post-operative delirium in elderly patients: A systematic review and meta-analysis. J Clin Anesthesia. 2020; 67: 110004.

21 Oliver D. Medical input, rehabilitation and discharge planning for patients with hip fracture: Why traditional models are not fit for purpose and how things are changing. Curr Anaesth Crit Care. 2005; 16(1):11-22.

# CHAPTER – 13

## Frailty and Abdominal Surgeries

**Background:**

Accurate patient selection is one of the most difficult aspects of surgery. Individual clinical judgment-based treatment decisions are prone to prejudice, and may result in unnecessary surgery and negative consequences. There is a constant and growing need for remedy in the general population, with often unrealistic expectations. Patients may be exposed to an excessive risk of significant postoperative morbidity and death, as well as a poor long-term prognosis, due to strong patient incentive for surgery and a lack of standardised risk assessment. In contrast, it is inappropriate to refuse to do surgery with the goal of curing patients who are deemed unfit based on broad and imprecise risk factors.[1, 2]

Despite technological developments and advancements in perioperative care, large abdominal operations continue to be associated with a high rate of severe complications, long-term impairment, and health and social expenses.[3] Furthermore, the chances of successfully saving patients from surgery-related morbidity remain uncertain. The chance of mortality following a significant complication is characterised as failure to rescue.[4, 5] Whether or not a patient can be saved after a complication is a result of the hospital's treatment, as well as its resources and facilities, but most importantly, of the patient's resilience.[6] Even when treated with the greatest available care, failure to rescue happens frequently in frail patients who lack the physiological reserve to endure serious postoperative sequelae. Frailty is a state of sensitivity to inadequate homeostasis resolution

after a stressful event.[7]

It occurs as a result of a gradual loss of function across several physiological systems, and it raises the likelihood of adverse consequences. It has recently been claimed that chronological age and comorbidity are insufficient criteria for determining whether a patient should have surgery.[8] Frailty, on the other hand, could be a more accurate and customised indicator of 'biological age'.[9] Frailty should not be thought of as an age-related condition; it can be identified in anyone with a low functional reserve for a variety of causes.

The variety of definitions and scoring methods proposed in the surgical scenario, as well as the metric complexity, may limit routine assessment and make it difficult to interpret. The scoring techniques used to evaluate frailty in surgical patients, as well as their capacity to predict unfavourable clinical outcomes, will be discussed in this chapter. The chapter's main goal is to describe the global influence of frailty on postoperative morbidity and mortality, as well as long-term mortality, in patients who have major abdominal procedures.

**Transdisciplinary Model of Care: the Ideal Model**

The transdisciplinary model of care has been developed to give smooth and outstanding care to senior patients undergoing major abdominal surgery through a patient-centered, collaborative care approach, in order to meet the complex and multidimensional needs of elderly surgical situations. [10]

With an integrated team of surgeons, anaesthetists, physicians, nurse clinicians, and allied healthcare professionals leveraging individual domain expertise in delivering the most holistic care for elderly surgical patients, the transdisciplinary model ensures consistent,

successful outcomes in elderly colorectal surgery patients. Transdisciplinary care is devoid of hierarchy, and communication is free-flowing, continuous, coordinated, and seamless, with an ongoing goal to improve. It emphasises open communication among team members, seamless evaluation, and team management of the patient rather than interdisciplinary referrals, with scheduled opportunities for talks, briefings, and debriefings, as well as central coordination by the hospitalist.

More than 83% of patients handled with this multidisciplinary approach were able to return to premorbid functional state 6 weeks following major colon resection, and more than 90% after 90 weeks, according to Alexandra Health's geriatric surgery service (GSS).[11]Following the transdisciplinary approach's success, a trans-institutional start-to-finish (STF) model was proposed, which included prehabilitation in the patients' homes in collaboration with the community or in a day rehabilitation centre, followed by postoperative rehabilitation in either the community hospital or the patients' homes.The GSS has been tracking its performance using the cumulative summation (CUSUM) methodology since its inception in 2007.[12] The occurrence of one or more of the following events: Failure was defined as

(1) Perioperative mortality,

(2) An unplanned prolonged hospital stay for any reason, including morbidity, or

(3) Failure to achieve a functional score (Barthel score) within 10% of preoperative function at 6 weeks, as indicated by an upward slope on the CUSUM curve.

A descending slope would suggest consistent success. Figure 1 shows the CUSUM curve for the GSS's performance from 2007 to 2016. The download slope reflects the transdisciplinary approach's consistent success.

Figure 1: CUSUM curve tracking performance of the geriatric surgery service. The downward sloping curve indicates consistent success, i.e., reduced occurrence of perioperative[12]

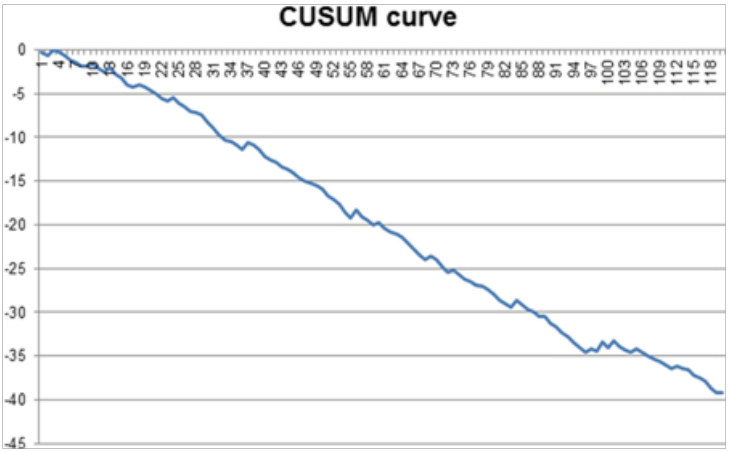



Image source: Lee DJ, Mak MH, Tan KY. Frailty in surgical preoperative evaluation and postoperative recovery. Curr Geri Rep. 2019;8(2):87-96.

**Sarcopenia and abdominal surgeries:**

The loss of muscle mass, also known as sarcopenia, can be measured in a more reproducible and objective way to determine frailty. Sarcopenia is defined as a syndrome characterised by a gradual and widespread loss of skeletal muscle mass and strength. [13]It can be thought as organ dysfunction, or skeletal muscle impairment, that develops after a prolonged period of disease or illness. Sarcopenia has been associated to falls, physical weakness and impairment, and a higher risk of mortality in older individuals who are referred to acute care units. Sarcopenia and postoperative outcomes are now the subject of a

growing amount of research. Poor surgical results have been linked to pancreatic cancer, liver tumours, colon cancer, and gastric cancer resection in studies. Therefore assessment of sarcopenia prior to any abdominal surgical procedure is of utmost importance to determine the post-operative outcome. [12]

A recent subsidiary study based on data from the National Emergency Laparotomy Audit (NELA) found 13.9% and 28.2% 30-day and 1-year mortality among the elderly, respectively.[14] Sarcopenia, as defined by psoas density and CT area, is linked to a higher risk of 30-day and 1-year death. In this study, psoas density as evaluated by CT predicted a higher likelihood of bad outcome than psoas area, implying that the quality of lean muscle mass, rather than the quantity, is more closely linked to sarcopenia and frailty. Rangel et al. observed a 32% 1-year death rate among elderly patients following emergency abdominal surgery in the United States.[15] Sarcopenia, as measured by a CT scan's total psoas index, was found to be related with 30-day mortality.[12]

**Investigative tools and abdominal surgeries:**

Because of their ability to differentiate fat from other soft tissues, computed tomography (CT) scans and magnetic resonance imaging (MRI) are regarded the gold standard for determining muscle mass. [16, 17] The cross-sectional psoas muscle index and the skeletal muscle index at L3, both adjusted for height, have previously been demonstrated to predict overall muscle mass. Jones et al evaluated image analysis using IMAGEJ software and manual CT methodology and found a significant correlation between the two methods.[18] Sarcopenic frail patients undergoing elective resection for colon cancer had a considerably greater chance of experiencing serious problems, according to his research.For elderly patients requiring major abdominal

surgery, a CT scan is usually routinely conducted prior to surgery. As a result, it is possible to estimate lean muscle mass for the aim of detecting sarcopenia at no additional cost, and it eliminates the need for additional time-consuming procedures to assess frailty. This is especially helpful in an emergency situation.

**Post-operative outcomes:**

An increased risk of adverse events is expected when a frail patient has a high-risk emergency surgery. A study by Castillo-Angeles and colleagues confirms this assumption, but also shows that frailty is linked to poorer outcomes, even following low-risk surgeries.[19] The authors discovered that patients with frailty were twice as likely to die within 30 days of discharge following low-risk emergency surgery in their examination of over 880 000 emergency general surgery procedures collected in the Medicare Inpatient Claims files (from 2007 to 2015), especially of appendectomy or cholecystectomy. This risk was substantially larger than the 53% increase in mortality risk following high-risk emergency surgery (exploratory laparotomy, lysis of adhesions, bowel resection, or peptic ulcer repair).[20]

Sandini M and coauthors used data from 35 trials with over one million participants in a meta-analysis. When compared to non-frail patients, having a frailty condition before surgery was linked to a threefold increase in long-term mortality, a sixfold increase in early postoperative death, and a more than doubled chance of significant postoperative morbidity.[21] This shows that frailty should always be assessed in patients who are scheduled for majorabdominal surgical operations before deciding whether and how to proceed.

Additionally, the prevalence of frailty among patients undergoing emergency abdominal surgery was 30.8%, according to a comprehensive review and meta-analysis by Kennedy CA and co-authors. The death rate from all causes was 15.68%. The mortality rate was 24.7% among the frail undergoing emergency general surgery. When compared to the non-frail, frailty was related with a higher mortality rate (p 0.05).[22] There is compelling evidence that frailty in the elderly predicts post-operative mortality, complications, a longer hospital stay, and loss of independence. In the perioperative pathway, collaborative working with medicine for the elderly physicians to target modifiable components of the frailty syndrome may enhance results. To improve decision-making and the development of novel postoperative methods, frailty score should be integrated into acute surgical assessment practise.

**Pre-cautions prior to abdominal surgeries:**

In order to achieve the best result, it is critical to select the appropriate treatment for the appropriate patient. The observation that frailty is a risk factor for poor surgical outcome raises the question of how to apply it. It could be used to limit access to major surgery for frail patients, albeit this is somewhat limited, given the growing number of elderly and frail patients. [23] It could allow for more individual risk assessment, discussion, and permission, as well as focused preoperative patient optimization. Wick and Finlayson's recent editorial encourages medical research to'move beyond measurement to action,' highlighting on the need to demonstrate that outcomes may be truly improved by modifying frailty components.[24]

Integrated care delivery methods, such as enhanced recovery after surgery programmes, have previously been shown to improve clinical and functional outcomes in

older and high-risk patients.Prehabilitation programmes, which include preoperative optimization of concomitant chronic illness therapy, nutritional status, physical function, and physiological support, may provide a more comprehensive and effective option in this setting, despite minimal evidence.

**Summary:**

Frailty affects more than 20% of older persons undergoing emergency laparotomies and other abdominal procedures, regardless of their age. Frailty raises the risk of postoperative mortality and morbidity in the older adult. Pre-operative frailty assessment and risk assessment, evaluation of extent of sarcopenia are the essential criteria to be considered prior to any abdominal surgical procedures. Proper pre-operative assessment along with prehabilitation and optimization can reduce the adverse surgical outcome.

**References:**

1. Revenig LM, Canter DJ, Henderson MA, Ogan K, Kooby DA, Maithel SK et al Preoperative quantification of perceptions of surgical frailty. J Surg Res 2015; 193: 583–589.

2. Symeonidis D, Christodoulidis G, Koukoulis G, Spyridakis M, Tepetes K. Colorectal cancer surgery in the elderly: limitations and drawbacks. Tech Coloproctol 2011; 15(Suppl 1): S47–S50.

3. Gianotti L, Braga M, Frei A, Greiner R, Di Carlo V. Health care resources consumed to treat postoperative infections: cost saving by perioperative immunonutrition. Shock 2000; 14: 325–330.

4. Silber JH, Romano PS, Rosen AK, Wang Y, Even□Shoshan O, Volpp KG. Failure□to□rescue: comparing definitions to measure quality of care. Med Care 2007; 45: 918–925.

5. Tamirisa NP, Parmar AD, Vargas GM, Mehta HB, Kilbane EM, Hall BL et al Relative contributions of complications and failure to rescue on mortality in older patients undergoing pancreatectomy. Ann

Surg 2016; 263: 385–391.

6. Ghaferi AA, Birkmeyer JD, Dimick JB. Variation in hospital mortality associated with inpatient surgery. N Engl J Med 2009; 361: 1368–1375.

7. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet 2013; 381: 752–762.

8. Robinson TN, DS Wu, Pointer L, Dunn CL, Cleveland JC Jr, Moss M. Simple frailty score predicts postoperative complications across surgical specialties. Am J Surg 2013; 206: 544–550.

9. Cesari M, Prince M, Thiyagarajan JA, De Carvalho IA, Bernabei R, Chan P et al Frailty: an emerging public health priority. J Am Med Dir Assoc 2016; 17: 188–192.

10. Tan K-Y, Tan P, Tan L. A collaborative transdisciplinary "geriatric surgery service" ensures consistent successful outcomes in elderly colorectal surgery patients. World J Surg. 2011;35(7):1608–14.

11. Wang Z, Tan K-Y, Tan P. Functional outcomes in elderly adults who have undergone major colorectal surgery. J Am Geriatr Soc. 2013;61(12):2249–50.

12. Lee DJ, Mak MH, Tan KY. Frailty in surgical preoperative evaluation and postoperative recovery. Curr Geri Rep. 2019; 8(2): 87-96.

13. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. Sarcopenia: European consensus on definition and diagnosis: report of the EuropeanWorking Group on Sarcopenia in Older People. Age Ageing. 2010;39(4):412–23.

14. Trotter J, Johnston J, Ng A, Gatt M, MacFie J, McNaught C. Is sarcopenia a useful predictor of outcome in patients after emergency laparotomy? A study using the NELA database. Ann R Coll Surg Engl. 2018;100(5):377–81.

15. Rangel EL, Rios-Diaz AJ, Uyeda JW, Castillo-Angeles M, Cooper Z, Olufajo OA, et al. Sarcopenia increases risk of long-term mortality in elderly patients undergoing emergency abdominal surgery. J Trauma Acute Care Surg. 2017;83(6):1179–86.

16. Shen W, Punyanitya M, Wang Z, Gallagher D, St-Onge M-P, Albu J, et al. Total body skeletal muscle and adipose tissue volumes:

estimation from a single abdominal cross-sectional image. J Appl Physiol. 2004;97(6):2333–8.

17. Mourtzakis M, Prado CMM, Lieffers JR, Reiman T, McCargar LJ, Baracos VE. A practical and precise approach to quantification of body composition in cancer patients using computed tomography images acquired during routine care. Appl Physiol Nutr Metab. 2008;33(5):997–1006.

18. Jones KI, Doleman B, Scott S, Lund JN,Williams JP. Simple psoas cross-sectional area measurement is a quick and easy method to assess sarcopenia and predicts major surgical complications. Color Dis. 2015;17(1):O20–6.

19. Castillo-Angeles M, Cooper Z, Jarman MP, Sturgeon D, Salim A, Havens JM. Association of frailty with morbidity and mortality in emergency general surgery by procedural risk level. JAMA Surg. 2021;156(1):68-74.

20. Kazaure HS, Lidsky ME, Lagoo-Deenadayalan SA. If the Patient Is Frail, Emergency Abdominal Surgery Is High Risk. JAMA Surg. 2021;156(1):74-5.

21. Sandini M, Pinotti E, Persico I, Picone D, Bellelli G, Gianotti L. Systematic review and meta-analysis of frailty as a predictor of morbidity and mortality after major abdominal surgery. BJS open. 2017; 1(5): 128-37.

22. Kennedy CA, Shipway D, Barry K. Frailty and emergency abdominal surgery: A systematic review and meta-analysis. Surgeon. 2021.

23. Walston J, Hadley EC, Ferrucci L, Guralnik JM, Newman AB, Studenski SA et al Research agenda for frailty in older adults: toward a better understanding of physiology and etiology: summary from the American Geriatrics Society/National Institute on Aging Research Conference on Frailty in Older Adults. J Am Geriatr Soc 2006; 54: 991–1001.

24. Wick EC, Finlayson E. Frailty – going from measurement to action. JAMA Surg 2017; 152: 757–758.

# CHAPTER – 14

## Frailty and Cardio-thoracic Surgery

**Background:**

Age over 70 years has been deemed to be a significant risk factor for mortality and morbidity in cardiac surgery in the past.[1] With the rising popularity of minimally invasive procedures for patients considered unsuitable for open surgery, the number of elderly people presenting for cardiac intervention is likely to climb in the coming years.[2,3] In recent years, biologic age, rather than chronological age, has emerged as a concept that may explain the variation in outcomes seen in senior patients after heart surgery and aid in the identification of susceptible elderly individuals who will benefit from novel intervention strategies.[4]

Although chronological age is integrally connected to frailty, it should not be used as the only indicator of surgical vulnerability or treatment futility. Frailty can also affect younger individuals. Frailty was found to be prevalent in those aged 18 to 34 years, 4% to 6% in those aged 35 to 49 years, 7% to 12% in those aged 50 to 64 years, and 8% to 20% in those aged 65 years, according to the Canadian Health Measures Study.[5] Because obese patients have greater metabolic reserve and can cope better with catabolic stimuli encountered in chronically advanced heart failure and acutely in cardiac surgery, we tend to link frailty with a low BMI.The "obesity paradox" is a term used to describe this situation.[6] Obese persons, however, can also be feeble, a condition known as "sarcopenic obesity".[7]

In-hospital mortality and significant morbidity are higher in frail patients, as are rates of institutional discharge and mid-term survival after cardiac surgery.There is now

adequate evidence to support the idea that frailty is a risk factor for poor cardiac outcomes. These patients must be pre-operatively assessed and the frailty score must be considered during treatment planning.

**Risk scoring in cardiac patients:**

The European System of Cardiac Operative Risk Evaluation (EuroSCORE) and the Society of Thoracic Surgeons (STS) score are routinely used to estimate cardiac surgical operative risk.[8, 9] Both of these scoring systems, on the other hand, ignore the patient's heightened physiologic susceptibility as a result of factors other than standard medical diagnosis and comorbidities. It has been proven that the EuroSCORE underestimates mortality at higher score levels of >13 and overestimates mortality at lower score levels of <6. [10]

Sündermann et al. proposed a Comprehensive Assessment of Frailty (CAF) score that took into account physical capacity, patient profile, Fried criteria, and laboratory results (Table 1).[11] The CAF score, as well as the EuroSCORE and STS scores, had a strong connection with observed 30-day mortality (area under receiver operating characteristic [ROC] curve 0.71).The CAF score, on the other hand, takes 10 to 20 minutes to complete, requires special equipment to measure grip strength, and may not be viable to include in a typical preoperative cardiac evaluation.[12] The CAF score was condensed into the simplified FORECAST (Frailty predicts mortality One year after Elective Cardiac Surgery test) score by the same authors, which incorporates the most highly predictive components of the CAF score and takes only 3 to 5 minutes to complete.

The FORECAST score outperformed the STS and EuroSCORE scores in predicting 1-year mortality risk (area under the ROC curve 0.76 vs. 0.67 and 0.67, respectively, for STS and EuroSCORE).[13] Afilalo et al. showed that

integrating frailty, disability, and risk scores offers a more complete method to predicting mortality or significant morbidity in older patients undergoing heart surgery.[14] When frailty and disability measurements were added to the model, it improved discrimination compared to using only the Parsonnet or STS scores (area under the ROC curve 0.73-0.76 v 0.68-0.72).[15]

Table 1
Comprehensive Assessment of Frailty Score

| | |
|---|---|
| Fried Scale[26] | Unintentional weight loss |
| | Grip strength |
| | Endurance (ie, self-reported exhaustion using the Centre for Epidemiological Studies Depression Scale) |
| | Gait speed |
| | Physical activity (evaluation of 18 activities from the Minnesota Leisure Time Physical Activity Questionnaire) |
| Modified Physical Performance Test[27] | Standing static balance |
| | Chair rise |
| | Put on and remove a jacket |
| | Pick up a pen from the floor |
| | Turn 360 degrees |
| Clinical Frailty Scale[28] | Score from 1-7 determined by individual scoring the test (ranges from 1 [robust health]) to 7 [complete functional dependence on others]) |
| Laboratory values | Serum albumin |
| | Forced expiratory volume in 1 s |
| | Serum creatinine |
| Body mass index score | < 18.5 in females and 19.5 in males |

Table adapted from Frailty inCardiacSurgery Li YingKoh[16]

Mobility assessment using gait speed appeared to be the most sensitive single component of the frailty assessment in predicting post-discharge institutionalisation, disability, morbidity, and mortality, according to a systematic review by Kim et al examining frailty instruments for major and minimally invasive cardiac surgical procedures.[4] Multicomponent frailty indexes may improve these instruments' sensitivity in forecasting risk outcomes,

albeit at the cost of time and money. The Mini Mental State Examination, Katz Index of Independence in Activities of Daily Living, and Mini Nutritional Assessment, respectively, are used to test cognition, disability, and nutritional status.[17]

However, because these investigations are primarily single-center studies and the components assessed are quite heterogeneous, the biggest disadvantage of these frailty assessment tool studies is their lack of application to the broader cardiac surgery population. In their most recent edition of the adult cardiac surgery database, the Society of Thoracic Surgeons has incorporated 5-m gait speed as a diagnostic of frailty (Version 2.73). [18] The inclusion of a single, readily measured frailty metric is a step in the right direction, but it is not sufficient and does not represent the real impact of frailty on individual patient scores. Increased integration of frailty assessment into clinical databases and clinical risk scores for cardiac surgery patients will provide surgeons and their patients with critical risk information and aid in shared decision-making, as well as provide health economists with data to plan healthcare costs.

With the ageing cardiac surgery demographic, registries must contain frailty indicators to allow longitudinal monitoring of outcomes following intervention decisions in the frail older adult. Clinical trials must also collect frailty measures in order to spark comparative effectiveness research that compares the risks and benefits of therapies in frail versus non-frail patients. The goal is to ensure that patients not only survive but also thrive following cardiac surgery, with a good health-related quality of life and functional independence.A consensus on a precise and objective frailty scoring system has yet to be reached, and this is an area where more research is needed.

**Frailty and cardiac surgery:**

A prospective study by Lee et al. is one of the largest studies to assess frailty in cardiac surgery patients.[19] Frailty and clinical data were collected from 3,826 patients in one centre, including emergency and elective cardiac surgery cases. The Katz Index of Independence in Activities of Daily Living, an evaluation of independence in ambulation, and the presence or absence of dementia were all used to determine frailty. [20] Frailty was discovered in 4.1% of these patients, putting them at an elevated risk of in-hospital mortality, institutional discharge, and lower mid-term survival. These impacts of frailty were shown to be age-independent, according to the investigators.In a prospective cohort of 15,171 patients undergoing cardiac surgery (coronary artery bypass grafting [CABG] or valve surgery), Afilalo et al found similar results. In their investigation, a single measure of frailty, 5-m walking speed, independently predicted surgical mortality and the composite outcome of mortality or significant morbidity.[1]

The CAF score was applied to 400 patients aged 74 and older who were undergoing CABG or valve surgery, including transcatheter aortic valve implantation (TAVI).[13,21] The median CAF score of patients who died within a year was 16 (5-33) compared to 11 (3-33) for survivors. Patients who were not frail had a 4-percent 30-day mortality rate, compared to 8% and 26% for moderately and extremely frail patients, respectively. Despite significant variation in the frailty and post-operative outcomes criteria utilised in these studies, there is compelling evidence for a link between frailty and poor outcomes in heart surgery.[22]

Frailty appears to have negative consequences for advanced heart failure patients undergoing surgery to implant a left ventricular assist device. According to a recent systematic analysis, frail patients had a considerably longer time to extubation when their hospital stay was longer. Even though frailty did not predict short-term mortality, it did predict long-term mortality in this group of patients.[23]

Overall, a frail patient tends to have poor post-

operative outcome, however, the extent of post-operative complication depends upon the severity of the condition and the type of surgical procedure (Figure 1).

**Figure 1: Three-strikes model of frailty and outcome of cardiac surgery[24]**

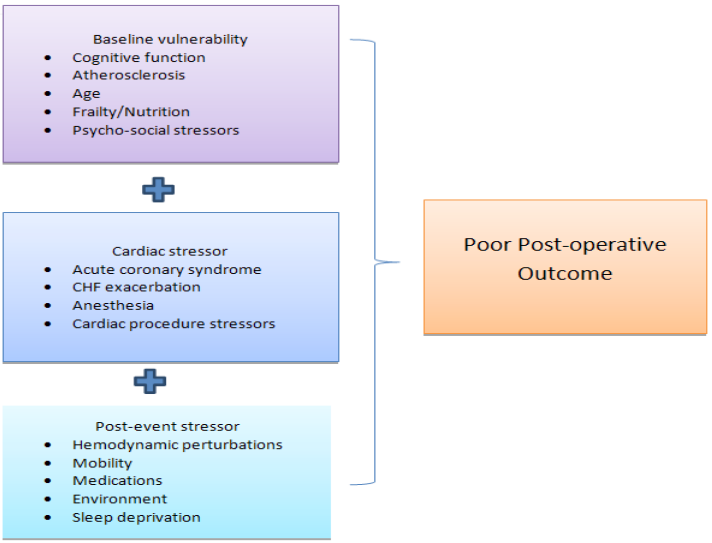



Image source: Arora RC, Djaiani G, Rudolph JL. Detection, prevention, and management of delirium in the critically ill cardiac patient and patients who undergo cardiac procedures. Can J Cardiol. 2017;33:80-7

**'Defrailing' the patients prior to cardiac surgeries:**

Aside from frailty tests, identifying at-risk frail persons, and weighing risk versus benefit in these patients, it's important to think about how frail patients might be better prepared for their surgery. Identification of frailty in elective patients may prompt the start of preoperative rehabilitation, or 'prehab' (Figure 2). A small pilot randomised controlled trial of prehab versus standard care, including exercise and education classes for 60 minutes/day, twice weekly for at least 4 weeks

versus standard care, was conducted for patients undergoing coronary artery bypass grafting and valvular surgery, building on the work of Arthur and colleagues.Although there were no changes in key clinical outcomes, participants in the prehab group had better walk distance and gait speed than those in the standard care group and were more likely to engage in cardiac rehabilitation.[25]

**Figure 2: Infographic regarding frailty in the cardiac surgical setting[26]**

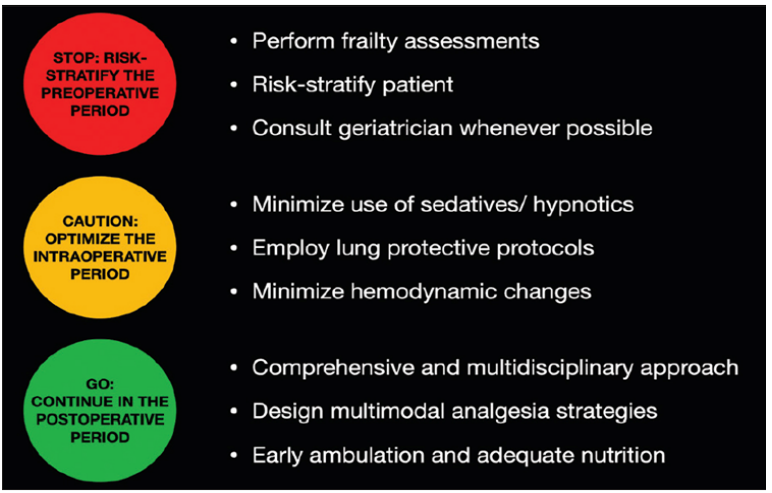



**Image source:** Shanker A, Upadhyay P, Rangasamy V, Muralidhar K, Subramaniam B. Impact of frailty in cardiac surgical patients—Assessment, burden, and recommendations. Ann Cardiac Anaesth. 2021; 24(2): 133.

**Interdisciplinary team for frail patients:**

Major practice guidelines in cardiology and cancer treatment, among other professions, have expressed interest in and support for the notion of Interdisciplinary Team–based care. A geriatrics consult for elective patients could assist identify vulnerable individuals, improve reversible frailty-related

preoperative patient features, and enable the team deliver better postoperative care for such patients. Physiotherapists, dietitians, and social workers may also be important components of the interdisciplinary team.[25]

**Summary:**

Frailty is linked to a number of negative outcomes, including increased hospital length of stay, use of medical resources, readmission rates, and mortality. In the management of frail cardiac surgery patients, prehabilitation may play a bigger role. Because the prevalence of frailty among cardiac surgery patients is expected to rise, multicenter trials to investigate management and therapy alternatives are needed. Until those trials are completed, high-volume surgical hospitals with competence in the management of frail patients may be the best option for frail heart surgery patients.

**References:**

1. Afilalo J, Eisenberg MJ, MorinJF ,etal. Gait speed as an incremental predictor of mortality and major morbidity in elderly patients undergoing cardiac surgery. J Am Coll Cardiol 2010; 56: 1668–76.

2. Benjamin EJ, Blaha MJ, Chiuve SE, etal. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2017 update :A report from the American Heart Association. Circulation. 2017;135:146–603.

3. Afilalo J, KimS, O'Brien S, etal. Gait speed and operative mortality in older adults following cardiac surgery. JAMA Cardiol 2016; 1: 314–21.

4. Kim DH, KimCA, PlacideS, etal. Preoperative frailty assessment and outcomes at 6 months or later in older adults undergoing cardiac surgical procedures. Ann Intern Med. 2016;165:650–60.

5. O'Neill DE, Knudtson ML, Kieser TM, Graham MM. Considerations in cardiac revascularization for the elderly patient: age isn't everything. Can J Cardiol. 2016;32:1132-9.

6. Lavie CJ, Alpert MA, Arena R, Mehra MR, Milani RV, Ventura HO.

Impact of obesity and the obesity paradox on prevalence and prognosis in heart failure. JACC Heart Fail. 2013;1:93-102.

7. Zamboni M, Rossi AP, Corzato F, Bambace C, Mazzali G, Fantin F. Sarcopenia, cachexia and congestive heart failure in the elderly. Endocr Metab Immune Disord Drug Targets. 2013;13:58-67.

8. Lebreton G, Merle S, Inamo J,etal. Limitations in the inter-observer reliability of EuroSCORE: What should change in EuroSCOREII? Eur J Cardiothorac Surg 2011; 40: 1304–8.

9. Shahian DM, O'Brien SM, Filardo G,et al. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: Part1—coronary artery bypass grafting surgery. Ann Thorac Surg. 2009; 88: 2–22.

10. Gogbashian A, Sedrakyan A, Treasure T. EuroSCORE: A systematic review of international performance. Eur J Cardiothorac Surg. 2004; 25: 695–700.

11. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: Evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56:M146–56.

12. Rowe R, Iqbal J, Murali-Krishnan R, et al. Role of frailty assessment in patients undergoing cardiac interventions. Open Heart. 2014;1:e000033

13. Sündermann S, Dademasch A, Rastan A, et al. One-year follow-up of patients undergoing elective cardiac surgery assessed with the Comprehensive Assessment of Frailty test and its simplified form. Interact Cardiovasc Thorac Surg. 2011;13:119–23.

14. Afilalo J, Mottillo S, Eisenberg MJ, etal. Addition of frailty and disability to cardiac surgery risk scores identifies elderly patients at high riskof mortality or major morbidity. Circ Cardiovas Qual Outcomes. 2012;5: 222–8.

15. Parsonnet V, Dean D, Bernstein AD. A method of uniform stratification of risk for evaluating the results of surgery in acquired adult heart disease. Circulation. 1989;79:1.3–12.

16. Koh LY, Hwang NC. Frailty in cardiac surgery. J Cardiothorac Vasc Anesth. 2019; 33(2): 521-31.

17. Stortecky S, Schoenenberger AW, Moser A, et al. Evaluation of multi-dimensional geriatric assessment as a predictor of mortality and cardiovascular events after transcatheter aortic valve implantation. JACC Cardiovasc Interv. 2012;5:489–96.

18. Shahian DM, Jacobs JP, Badhwar V, Kurlansky PA, Furnary AP,

Cleveland Jr JC, Lobdell KW, Vassileva C, von Ballmoos MC, Thourani VH, Rankin JS. The Society of Thoracic Surgeons 2018 adult cardiac surgery risk models: part 1—background, design considerations, and model development. The Annals of thoracic surgery. 2018 May 1;105(5):1411-8.

19. Lee DH, Buth KJ, Martin BJ, et al. Frail patients are at increased risk for mortality and prolonged institutional care after cardiac surgery. Circulation. 2010;121:973–8.

20. Katz S. Assessing self-maintenance: Activities of daily living, mobility, and instrumental activities of daily living. J Am Geriatr Soc. 1983;31: 721–7.

21. Sündermann S, Dademasch A, Praetorius J, et al. Comprehensive assessment of frailty for elderly high-risk patients undergoing cardiac surgery. Eur JCardiothoracSurg2011;39:33–7.

22. Mejía OAV, SáM PBO, Deininger MO, et al. Off-pump versus on-pump coronary artery bypass grafting in frail patients: Study protocol for the FRAGILE multicentre randomized controlled trial. Braz J Cardiovasc Surg. 2017;32:428–34.

23. Tse G, Gong M, Wong SH, et al. Frailty and clinical outcomes in advanced heart failure patients undergoing left ventricular assist device implantation: A systematic review and meta-analysis. J Am Med Dir Assoc. 2018;19: 255–61.

24. Arora RC, Djaiani G, Rudolph JL. Detection, prevention, and management of delirium in the critically ill cardiac patient and patients who undergo cardiac procedures. Can J Cardiol. 2017;33:80-7

25. Yanagawa B, Graham MM, Afilalo J, Hassan A, Arora RC. Frailty as a risk predictor in cardiac surgery: beyond the eyeball test. J Thorac Cardiovasc Surg. 2018; 156(1): 172-6.

26. Shanker A, Upadhyay P, Rangasamy V, Muralidhar K, Subramaniam B. Impact of frailty in cardiac surgical patients—Assessment, burden, and recommendations. Ann Cardiac Anaesth. 2021; 24(2): 133.

# CHAPTER – 15

## Frailty and Laparoscopic Surgery

**Background:**

As there is an increase in world's aging populations, emergency abdominal surgery for acute abdomen in the elderly has become a worldwide problem. The profile of emergency abdominal surgery has changed as a result of demographic shifts, with common causes of acute abdomen among the elderly including acute cholecystitis, incarcerated hernia, intestinal blockage, and appendicitis. Recovery from surgery is generally difficult in older patients, resulting in lengthier hospital stays than in younger people. In the emergency room, laparoscopy is well-established and has a variety of advantages over open surgery, including lower postoperative discomfort, hospital stay, and complication rates.While laparoscopic surgery for acute diverticulitis has grown more common, laparotomy is still utilised in roughly 70% of cases for other disorders such as small intestinal blockage and perforated peptic ulcer. Furthermore, despite the critical need for information on surgical treatment of acute abdomen in the elderly, there is still a paucity of evidence in this subject. [1]

Since the invention of diagnostic laparoscopy in the 1960s, laparoscopic surgery has been successfully employed for abdominal surgeries. At the beginning of the 1980s, the pioneers of laparoscopic surgery, Semm K and Muehe E, moved it from a diagnostic to a surgical operation, and it has since become a widely used method for a variety of purposes.[2] The treatment has established the gold standard for a variety of organ systems, including the reproductive (especially gynaecological) and digestive systems (as for cholecystectomy). Laparoscopic surgery has become safe and

viable in a variety of medical sectors thanks to significant advancements in surgical training, as well as breakthroughs in instruments, imaging, and surgical procedures.[3]

Due to concerns about prolonged surgical time, higher technical challenge, increased pneumoperitoneum-related physiologic demands, and patient posture, the utility of laparoscopic surgery in the medically unfit patient has been questioned. There is considerable debate on the safety of minimally invasive abdominal surgery in elderly patients, as some studies have found an increased risk of problems, while others have found laparoscopic surgery to be a safe treatment even in the elderly. As a result, whether open or laparoscopic colorectal surgery is indicated in frail older patients is still debatable.[3]

The impact of frailty on outcomes after laparoscopic surgery is poorly understood. It's unclear whether the growing technical and physiological demands of laparoscopic surgery offset the advantages of a minimally invasive procedure. The purpose of this chapter is to discuss the impact of frailty on laparoscopic operations and the surgical outcomes.

**Evidence based assessment of impact of frailty on laparoscopic surgery outcome:**

Palmer et al documented the prevalence of frailty in older adults undergoing emergency laparotomy and explored the relationships between frailty and postoperative morbidity and mortality.According to the findings, one-fifth of elderly persons who require an emergency laparotomy were frail. Frailty was linked to a higher risk of postoperative mortality and morbidity, and it is independent of age. To improve decision-making and the development of novel postoperative methods, the authors suggested that frailty score should be integrated into acute surgical assessment practice. [4]

The role of laparoscopy in fragile patients undergoing colorectal surgery for colorectal cancer was investigated by Ho B and co-authors.[5] An examination of the American College of Surgeons National Surgical Quality Improvement Program

database from 2011 to 2014 was conducted to identify frail patients who underwent colorectal cancer resection (using a frailty index). 30-day mortality and Clavien–Dindo grade IV (CD-IV) sequelae were assessed using univariable and multivariable models. There were 52,087 colorectal cancer patients identified, with frailty accounting for 2.63% (index score 5). Patients beyond the age of 85 were labelled frail 6.8% of the time, accounting for 24.5% of all frail patients. In 32.9% and 53.1% of patients with and without frailty, respectively, laparoscopic surgery was conducted. Patients with fragility were less likely to die within 30 days of surgery if they were younger, had the procedure done on their own, or had it done laparoscopically. On multivariate analysis, laparoscopy and elective surgery were linked to greater perioperative survival, whereas 30-day mortality was linked to older age, male sex, and tobacco use.

The study concluded that Clavien–Dindo grade IV problems were shown to be less common with laparoscopy and a lower BMI.Although laparoscopy is less common in the elderly, this study found that individuals over the age of 85 who had elective surgery had superior perioperative results.[5]

Mosquera C and co-authors did a retrospective study to understand the influence of frailty on postoperative outcomes for laparoscopic and open colectomy.[6]Patients undergoing colon resection [open colectomy (OC) and laparoscopic colectomy (LC)] were studied using data from the National Surgical Quality Improvement Program (2005-2012).

A total of 94811 individuals were identified, with the majority undergoing OC (58.7%), being white (76.9%), and not being fragile (44.8%). Longer lengths of stay (LOS) occurred in 4.7% of cases, with a 2.28% 30-day death rate.[6] Patients who had OC were older and had a higher ASA score than those who did not. Patients undergoing OC had considerably higher rates of complications, longer LOS, and mortality. For all frailty ratings, OC had a greater risk of death and comorbidities than LC, as well as an increase in absolute mortality with increasing frailty.

The study concluded that LC has been linked to better outcomes. Despite the fact that non-frail people have a higher risk of death, mortality rates rise as frailty increases. [6]

A 2-year follow-up examination of frail elderly patients treated with immediate surgical intervention was undertaken by Zese M et al.[7] The study included 120 individuals over the age of 65 who had surgical abdominal crises. The study took into account co morbidities, operation type (laparoscopy, laparotomy, or converted), frailty score, mortality, and complications at 30 days and 2 years. They came to the conclusion that death was highly dependent on the type of surgery (laparotomy vs. laparoscopy), recovery difficulties, and a lower Fried frailty criterion score on average.

The study's long-term follow-up can be considered a useful tool for highlighting a safer surgical strategy in frail elderly patients, such as laparoscopy. In emergency cases, the authors believed the laparoscopic method is possible, with similar or better outcomes than laparotomy, especially in frail elderly patients.[7]

As a less intrusive procedure, laparoscopic gastrectomy (LG) may offer more clinical benefits for elderly patients; nevertheless, there is still no evidence to support this claim. In a countrywide prospective cohort study, Honda M et al looked at the surgical outcomes of elderly patients. A total of 8827 patients were enrolled in the study. 161 (10.9%) of patients who had an open gastrectomy (OG) and 98 (7.2%) of patients who had a laparoscopic gastrectomy (LG) experienced grade 3 problems. [8]

The authors demonstrated that laparoscopic surgery was not an independent risk factor after correcting for confounding factors. In comparison to LG, OG was linked with a considerably longer median length of postoperative stay (16 versus 12 days). Other postoperative comorbidities were not found to be significantly different.The study demonstrated the safety of LG in elderly patients. Furthermore, the authors concluded that LG shortened the length of postoperative hospital stay.[8]

**Clinical implications of frailty for Clinicians:**

All older persons undergoing an emergency laparotomy should have their frailty status evaluated prior to surgery to help with complex decision-making and perioperative care. Few of the existing prognostic scores are simple to grasp for the patient and their family, which could make shared decision-making difficult. [9, 10]Frailty, on the other hand, is a concept that many people are familiar with. This foundational knowledge could help patients and their families better comprehend not only the chances of dying during surgery, but also the dangers of substantial life-altering consequences and a lengthy and difficult recovery. The fragility score could lead to tailored perioperative paths once the decision to have surgery has been made. Patients with Clinical Frailty Score (CFS) 4–7, for example, had the highest chance of death, therefore early participation and assessment by critical care might help with postoperative planning. During the first several days after surgery, critical care and surgeons focus on on-going treatment for the initial pathology (example: sepsis, renal support, ventilator support, wound management).

This could be improved by collaborating with geriatricians and using the Comprehensive geriatric assessment (CGA), with the goal of preventing frailty-related complications, such as protecting muscle mass[11, 12] (early mobility or movement whether on or off a ventilator); maintaining respiratory capacity (timed regular physiotherapy); and maintaining nutrition and energy balance (parental or enteral). [13, 14] In contrast, a patient with CFS 3 may only need to be in critical care for a brief time before continuing with focused rehabilitation recommended by a hospitalist or geriatrician and overseen by surgical ward nurses. This modified emergency laparotomy CGA allows for tailored training in surgical and geriatric curricula, allowing for multidisciplinary perioperative care.[12,15]

**Figure 1: Scatterplot displaying the relationship between frailty and 90-day mortality in older adults undergoing emergency laparotomy.**

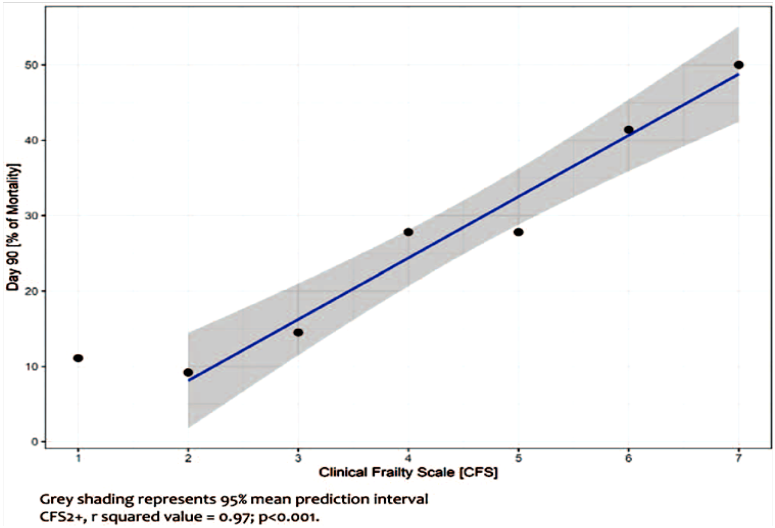



Image source: Parmar KL, Law J, Carter B, Hewitt J, Boyle JM, Casey P, et al. Frailty in older patients undergoing emergency laparotomy: results from the UK observational emergency laparotomy and frailty (ELF) study. Ann Surgery. 2021;273(4):709-18.[4]

**Summary:**

Frailty is evident in 20% of older persons who have an emergency laparotomy, regardless of age.[4] Frailty raises the risk of postoperative mortality and morbidity in the older adult. Several studies back the inclusion of preoperative frailty assessment and emphasise the urgent need to find novel postoperative treatments to enhance outcomes for this high-risk category of patients. Furthermore, long-term randomised clinical trials are needed to prove that laparoscopic surgery is superior to open surgery for treating abdominal problems.

**References:**

1. Agresta F, Podda M, Campanile FC, Bergamini C, Anania G. Emergency laparoscopic surgery in the elderly and frail patient.Springer Nature, Switzerland AG, 2021.

2. Reynolds W Jr. The first laparoscopic cholecystectomy.JSLS. 2001; 5(1):89-94.

3. Buia A, Stockhausen F, Hanisch E. Laparoscopic surgery: a qualified systematic review. World J Methodol. 2015;5(4):238.

4. Parmar KL, Law J, Carter B, Hewitt J, Boyle JM, Casey P, et al. Frailty in older patients undergoing emergency laparotomy: results from the UK observational emergency laparotomy and frailty (ELF) study. Ann Surgery. 2021;273(4):709-18.

5. Ho B, Lewis A, Paz IB. Laparoscopy can safely be performed in frail patients undergoing colon resection for cancer. The American Surgeon. 2017;83(10):1179-83.

6. Mosquera C, Spaniolas K, Fitzgerald TL. Impact of frailty on approach to colonic resection: Laparoscopy vs open surgery. World J Gastroenterol. 2016;22(43):9544.

7. Zese M, Finotti E, Cestaro G, Cavallo F, Prando D, Gobbi T, Zese R, Di Saverio S, Agresta F. Emergency Surgery in the Elderly: Could Laparoscopy Be Useful in Frailty? A Single-Center Prospective 2-Year Follow-Up in 120 Consecutive Patients. Surgeries. 2021;2(1):119-27.

8. Honda M, Kumamaru H, Etoh T, Miyata H, Yamashita Y, Yoshida K, Kodera Y, Kakeji Y, Inomata M, Konno H, Seto Y. Surgical risk and benefits of laparoscopic surgery for elderly patients with gastric cancer: a multicenter prospective cohort study. Gastric Cancer. 2019;22(4):845-52.

9. Smith AK, Williams BA, Lo B. Discussing overall prognosis with the very elderly. N Engl J Med. 2011;365:2149–2151.

10. Reaslising Realistic Medicine. Catherine Calderwood, Chief Medical Officer, Scotland. Available at: https://beta.gov.scot/news/realising-realistic-medicine/.Accessed May 22, 2019.

11. The National Emergency Laparotomy Audit (NELA). Available at: www.nela.org.uk.Accessed May 22, 2019.

12. Pearce L, Bunni J, McCarthy K, et al. Surgery in the older person:

training needs for the provision of multidisciplinary care. Ann R Coll Surg Eng. 2016;98:367–370.

13. The High-Risk general Surgical Patient: Raising the Standard. The Royal College of Surgeons of England Updated Recommendations on the Perioperative Care of the High-Risk General Surgical Patient, 2018. Available at: https://www.rcseng.ac.uk/news-and-events/media-centre/press-releases/highrisk- general-surgical/.Accessed May 22, 2019.

14. Oliver DM, Bassett MG, Poulton TE, et al. Organisational factors and mortality after an emergency laparotomy: multi-level analysis of 39 903 National Emergency Laparotyotmy Audit patients. BJA. 2018;1346–1356.

15. Barbas AS, Haney JC, Henry BV, et al. Development and implementation of a formalized geriatric surgery curriculum for general surgery residents. Gerontol Geriatr Educ. 2014;35:380–394.

# CHAPTER – 16

## Frailty and Brain Surgery

**Background:**

The judgement of whether a patient would endure a surgical procedure is usually subjective, based on the surgeon's anecdotal experience and the patient's wishes. This is especially true in people who are at higher risk, such as the elderly or those who have many comorbidities. There are few standardised, easily reproducible techniques for predicting postoperative outcomes, particularly in brain tumour patients.[1-3] Because physicians' perceptions of life expectancy differ significantly, relying solely on anecdotal information is insufficient. Although cognitive impairments have been associated to poor outcomes in older patients and patients with brain tumours, the most generally used measures to estimate preoperative risk do not account for a patient's physiologic reserve, instead focusing on existing abnormalities of discrete organ systems.[2, 5-7]

To aid in preoperative decision-making, surgeons require a standardised, verified preoperative risk assessment tool. Over the last two decades, geriatricians' research has led to a better understanding of frailty as a clinical entity.[2, 8] Frailty has been associated to a higher risk of poor outcomes in medical and surgical patients, including impairment, dementia, falls, hospitalisation or institutionalization; longer hospital stays, and increased mortality.[9] Makary et al introduced the Hopkins Frailty Score(HFS) to find a standardised, proven preoperative risk assessment tool for surgical patients (Table 1).[8] The HFS was tested on a diverse group of individuals who had major and minor general, neurologic, and urologic operations. This score was later confirmed in a group of older patients who had undergone similar general, neurologic

surgery and urological procedures. [2]

**Table 1: Hopkins Frailty score[8]**

| Criterion | Description |
|---|---|
| Shrinking | Determined by asking the patients their current weight and their weight 1 year ago. Patients who report unintentional weight loss of >10lb (> 4-5 kgs) in the last year were considered frail |
| Exhaustion | Determined by asking 2 questions from the CES-D scale.<br><br>1. How often in the last week did you feel this way? 2. Did you feel that whatever you did was an effort or could not get going? Patients who felt either way for >3 days in the past week was considered frail |
| Physical activity | The short version of the Minnesota leisure Time Activity questionnaire was used to assess frequency of physical activities. Physical activity was converted to kilocalories per week expended using a standardized algorithm (number of days physical activity took place in the past 2 weeks × duration of activity in minutes × number of kilocalories expended per minute. Men who expended <383 Kcal/week and women who expended <270Kcal/week were considered frail |
| Walking speed | Patients were timed while walking 15 feet (4.5 meters). Men who were <173 cms and required >7seconds or >173 cms and required 6 seconds were considered frail. Women who were <159 cms and required >7 seconds or who were >159 cms and required >6 seconds were considered frail |
| **Grip strength** | **Criteria for grip strength** |

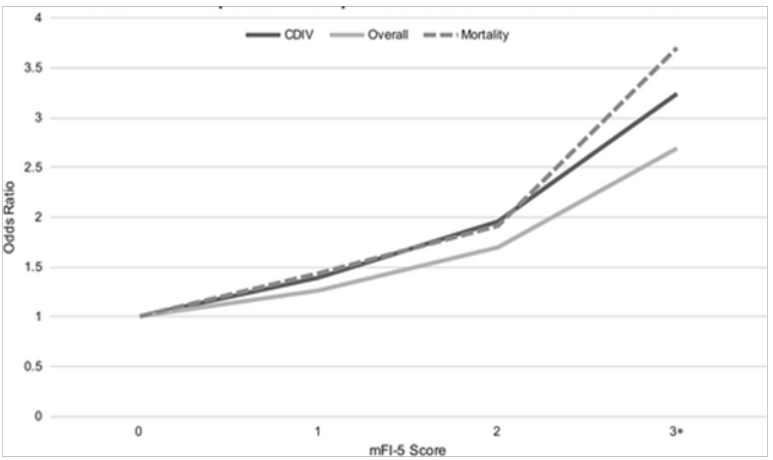
| | |
|---|---|
| Men<br><br>BMI ≤24.0<br><br>BMI =24.1-28.0<br><br>BMI >28.0 | <br><br>≤29<br><br>≤30<br><br>≤32 |
| M=Women<br><br>BMI ≤23.0<br><br>BMI =23.1-26.0<br><br>BMI =26.1-29.0<br><br>BMI >29.0 | <br><br>≤17<br><br>≤17.3<br><br>≤18<br><br>≤21 |
| The output is a single score that is automatically generated, providing a classification of either frail (score 3-5), pre-frail (score 1 or 2) or robust (score 0). | |

**Frailty and brain surgery:**

Global fertility decreases and improvements in life expectancy have spurred a "demographic transition" in the world's age distribution in recent decades.[10] The repercussions of this transition are already being felt in the world of neuro-oncology, as incidence rates of primary central nervous system (CNS) cancers such as non-malignant meningioma have risen by 3% to 5% in recent years, with substantial age-related associations. [11] In addition to this demographic transition, important changes in the field of skull base surgery have occurred in the last decade. Advances in neuroimaging, stereotactic guiding, and regional and microvascular flap repair have expanded our reach beyond the sella turcica while achieving equivalent, if not better, overall mortality, morbidity, and healthcare costs, even in the elderly. [12]

According to a population-level study by Henry RK et al, increasing frailty is related with a higher risk of overall problems, life-threatening complications, and a longer hospital stay within the 30-day postoperative period following skull base surgeries (Figure 1).[12] For each unit increase in frailty score, the risk of life-threatening systemic complications increased by 42.8%. Prior examinations of frailty in the setting of anterior cerebral fossa procedures and major head and neck surgeries in general have found similar results.

**Figure 1: Odds of post-operative complications as a function of mFI-5 Score [12]**




Multivariate odds of skull base surgery complications as a function of mFI-5 score. Odds ratios were given at each mFI-5 level, with score of 0 as reference, controlling for operation time, age, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, wound class, and operative location.

Image source: Henry RK, Reeves RA, Wackym PA, Ahmed OH, Hanft SJ, Kwong KM. Frailty as a Predictor of Postoperative Complications Following Skull Base Surgery. Laryngoscope. 2021

**Frailty and Brain tumour:**

Primary and metastatic brain tumours have become more common as the population ages. [13] For informed surgical decision-making, it's critical to identify risk variables that put surgical candidates at higher risk of peri-operative morbidity or fatality. According to research, age is just a weak predictor of poor outcomes in individuals who have a craniotomy for a brain tumour.[14] Although evidence on cerebral tumour excision is far scarcer, both small institutional cohorts and larger retrospective database analyses have revealed a relationship between fragility, morbidity, and mortality. However, because the standards of neuro-oncologic care for both primary and metastatic brain tumours have changed, these assessments must be revised to match current practice.[15, 16, 17]

Understanding characteristics that may raise the risk of negative outcomes is critical for surgical decision-making and improving the informed consent procedure, which may be inadequate for older patients undergoing major surgery. Although factors such as major post-operative complications, unplanned readmissions, and mortality are intrinsically meaningful for patients and their families, it is also true that major post-operative complications can delay adjuvant therapy and impose an independent survival cost on patients in the context of oncologic care. When controlling for pertinent factors, Sastry et al found that increasing frailty is related with an increased risk of significant complication, discharge destination other than home, 30-day readmission, and 30-day mortality.[18]

When compared to non-frail patients, a multivariate analysis reveals that low- and medium-to-high frailty state provide nearly 2- and 2.5-fold greater odds of mortality. In terms of these negative outcomes, different tumour types have mixed effects; for example, metastatic tumours were not associated with a significant increase in immediate postoperative outcomes (major complication, discharge destination), but were associated with a significant increase in delayed

postoperative outcomes (30-day readmission and mortality).[18]

A study by Cloney M et al suggested that frailer glioblastoma patients undergo less aggressive treatment, stay in the hospital longer, and have more complications from craniotomy for tumour excision. Frailty may be an underappreciated parameter for assessing geriatric glioblastoma patients prior to surgery.[15]

**Frailty and Cerebrovascular Diseases:**

Frailty appears to predispose people to the development of certain noncommunicable diseases, while chronic conditions appear to raise the likelihood of frailty in older people. [19] Frailty and chronic renal disease, atrial fibrillation, chronic obstructive pulmonary disease, anaemia, and hypertension have all been linked in this way. Frailty is also linked to polypharmacy and multimorbidity (the co-occurrence of numerous disorders in a single person). Frailty has been linked to both cardiovascular and cerebrovascular illnesses. [20, 21] In the Whitehall cohort research, cardiovascular disease risk scores were found to predict the occurrence of frailty over a 10-year period; the Framingham Stroke risk score, in particular, was related with a 35 percent increase in frailty per standard deviation increment.[22, 23, 24]

Frailty has been linked to cerebrovascular disease, according to emerging data; studies show an increased risk of frailty in people who have had a stroke, and frailty has been linked to a lower post-stroke survival rate. Frailty and prefrailty are widespread in people who have had a stroke, according to a study by Palmer K et al. [25] These findings could have clinical consequences since they highlight the importance of assessing frailty in post-stroke survivors and determining how it affects prognosis. Studies on additional forms of cerebrovascular disease, as well as better quality longitudinal research that addresses the temporal link between stroke and frailty, are needed.

**Frailty and risk of stroke:**

According to a recent meta-analysis of 18 studies involving 48,009 people, the prevalence of pre-frailty and frailty in people who have had a stroke is 49% and 22%, respectively.[25] Although much of the attention paid to the relationship between frailty and stroke has focused on the influence of frailty on stroke, it's also vital to evaluate the impact of stroke on frailty. Prior stroke has been demonstrated to be an essential component in the shift from robust to frail, as well as a worsening of a frailty trajectory, and neurological abnormalities following a stroke are likely to increase the phenotypic traits of frailty. More research is needed to see if this bi-directional interaction becomes a self-replicating cycle and if it may be used as a target for intervention.[26]

**Figure 2: Factors influencing propagation of frailty and stroke risk**[27]

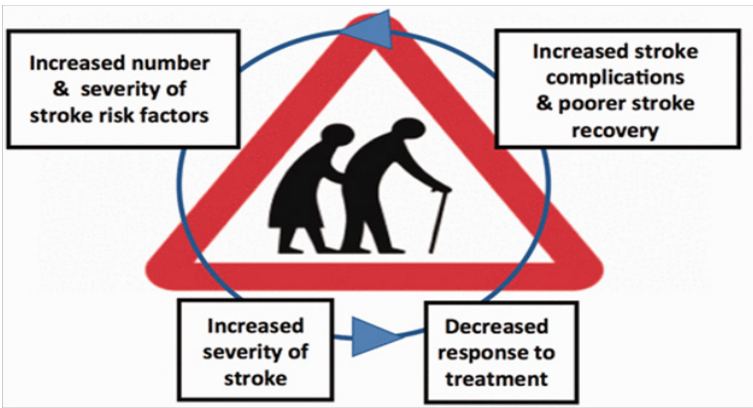



Image source: Evans NR, Todd OM, Minhas JS, Fearon P, Harston GW, Mant J, Mead G, Hewitt J, Quinn TJ, Warburton EA. Frailty and cerebrovascular disease: Concepts and clinical implications for stroke medicine. IntJ Stroke. 2021:17474930211034331.

As evaluated by the National Institute of Health Stroke Severity Scale, pre-stroke fragility is related with stroke

severity in the acute situation (NIHSS).[28] In a single-center study, mediation analysis revealed that pre-stroke frailty is not directly linked to poorer outcomes, but rather that the effect is mediated by the link between frailty and stroke severity. Other studies, on the other hand, have found that even adjusting for stroke severity, the link between premorbid frailty and early outcomes remained substantial.[29] Following adjusting for age, vascular risk factors, and NIHSS, CFS was linked to increased 30-day mortality after ischemic stroke in a retrospective single-center research.[30]

**Summary:**

In patients undergoing surgery for brain tumour resection, frailty is an independent predictor of discharge disposition, postoperative complications, and LOS. Preoperative frailty assessment may aid neurosurgeons and patients in making more informed decisions about surgical therapy. To further investigate the use of HFS to guide clinical decisions about tumour removal and to assess the effectiveness of risk reduction methods to enhance outcomes for fragile patients, randomised controlled clinical trials will be required.

Furthermore, frailty is emerging as a significant clinical risk factor for stroke, and it is linked to a variety of negative post-stroke outcomes. Because of changing demographics and the resulting increase in frailty, the burden of frailty and its impact on cerebrovascular disease is projected to rise. Both clinical care and research are grappling with how to adequately diagnose frailty in stroke, mitigate its effects, and incorporate frailty assessment into treatment decisions.

**References:**

1. Partridge JS, Harari D, Dhesi JK. Frailty in the older surgical patient: a review. Age Ageing. 2012; 41:142-147.

2. Revenig LM, Canter DJ, Taylor MD, et al. Too frail for surgery? Initial results of a large multidisciplinary prospective study examining

preoperative variables predictive of poor surgical outcomes. J Am Coll Surg. 2013;217:665-670.

3. Sullivan LM, Massaro JM, D'Agostino RB Sr. Presentation of multivariate data for clinical use: the Framingham Study risk score functions. Stat Med. 2004;23:1631-1660.

4. Wilson JR, Clarke MG, Ewings P, et al. The assessment of patient life-expectancy: how accurate are urologists and oncologists? BJU Int. 2005; 95:794-798.

5. Davenport DL, Bowe EA, Henderson WG, et al. National Surgical Quality Improvement Program (NSQIP) risk factors can be used to validate American Society of Anesthesiologists Physical Status Classification (ASA PS) levels. Ann Surg. 2006;243:636-641.

6. Inouye SK, Studenski S, Tinetti ME, Kuchel GA. Geriatric syndromes: clinical, research, and policy implications of a core geriatric concept. J Am Geriatr Soc. 2007;55:780-791.

7. Robinson TN, Eiseman B, Wallace JI, et al. Redefining geriatric preoperative assessment using frailty, disability and comorbidity. Ann Surg. 2009;250:449-455.

8. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210:901-908.

9. Boyd CM, Darer J, Boult C, et al. Clinical practice guidelines and quality of care for older patients with multiple comorbid diseases: implications for pay for performance. JAMA. 2005;294:716-724.

10. Centers for Disease Control, Prevention. Trends in aging–United States and worldwide. MMWR Morb Mortal Wkly Rep 2003; 52: 101– 104.

11. Achey RL, Gittleman H, Schroer J, Khanna V, Kruchko C, Barnholtz-Sloan JS. Nonmalignant and malignant meningioma incidence and survival in the elderly, 2005-2015, using the central brain tumor registry of the United States. Neuro Oncol 2019; 21: 380– 391.

12. Henry RK, Reeves RA, Wackym PA, Ahmed OH, Hanft SJ, Kwong KM. Frailty as a Predictor of Postoperative Complications Following Skull Base Surgery. Laryngoscope. 2021.

13. Ostrom QT, Cioffi G, Gittleman H, et al. CBTRUS statistical report: primary brain and other central nervous system tumors diagnosed in the United States in 2012–2016. Neuro-Oncol 2019;21(5):v1–v100.

14. Seicean A, Seicean S, Schiltz NK, Alan N, Jones PK, Neuhauser D,

Weil RJ. Short-term outcomes of craniotomy for malignant brain tumors in the elderly. Cancer 2013;119(5):1058–64.

15.Cloney M, D'Amico R, Lebovic J, Nazarian M, Zacharia BE, Sisti MB, Bruce JN, McKhann GM, Iwamoto FM, Sonabend AM. Frailty in geriatric glioblastoma patients: a predictor of operative morbidity and outcome. World Neurosurg 2016;89:362–7.

16.Youngerman BE, Neugut AI, Yang J, Hershman DL, Wright JD, Bruce JN. The modified frailty index and 30-day adverse events in oncologic neurosurgery. J Neurooncol 2018;136(1):197–206.

17. Kayama T, Sato S, Sakurada K, Mizusawa J, Nishikawa R, Narita et al. Effects of surgery with salvage stereotactic radiosurgery versus surgery with whole-brain radiation therapy in patients with one to four brain metastases (JCOG0504): a phaseIII, noninferiority, randomized controlled trial. JCO 2018;36(33):3282–9.

18. Sastry RA, Pertsch NJ, Tang O, Shao B, Toms SA, Weil RJ. Frailty and outcomes after craniotomy for brain tumor. J Clin Neurosci. 2020;81:95-100.

19. Villani ER, Tummolo AM, Palmer K, Gravina EM, Vetrano DL, Bernabei R, et al. Frailty and atrial fibrillation: a systematic review. Eur J Intern Med. 2018; 56:33–8

20. Vetrano DL, Palmer KM, Galluzzo L, Giampaoli S, Marengoni A, Bernabei R, et al. Hypertension and frailty: a systematic review and meta-analysis. BMJ Open. 2018; 8:e024406.

21. Chowdhury R, Peel NM, Krosch M, Hubbard RE. Frailty and chronic kidney disease: a systematic review. Arch Gerontol Geriatr. 2017; 68:135–42.

22. Bouillon K, Batty GD, Hamer M, Sabia S, Shipley MJ, Britton A, et al. Cardiovascular disease risk scores in identifying future frailty: the Whitehall II prospective cohort study. Heart. 2013; 99:737–42

23. Llibre Rodriguez JJ, Prina AM, Acosta D, Guerra M, Huang Y, Jacob KS, et al. The prevalence and correlates of frailty in urban and rural populations in Latin America, China, and India: a 10/66 population-based survey. J Am Med Dir Assoc. 2018; 19:287–95

24. Winovich DT, Longstreth WT, Arnold AM, Varadhan R, Al Hazzouri AZ, Cushman M, et al. Factors associated with ischemic stroke survival and recovery in older adults. Stroke. 2017; 48:1818–26

25. Palmer K, Vetrano DL, Padua L, Romano V, Rivoiro C, Scelfo B, Marengoni A, Bernabei R, Onder G. Frailty syndromes in persons with

cerebrovascular disease: a systematic review and meta-analysis. Front Neurol. 2019;10:1255.

26. Lee, Y, Kim, J, Han, ES, Ryu, M, Cho, Y, Chae, S. Frailty and body mass index as predictors of 3-year mortality in older adults living in the community. Gerontology. 2014; 60: 475–482.

27. Evans NR, Todd OM, Minhas JS, Fearon P, Harston GW, Mant J, Mead G, Hewitt J, Quinn TJ, Warburton EA. Frailty and cerebrovascular disease: Concepts and clinical implications for stroke medicine. IntJ Stroke. 2021:17474930211034331.

28. Kanai, M, Noguchi, M, Kubo, H, et al. Pre-stroke frailty and stroke severity in elderly patients with acute stroke. J Stroke Cerebrovasc Dis. 2020; 29: 105346.

29. Noguchi, M, Kubo, H, Kanai, M, Nozoe, M, Shimada, S. Relationship between pre-stroke frailty status and short-term functional outcome in older patients with acute stroke – a mediation analysis. Arch Gerontol Geriatr. 2021; 94: 104370.

30. Evans NR, Wall J, To B, Wallis SJ, Romero-Ortuno R and Warburton EA. Clinical frailty independently predicts early mortality after ischaemic stroke. Age Ageing. 2020; 49(4): 588–591.

# CHAPTER – 17

## Frailty and Transplant Surgery

**Background:**

Frailty has been linked to a higher risk of negative postoperative outcomes in general surgery.[1] It has also been identified as a predictor of prolonged hospital stays and early readmission (EHR).[2, 3] Furthermore, independent of age, frailty has been identified as the strongest predictor of 30-day postoperative complications.[4] Frailty's impact on kidney transplant outcomes has been widely studied, but only infrequently. Furthermore, with a selection bias for those who have been authorized for transplantation, evaluating the risks of frailty on post-transplant outcomes may be difficult.[4] This chapter aims to elaborate on various solid organ transplantation and the involved risk in frail patients.

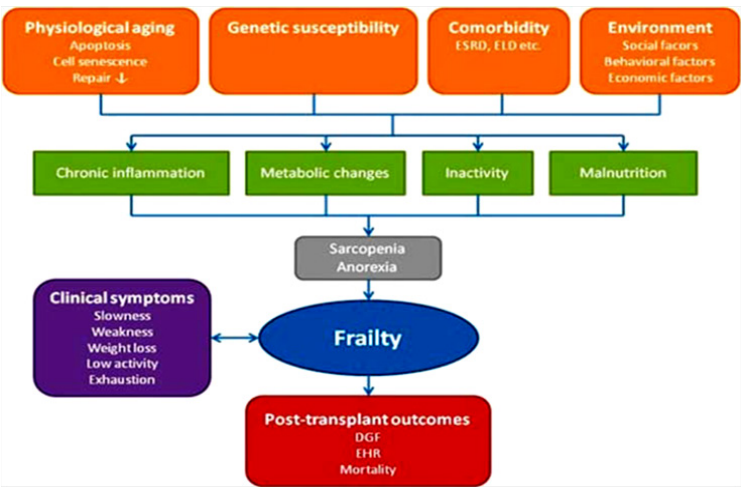



**Figure 1:** Risk factors, pathophysiological changes, clinical symptoms effects on post-transplant outcome. ELD indicates end-stage liver disease.[4]

**Frailty considerations in kidney transplantation:** Chowdhury et al found that the FFP was the most commonly used frailty assessment tool, accounting for 72% of the studies, despite significant heterogeneity in its interpretation, in a systematic review of studies on the association of frailty and chronic kidney disease (CKD) that included over 36 000 patients. [5] Frailty is related with CKD, and the incidence of frailty in CKD increases as renal function declines. Using the FFP, Fitzpatrick and colleagues discovered that 52% of dialysis patients were frail.[6] McAdamsDeMarco and colleagues conducted a cohort study and found that 18% of patients on the kidney transplant waiting list and 20% of kidney transplant recipients were frail through FFP.[7, 8]

Furthermore, McAdamsDeMarco and colleagues discovered that frailty at the time of kidney transplant evaluation was linked to a 2.8-fold increased risk of fair or poor health-related quality of life (HRQOL), a 2.9-fold increased risk of declining HRQOL while waiting for kidney transplantation, and a 2.2-fold increased risk of waitlist mortality in this large cohort.[7,9]Moreover, frail kidney transplant recipients have a 2.1-fold higher risk of delirium [10], a 1.6-fold higher risk of longer hospital stays [11], a 0.9-fold higher risk of delayed graft function[12], a 0.6-fold higher risk of early hospital readmission[13], a 0.3-fold higher risk of immunosuppression intolerance[14], and a 2.2-fold higher risk of death[15].

In patients with end-stage renal illness, low physical function assessments and difficulty to conduct activities of daily living (ADLs) have both been linked to a higher risk of mortality (ESRD).[16,17] The United Network for Organ Sharing (UNOS) registry data of 10,875 kidney transplant recipients was analysed using the Medical Outcomes Study Short Form 36 (SF36) Physical Component Scale (PCS) questionnaire to evaluate physical function. Low physical function was found to be an independent predictor of mortality (HR = 1.7).[18] Lower extremity impairment as measured by the SPPB, another objective marker of frailty, is linked to poor outcomes following kidney transplantation and a longer length of stay in the renal transplant hospital.[19] According to a recent study,

the prevalence of lower extremity disability was higher in the frail group of kidney transplant patients (70%) compared to the overall cohort of frail and non-frail kidney transplant recipients (47%). [20] Importantly, regardless of the frailty phenotype, impairment was linked to a 2.3-fold increased risk of death.

Small, randomized trials of individuals with CKD and ESRD have shown that rehabilitation regimens can help dialysis patients prevent or reverse sarcopenia and enhance physical performance. [21] Dependent hemodialysis patients may benefit from integrated inpatient rehabilitation to help them restore function.[22] The key points in kidney transplantation is elaborated in table 1.

**Table 1: Key points in kidney transplantation[23]**

| |
|---|
| 1. Frailty is common in patients with CKD (pre-transplant and post-transplant) and ESRD with numerous negative implications for health status. |
| 2. The ideal components of the frailty metric for kidney transplant candidates and recipients are unknown; studies to compare metrics, harmonize measurements, and identify an ESRD□specific measure of frailty would be of value. |
| 3. Patients identified to be frail may benefit from physical therapy and rehabilitation, and additional studies are needed to understand how such interventions affect outcomes in kidney transplant candidates and recipients. |

**Frailty considerations in liver transplantation:**

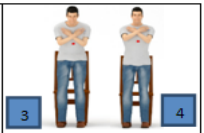
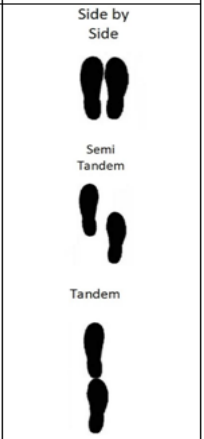
Frailty applications in liver transplantation have primarily focused on the physical dimension of the construct (example: FFP), but they have lately expanded to include assessments that capture functional capability and disability. Physical frailty is common in cirrhotic patients: the frequency of frailty in outpatients ranged from 17% to 35% according to

the FFP, and was assessed to be 38% by the SPPB; inpatients, 68% were functionally impaired according to the Karnofsky Performance Scale 70%. [24,25,26] Frailty has been found to be a significant predictor of liver transplant outcomes, including hospitalizations and mortality, both before and after the procedure.[27,28]

In this population, a variety of techniques for measuring frailty and physical function have been examined, and the Liver Frailty Index (LFI) is the result of recent efforts to standardise frailty testing in liver transplantation.[5,25] The LFI was developed expressly to capture the notion of physical frailty in liver transplant candidates and is a powerful predictor of waitlist mortality. It includes handgrip strength, chair stands, and balance testing. It classifies waitlist mortality more accurately than the MELDNa score alone. This metric is simple to use and score on a continuous scale, making it ideal for use in a liver transplant environment. To standardise the incorporation of frailty into center-level transplant decision-making, we recommend for the implementation of the LFI in baseline and longitudinal examinations of liver transplant patients.[23]

**Table 2: Liver Frailty Index** [5, 25]

| Test | Instructions | Image |
|---|---|---|
| Gender | Male/Female should be noted | |
| **Grip strength:** The average of three trials, measured in the subject's dominant hand using a dynamometer | Allow the patient to grip the dynamometer in the standard position with their dominant hand (as shown below). The hand dynamometer is usually set to the second position while testing grip strength. Request that the patient squeeze the gadget as hard as they can and then release it three times. Keep track of the value in kilogrammes for each serial test. After each attempt, make sure to reset the device to zero. When grasping the device, do not allow the patient to rest it on any surface. |  |
| **Timed chair stands:** This is measured as the number of seconds it takes to do five chair stands with the subject's arms folded across the | This is the amount of time it takes a patient to stand and sit in a chair five times without using their arms. The arms should be crossed over the chest. Start the timer when they first get up from their chair and stop it when they |   |

| | | |
|---|---|---|
| chest | reach their fifth chair rise. Enter 0 for the time if the patient cannot do all 5 chair stands in 60 seconds. |  |
| **Balance testing:** It is measured as the number of seconds that the subject can balance in three positions (feet placed side-to side, semitandem, &tandem) for a maximum of 10 seconds each. | The patient is asked to perform three different postures for ten seconds each. Start the timer for each position when the patient's feet are in the proper position and they have let go of any support. Stop the timer, tell them that they must hold the entire 10 seconds for it to count, and ask if they want to try again if they catch themselves. Record the time in seconds to one decimal place if they don't finish the entire ten seconds. If they can hold a pose for 10 seconds, record that timeand move on to the next pose. |  |
| With these three individual tests of frailty, the Liver Frailty Index must be calculated using the following equation: (−0.330×gender-adjusted grip strength)+(−2.529×number of chair stands per second)+(−0.040×balance time)+6<br>or<br>a calculator can be used to calculate the same (calculator available at: http://liverfrailtyindex.ucsf.edu) | | |

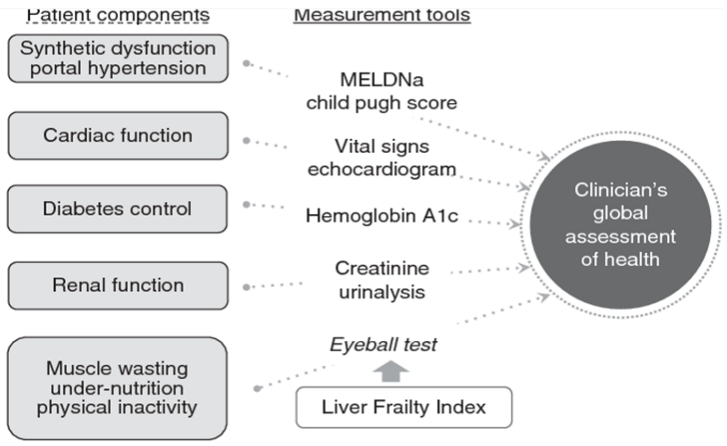


**Figure 2:** A conceptual model of some of the patient components that clinicians incorporate into their global assessment of a patient's health and the tools that they use to inform this holistic assessment.[27]

Image source: Lai JC, Covinsky KE, McCulloch CE, Feng S. The liver frailty index improves mortality prediction of the subjective clinician assessment in patients with cirrhosis. Am J Gastroenterol. 2018; 113(2): 235.

The pathophysiology of frailty in individuals with cirrhosis is multifactorial, and includes under-nutrition from poor oral intake, low physical activity, systemic inflammation, and hypogonadism. The contributions of hepatic synthesis dysfunction in increasing muscle protein degradation, as well as the negative effects of poor ammonia detoxification on muscle health, are unique to cirrhosis.[29] Each of these factors hastens the onset of sarcopenia, which is a key element in the pathophysiology of frailty. Sarcopenia affects anywhere from 22% to 70% of liver transplant candidates.[30]

Understanding the pathophysiology of cirrhosis-specific frailty has revealed a slew of potential intervention targets, and it's quickly becoming the next frontier in liver transplantation frailty research. Several short trials of exercise therapies, some of which included food counselling, have shown improvements in muscle mass, muscle strength, exercise capacity, HRQOL, and reductions in portal hypertension in individuals with cirrhosis.[31] In a single randomized clinical trial of intramuscular testosterone in hypogonadal males with cirrhosis, improvements in muscle mass were seen, with a trend toward strength gains.[32]

While there is currently minimal evidence on the topic of rehabilitation prior to liver transplantation, early studies are encouraging, leading to the conclusion that physical frailty, or at least some of its components, can be modified in liver transplant candidates. More research into establishing rehabilitation programmes that address frailty components with the objective of enhancing outcomes such as survival and HRQOL before and after liver transplantation should be

done.[23] Key points to be considered in liver transplantation are mentioned in Table 3.

**Table 3: Key points in liver transplantation [23]**

1. Frailty is prevalent and a critical determinant of poor outcomes.
2. Frailty measurements should be standardized and performed routinely in patients undergoing evaluation for liver transplantation.
3. Although subjective screening tools may be useful for quickly identifying patients vulnerable to poor outcomes, performance based tools better assess response to interventions and inform candidate selection.
4. Poor caloric intake, low physical activity, and muscle depletion are integral components of frailty and represent potential targets for intervention through rehabilitation programs.

**Frailty considerations in lung transplantation:**

Frailty may be linked to increased morbidity and death before and after lung transplantation, according to new research. Frailty's predictive value in lung transplantation has been studied in three trials so far. Singer et colleagues found that phenotypic frailty, as measured by the FFP or the SPPB, was common in lung transplant candidates and was linked to impairment, delisting, or death prior to surgery, as well as 1 and 4 year mortality following surgery.[33, 34] Wilson and colleagues found that using the frailty deficit measure, increasing cumulative deficits revealed a significant frequency of frailty (45% in 102 patients) and was independently related with shorter post-transplant survival.[35]

Frailty assessment before transplantation has the potential to improve risk categorization and candidate selection. It's crucial to remember that the right frailty index should appropriately assess risk for the desired goal. The FFP, for example, includes elements that are likely to improve after lung transplantation (such as slowness and weight loss), whereas the cumulative frailty deficits index may change less

or even worsen with the development of new extrapulmonary comorbidities (such as diabetes and renal dysfunction) even after a successful transplant.[36]The best frailty assessment, the usefulness of frailty instruments for candidate selection, and which frailty parameters are most receptive to rehabilitation pre and post lung transplantation are all open concerns.[37] Phenotypic frailty was reversible in a group of non-transplanted chronic obstructive pulmonary disease patients who completed pulmonary rehabilitation, suggesting that frail lung transplant candidates could improve significantly from rehabilitation.[38]

Several therapies to ameliorate frailty in lung transplant candidates were explored, with the acknowledgement that more research is needed to determine their effectiveness. These interventions included the following points:[23]

1. A consultation with a nutritionist and the possibility of nutritional supplementation
2. Enrolment in a physical therapy programme and/or an integrated pulmonary rehabilitation programme
3. Geriatric consultation to identify and improve factors that may be contributing to frailty, such as polypharmacy and cognitive impairment. Furthermore, assessment of social work services must be done in order to improve social support.

Key points that must be remembered during lung transplantation are enlisted in table 4.

**Table 4: Key points in lung transplantation [23]**

1. Phenotypic frailty is prevalent in lung transplant candidates.
2. Increased cumulative deficits are independently associated with lower post-transplant survival.
3. Candidate selection is fundamentally dependent on establishing the validity of frailty measures and demonstrating their strongand independent association with outcomes after lung transplantation.
4. Potential interventions to reverse frailty that require further study include pulmonary rehabilitation and

nutritional supplementation.

**Frailty considerations in heart transplantation:**

Frailty prevalence in advanced heart failure ranges from 25% to 78%, depending on the instrument and individual criteria used to define frailty. Heart failure and frailty have similar symptoms that can be attributed to either condition (For example: fatigue, exhaustion, weight loss).[39] Jha and colleagues found that one-third of their heart failure patients were frail, regardless of their age, gender, or ejection fraction.[40] Frail patients had a 54% one-year survival rate compared to 79%t for non-frail individuals. Furthermore, non-frail individuals who received a heart transplant had a 100% one-year post-transplant survival rate, compared to 52% in frail patients.[41] Sarcopenia of the pectoralis muscle on chest CT has been proven to be highly selective in its capacity to predict risk of mortality after mechanical circulatory support device (MCSD) therapy. Assessment of the efficacy of this muscle is another way to assess frailty. [23]

The rehabilitation of frail individuals prior to heart transplantation has piqued interest. The use of an MCSD in advanced heart failure patients reveals that about half of the patients improve their frailty level, but the remainder of patients remain prefrail. Certain cardiologists, in particular, did not believe that rehabilitation was a realistic therapeutic choice for patients since improvement in frailty would be small and patients would be at a higher risk of death.[23] Appropriate patients should be considered for MCSD therapy so that rehabilitation can continue. Normalization of cardiac output, restoration of end-organ balance, reversal of the catabolic condition of heart failure, improvement of muscle mass, and elimination of inactivity would all be possible with an MCSD.

A team of cardiologists highlighted the crucial need for more evidence to establish optimum frailty metrics in heart failure and to determine their potential predictive value compared to currently accepted methods.[23] Nonetheless, considering the large amount of data surrounding the FFP, it was decided that a modification of the FFP was the best tool to assess frailty in

clinical practise at this time, and that it should be included in future research studies. The inclusion of weight loss (due to predicted volume shifts) and the use of the Duke Activity Status Index (DASI) to measure activity are two changes to the standard FFP.

Because many patients with end-stage organ failure are hospitalized or critically ill during the transplant evaluation process, a comprehensive FFP is impractical, and handgrip strength alone should be used to diagnose frailty in these patients. Although depression and cognition are significant factors to examine, the enhanced predictive value of these domains must be confirmed before they can be recommended for inclusion in regular physical frailty tests.Key points in heart transplantation are mentioned in table 6.

**Table 5: Key points in heart transplantation**

1. When evaluating patients for heart transplantation or MCSD, a modified FFP should be used and is currently the most well□validated tool.
2. Frailty is at least partially reversible with durable MCSD through improved circulation, nutrition and structured rehabilitation programs.
3. A multi□center Frailty in Advanced Heart Disease Consortium should be developed to assess the relationship between the proposed frailty measures and outcomes. Patient□reported outcomes such as qualityof life after an intervention (eg, MCSD implantation or heart transplantation) are important and should be collected serially.

Prehabilitation and precautions to be taken ahead of any solid organ transplantation is enlisted in table 6.

**Table 6: Possible Interventions for Optimizing Frail Transplant Candidates Interventions[23]**

| Organ | Possible interventions |
|---|---|
| Kidney | • Exercise<br>• Physical therapy<br>• Intergrated inpatient rehabilitation |
| Liver | • Center-based rehabilitation programs<br>• BMI-stratified caloric intake targets (20 to 40 kcal/kg/day)<br>• Targeted protein intake (1.2-1.5 g/kg/day)<br>• Exercise |
| Lung | • Nutrition supplementation<br>• Physical therapy<br>• Pulmonary rehabilitation<br>•Intervention by social workers/ psychologists |
| Heart | • Nutrition supplementation<br>• Exercise<br>• Physical rehabilitation<br>• Mechanical circulatory support device |

**Summary:**

A large increase in older transplant patients has occurred from improved health care and demographic changes. It's difficult to accurately assess the prevalence of frailty in people with end-stage organ failure. The characteristics of organ failure and the indications of frailty are very similar. The Minnesota Leisure Time Activity Scale, which is used to assess physical activity in the general population, is unable to make this distinction. Individuals with organ failure require a comprehensive tool that integrates objective and dynamic measurements of frailty and allows for the evaluation of prospective therapies prior to transplantation.

## References:

1. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg. 2010;210:901–908.

2. Ommundsen N, Wyller TB, Nesbakken A, et al. Frailty is an independent predictor of survival in older patients with colorectal cancer. Oncologist. 2014;19:1268–1275.

3. Revenig LM, Canter DJ, Taylor MD, et al. Too frail for surgery? Initial results of a large multidisciplinary prospective study examining preoperative variables predictive of poor Surgical Outcomes. J Am Coll Surg.2013;217:665–670.e1.

4. Exterkate L, Slegtenhorst BR, Kelm M, et al. Frailty and transplantation. Transplantation. 2016;100(4):727-33.

5. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56:M146□M156.

6. Fitzpatrick J, Sozio SM, Jaar BG, et al. Frailty, body composition and the risk of mortality in incident hemodialysis patients: the Predictors of Arrhythmic and Cardiovascular Risk in End Stage Renal Disease study. Nephrol Dial Transplant. 2019;34(2):346-54.

7. McAdams□DeMarco MA, Ying H, Thomas AG, et al. Frailty, inflammatory markers, and waitlist mortality among patients with endstage renal disease in a prospective Cohort study. Transplantation. 2018;102:1740□1746.

8. McAdams□DeMarco MA, Ying H, Olorundare I, et al. Individual frailty components and mortality in kidney transplant recipients. Transplantation. 2017;101:2126□2132.

9. McAdams□DeMarco MA, Ying H, Olorundare I, et al. Frailty and health□related quality of life in end stage renal disease patients ofall ages. J Frailty Aging. 2016;5:174□179.

10. Haugen CE, Mountford A, Warsame F, et al. Incidence, risk factors, and sequelae of post□kidney transplant delirium. J Am Soc Nephrol. 2018;29:1752□1759.

11. McAdams□DeMarco MA, King EA, Luo X, et al. Frailty, length of stay, and mortality in kidney transplant recipients: a national registry and prospective Cohort study. Ann Surg. 2016;266:1084□1090.

12. Garonzik□Wang JM, Govindan P, Grinnan JW, et al. Frailty

and delayed graft function in kidney transplant recipients. Arch Surg. 2012;147:190□193.

13. McAdams□DeMarco MA, Law A, Salter ML, et al. Frailty and early hospital readmission after kidney transplantation. Am J Transplant. 2013;13:2091□2095.

14. McAdams□DeMarco MA, Law A, Tan J, et al. Frailty, mycophenolate reduction, and graft loss in kidney transplant recipients. Transplantation. 2014;99:805□810.

15. McAdams□DeMarco MA, Law A, King E, et al. Frailty and mortality in kidney transplant recipients. Am J Transplant. 2015;15:149□154.

16. McAdams□DeMarco MA, Law A, Garonzik□Wang JM, et al. Activity of daily living disability and dialysis mortality: better prediction using metrics of aging. J Am Geriatr Soc. 2012;60:1981□1982.

17. Harhay MN, Hill AS, Wang W, et al. Measures of global health status on dialysis signal early rehospitalization risk after kidney transplantation. PLoS ONE. 2016;11:e0156532.

18. Reese PP, Bloom RD, Shults J, et al. Functional status and survival after kidney transplantation. Transplantation. 2014;97:189□195.

19. Rozenberg D, Mathur S, Herridge M, et al. Thoracic muscle crosssectionalarea is associated with hospital length of stay postlung transplantation: a retrospective cohort study. Transpl Int. 2017;30:713□724.

20. Nastasi AJ, McAdams□DeMarco MA, Schrack J, et al. Pre□kidney transplant lower extremity impairment and post□transplant mortality. Am J Transplant. 2018;18:189□196.

21. Abdulnassir L, Egas□Kitchener S, Whibley D, Fynmore T, Jones GD. Captivating a captive audience: a quality improvement project increasing participation in intradialytic exercise across five renal dialysis units. Clin Kidney J. 2017;10:516□523.

22. Li M, Porter E, Lam R, Jassal SV. Quality improvement through the introduction of interdisciplinary geriatric hemodialysis rehabilitation care. Am J Kidney Dis. 2007;50:90□97.

23. Kobashigawa J, Dadhania D, Bhorade S, et al. Report from the American Society of Transplantation on frailty in solid organ transplantation. 2019; 984-994.

24. Tandon P, Tangri N, Thomas L, et al. A rapid bedside screen to predict unplanned hospitalization and death in outpatients withcirrhosis;

a prospective evaluation of the clinical frailty scale. Am J Gastroenterol. 2016;111:1759□1767.

25. Lai JC, Feng S, Terrault NA, et al. Frailty predicts waitlist mortality in liver transplant candidates. Am J Transplant. 2014;14:1870□1879.

26. Tandon P, Reddy K, O'Leary J, et al. A Karnofsky performance status□based score predicts death after hospital discharge in patients with cirrhosis. Hepatology. 2016;65:217□224.

27. Lai JC, Covinsky KE, McCulloch CE, Feng S. The liver frailty index improves mortality prediction of the subjective clinician assessmentin patients with cirrhosis. Am J Gastroenterol. 2018;113:235□242.

28. Pereira JLF, Galant LH, Rossi D, et al. Functional capacity, respiratory muscle strength, and oxygen consumption predict mortality in patients with cirrhosis. Can J Gastroenterol Hepatol. 2016;1□6.

29. Dasarathy S, Merli M. Sarcopenia from mechanism to diagnosis and treatment in liver disease. J Hepatol. 2016;65:1232□1244.

30. van Vugt JL, Levolger S, de Bruin RW, et al. Systematic review and meta□analysis of the impact of computed tomography assessed skeletal muscle mass on outcome in patients awaiting or undergoing liver transplantation. Am J Transplant. 2016;16:2277□2292.

31. Duarte□Rojo A, Ruiz□Margain A, Montano□Loza AJ, et al. Exercise and physical activity for patients with end□stage liver disease: improving functional status and sarcopenia while on the transplant waiting list. Liver Transpl. 2018;24:122□139.

32. Sinclair M, Grossmann M, Hoermann R, Angus PW, Gow PJ. Testosterone therapy increases muscle mass in men with cirrhosis and low testosterone: a randomised controlled trial. J Hepatol. 2016;65:906□913.

33. Singer JP, Diamond JM, Gries C, et al. Frailty phenotypes, disability, and outcomes in adult candidates for lung transplantation. Am J Respir Crit Care Med. 2015;192:1325□1334.

34. Singer JP, Diamond JM, Anderson MR, et al. Frailty phenotypes and mortality after lung transplantation: a prospective cohort study. Am J Transplant. 2018;18:1995□2004.

35. Wilson ME, Vakil AP, Kandel P, et al. Pretransplant frailty is associated with decreased survival after lung transplantation. J Heart Lung Transplant. 2016;35:173□178.

36. Weig T, Milger K, Langhans B, et al. Core muscle size predicts

postoperative outcome in lung transplant candidates. Ann Thorac Surg. 2016;101:1318□1325.

37. Lee S, Paik HC, Haam SJ, et al. Sarcopenia of thoracic muscle mass is not a risk factor for survival in lung transplant recipients. J Thorac Dis. 2016;8:2011□2017.

38. Maddocks M, Kon SS, Canavan JL, et al. Physical frailty and pulmonary rehabilitation in COPD: a prospective cohort study. Thorax. 2016;71:988□995.

39. Joseph SM, Rich MW. Targeting frailty in heart failure. Curr Treat Options Cardiovasc Med. 2017;19:31.

40. Jha SR, Hannu MK, Chang S, et al. The prevalence and prognostic significance of frailty in patients with advanced heart failure referred for heart transplantation. Transplantation. 2016;100:429□436.

41. Teigen LM, John R, Kuchnia AJ, et al. Preoperative pectoralis muscle quantity and attenuation by computed tomography are novel and powerful predictors of mortality after left ventricular assist device implantation. Circ Heart Fail. 2017;10:e004069.

# CHAPTER – 18

## Frailty and Emergency Surgery

**Background:**

An increasing proportion of senior adults are being admitted to the emergency room with urgent surgical needs. This demographic group has poor surgical results, with high rates of postoperative complications, death, resource utilization, and a higher likelihood of being dependent on others upon discharge from the hospital. As a result of preoperative deconditioning and/or postoperative difficulties, emergency surgery can also cause functional deterioration.[1] The most dreaded postoperative event among senior patients is the loss of preoperative capacities such as mental ability, continence, mobility, or independence in daily activities, which could result in the need for immediate caregiver help or admissioninto a nursing facility.

Frailty is the most major risk factor for functional decline. In a busy emergency room, where a frailty assessment is not available or reliable, the surgeon has limited tools to estimate postoperative functional loss.[2] Therefore, certain frailty assessment tools can be used to evaluate the status of the patients before performing any emergency surgery.

**Frailty assessment tools for emergency surgeries:**

In the case of general surgery, it has been shown that a detailed multidisciplinary preoperative assessment of senior patients improves postoperative outcomes in the elective environment, but it is unquestionably worthwhile to assess the frailty status in the case of older patients having urgent treatment requirements. It is self-evident that in such cases, the decision-making process should be preceded by an accurate and less time-consuming assessment, especially if we are dealing with

a frail patient who is weakened by comorbidities.

**The Emergency Surgery Frailty Index (EmSFI):**[3]

EmSFI represents a valid simple instrument to perform preoperative evaluations with moderate accuracy, improving perioperative risk management in elderly patients. This index allows to stratify patients in three risk classes according to the developed index: EmSFI 1–3: low-risk class; EmSFI 4–7: moderate-risk class; EmSFI: 8–14 high-risk class (Figure 1).

**Emergency Surgery Frailty Index (EmSFI)**

| Variable | Absent | | Present |
|---|---|---|---|
| Age ≥ 80 years | 0 | | 1 |
| Emergency | 0 | | 1 |
| SIRS | 0 | | 1 |
| Malignancy | 0 | | 1 |
| | Absent | Mild | Severe |
| Chronic cardiopathy | 0 | 1 | 2 |
| Chronic pneumopathy | 0 | 1 | 2 |
| Other comorbidities | 0 | 1 | 2 |
| Altered autonomy | 0 | 1 | 2 |
| Altered mobility | 0 | 1 | 2 |
| Maximum score = 14 points | | | |

Figure 1: Variables for calculating Emergency Surgery Frailty Index [3]

**Flemish version of the Triage Risk Screening Tool (fTRST):**[4]

Flemish version of the Triage Risk Screening Tool (fTRST), is a validated 5-item frailty screening tool that is effective in predicting 30- and 90-day morbidity and mortality after

emergency abdominal surgery among older patients (≥70 years). fTRST is based only on five domains and the total score can range from 0−6 (Figure 2).

1. Presence of cognitive decline - 2 points.

2. Living alone or no help from partner/family available - 1 point.

3. Reduced mobility or falls in the past 6 months - 1 point.

4. Hospitalized in the past 3 months - 1 point.

5. Polypharmacy (≥ 5 different medications) - 1 point.

This index also incorporates the Clavien-Dindo (CD) classification. CD classification is widely used to evaluate adverse events (complications) that occur after surgery (range I–V), was used to track all complications that occurred during the hospital stay or within 90 days following release. A serious complication was defined as a grade of III or higher.

| Item | Score | |
|---|---|---|
| | Yes | No |
| Presence of cognitive impairment (disorientation, diagnosis of dementia, or delirium) | 2 | 0 |
| Lives alone or no caregiver available, willing, or able | 1 | 0 |
| Difficulty with walking or transfers or fall (s) in the past 6 months | 1 | 0 |
| Hospitalized in the last 3 months | 1 | 0 |
| Polypharmacy: ≥5 medications | 1 | 0 |

Figure 2: Flemish version of the Triage Risk Screening Tool (fTRST) [5]

fTRST is a simple screening test with a lot of potential for identifying patients who have a 'geriatric profile' and could benefit from a more thorough geriatric evaluation. The first exploratory investigation of 55 older cancer patients found that the Flemish version of the TRST is a fairly accurate instrument when employing a cut-off score of 1.[5]

**Emergency general surgery frailty index (EGSFI):**[6]

The EGSFI is a 15-variable validated bedside instrument for determining the frailty state of individuals undergoing emergency general surgery (EGS). In geriatric EGS patients, frail state as defined by the EGSFI is an independent predictor of surgical complications and mortality. This could be a useful tool for making informed decisions, allocating hospital resources efficiently, and identifying chances for early intervention in high-risk frail patients.[6]

| EMERGENCY GENERAL SURGERY SPECIFIC FRAILTY INDEX | | | | | |
|---|---|---|---|---|---|
| **Co-Morbidities** | | | | | |
| Cancer | Yes (1) | | No (0) | | |
| Hypertension | Yes (1) | | No (0) | | |
| Coronary heart disease | MI (1) | CABG (0.75) | PCI (0.5) | Medication (0.25) | No (0) |
| Dementia | Mild (0.25) | Moderate (0.5) | Severe (1) | No (0) | |
| **Daily Activities** | | | | | |
| Need help with grooming | Yes (1) | | No (0) | | |
| Help managing money | Yes (1) | | No (0) | | |
| Need help with housework | Yes (1) | | No (0) | | |
| Need help toileting | Yes (1) | | No (0) | | |
| Help walking | Wheel chair (1) | Walker (0.75) | Cane (0.25) | None (0) | |
| **Health Attitude** | | | | | |
| Feel less useful | Most of time (1) | Sometime (0.5) | Rarely (0) | | |
| Feel sad | Most of time (1) | Sometime (0.5) | Rarely (0) | | |
| Feel effort to do everything | Most of time (1) | Sometime (0.5) | Rarely (0) | | |
| Feel lonely | Most of time (1) | Sometime (0.5) | Rarely (0) | | |
| Feel sexually active | Yes (0) | | No (1) | | |
| **Nutrition** | | | | | |
| Albumin | <3 mg/dl (1) | | >3mg/dl (0) | | |

**Figure 3:**Emergency general surgery frailty index (EGSFI) [6]

**The relationship between frailty, and morbidity and mortality in emergency general surgery (EGS):**

Frailty's impact on morbidity and mortality following elective operations has been well investigated; however, its role in poor postoperative outcomes following EGS has only recently been confirmed. This can be explained in part by the recent standardized definition of EGS, which includes seven operations that account for the vast majority of EGS operative load. The risk of complications and death, on the other hand, varies substantially between various operations. Appendectomy and cholecystectomy, for example, have significantlylower morbidity and fatality rates than the others, although accounting for the majority of cases.

Frailty was discovered in the acute general surgery population in a prospective study conducted by Goeteyn J et al in 2017.[7] Frailty was prevalent (23.5%) in the acute general surgery group aged 65 and up, according to this study that evaluated the Belgian population. Frailty was also linked to a higher risk of death at 30 and 90 days postoperatively. These findings should alert physicians to the fact that there are weak individuals out there who are more likely to develop problems and perish. The study concluded that this information could lead to a more aggressive or palliative response when a patient is examined in an emergency medical care unit.[7]

Kennedy CA and co-authors conducted a systematic review and meta-analysis assesses the correlation between frailty and EGS.[8] This review suggested that there is compelling evidence that frailty in the elderly predicts post-operative mortality, complications, a longer hospital stay, and loss of independence. Moreover, in the perioperative pathway, collaborative working with medicine for the elderly physicians to target modifiable components of the frailty syndrome may enhance results. The authors also added that, in order to aid decision-making and the development of novel postoperative strategies, frailty scoring should be integrated into acute surgical assessment practise.[8] This study also gave the followed points (Table 1).

**Table 1: Frailty and Emergency General Surgery[8]**

Few important points to know regarding the association between frailty and EGS:

Populations are ageing, as are the number of patients who require emergency surgery.

The prevalence of frailty amongst patients undergoing emergency surgery was 29.2%.

The mortality rate amongst the frail undergoing emergency general surgery was 24.7%.

Hewitt J et al in 2019 conducted an observational study that evaluated frailty amongst all ages and the correlation of the same with the outcome of emergency surgeries. [9] The cohort study included 2,279 patients and frailty was documented in patients of all ages. The detailed percentage of the age groups affected with frailty was 1% in patients under 40 years of age to 45% of those aged 80 years and above. The authors found that each incremental step of worsening frailty was associated with an 80% increase in mortality at Day 90. This finding supports a linear dose–response relationship. Additionally, the authors also found that the frailest patients were increasingly likely to stay in hospital longer, be readmitted within 30 days, and die within 30 days.[9]

Shinall Jr MC et al in 2020 conducted a study to analyse the association of preoperative frailty and operative stress with the mortality rate after any elective or emergency surgical procedure. [10] All the patients were categorized into robust, normal, frail, and very fail groups based on the RAI score (RAI 20, 21-29, 30-39, and 40, respectively for each of the above-mentioned groups). The outcomes measure was the rate of mortality noted in these groups at 30, 90, and 180 days.The study found that mortality was higher following emergency surgeries than after any elective operations, and that frail and very frail patients died at a higher rate than their more robust peers even after scheduled surgery.[10]

Association between mortality and frailty in emergency general surgery was examined in a systematic review and meta-analysis by Fehlmann CA et al in 2021.[11]The purpose of

this review was to determine the association between frailty and mortality among adults≥65 years old undergoing EGS. The results of this systematic review suggested that in adults of 65 years and above, frailty is linked to poorer outcomes following any EGS. Furthermore, the Clinical Frailty Scale could be used to improve patient risk assessment and collaborative decision-making with healthcare providers prior to surgery. Additionally, the authors added that the Clinical Frailty Scale's value in establishing a prognostic score in EGS should be investigated further in the future.[11]

**Summary:**

After elective operations of any level of operating stress, frail and very fragile patients experience significant postoperative mortality, with considerably greater rates of mortality after emergent operations. Mortality demonstrated a complex, nonlinear relationship with surgical stress for both emergent and elective surgeries, implying selection effects by operating surgeons.

The necessity for frailty assessment at the point of treatment in order to achieve critical goals such as risk-stratifying patients for surgeries, particularly those considered routine or low risk. Furthermore, there is a need to assist clinicians and frail patients in making informed surgical decisions, including palliative treatments, in both elective and emergency settings. When possible, the assessment tool should also provide guidelines for optimising preoperative care for these individuals. Additionally, it must also provide goal-concordant care, which may entail operating even when the risk of death is high if significant gains in quality of life are projected.

**References:**

1. Torrance ADW, Powell SL, Griffiths EA. Emergency surgery in the elderly: challenges and solutions. Emerg Med. 2015;7:55–68.

2. Zattoni D, Montroni I, Saur NM, et al. Prediction of functional loss in

emergency surgery is possible with a simple frailty screening tool. World JEmerg Surg. 2021;16(1):1-0.

3. Costa G, Bersigotti L, Massa G, et al. The Emergency Surgery Frailty Index (EmSFI): development and internal validation of a novel simple bedside risk score for elderly patients undergoing emergency surgery. Aging ClinExp Res. 2021; 33(8):2191-201.

4. Zattoni D, Montroni I, Saur NM, et al. A simple screening tool to predict outcomes in older adults undergoing emergency general surgery. J Am Geriatr Soc. 2019;67(2):309–16.

5. Kenis C, Geeraerts A, Braes T, et al. 19 The Flemish version of the Triage Risk Screening Tool (TRST): a multidimensional short screening tool for the assessment of elderly patients. Crit Rev OncolHematol. 2006(60):S31.

6. Jokar TO, Ibraheem K, Rhee P, et al. Emergency general surgery specific frailty index: a validation study. J Trauma Acute Care Surg. 2016;81(2):254-60.

7. Goeteyn J, Evans LA, De Cleyn S, et al. Older Persons Surgical Outomes Collaborative. Frailty as a predictor of mortality in the elderly emergency general surgery patient. Acta Chir Belg. 2017;117(6):370-5.

8. Kennedy CA, Shipway D, Barry K. Frailty and emergency abdominal surgery: A systematic review and meta-analysis. Surgeon. 2021.

9. Hewitt J, Carter B, McCarthy K, et al. Frailty predicts mortality in all emergency surgical admissions regardless of age. An observational study. Age Ageing. 2019;48(3):388-94.

10. Shinall MC, Youk A, Massarweh NN, et al. Association of preoperative frailty and operative stress with mortality after elective vs emergency surgery. JAMA Netw Open. 2020; 3(7):e2010358.

11. Fehlmann CA, Patel D, McCallum J, et al. Association between mortality and frailty in emergency general surgery: a systematic review and meta-analysis. Eur J Trauma Emerg Surg. 2021:1-1.

# CHAPTER – 19

## Frailty and Spinal Surgery

**Background:**

Several approaches for assessing frailty have been proposed, all of which rely on measuring physical functions, such as accumulation of deficits and frailty phenotype, where application is dependent on clinical availability, and/or self-reported items on strength, energy, and weight loss. Furthermore, specific techniques have been developed in specific circumstances; therefore there is still a lack of agreement on distinguishing diagnostic criteria. [1]

Frailty is linked to the result of general surgery, therefore it could predict the prognosis of patients undergoing spine surgery, who have a high rate of intra- and post-operative problems.[2] Degenerative disorders of the spine are common, with 90% of adults demonstrating some degree of lumbar disc or spine degeneration by the age of 50. [3] Degeneration of the spine can manifest as disc degeneration, spinal stenosis, facet hypertrophy, osteophytosis, foraminal stenosis, and instability, all of which can cause back discomfort and/or neurological symptoms. Back pain affects 15% to 20% of adults each year, and around 17.000 new cases of spinal column injuries are reported in the United States each year.[4, 5]

Furthermore, along with proximal femoral and wrist fractures, vertebral fractures are the most common osteoporotic fractures among the elderly. 30–70% of individuals with initial malignancies develop spinal metastases, which can cause spinal cord compression, discomfort, spinal instability, and pathologic fractures.[6] This chapter aims to explain in detail about the influence of frailty on the spinal surgical procedures.

**Frailty and Spine Surgery:**

Spine surgery will need to expand as the population ages, in order to reduce neurologic adverse events and pain. Because spine surgery is associated with problems or even death, it is critical to identify individuals who are at higher risk prior to surgery, in order to reduce health-care expenses.As people get older, degenerative spine disease becomes more common and can be devastating. Complex spine surgery may provide relief, but it increases riskier as people get older. Only after the decision to have surgery are efforts to reduce the physiological impact of surgery through minimally invasive procedures and enhanced recovery programmes made to reduce risk.[7]

Traditional perioperative risk classification techniques are outperformed by frailty assessments. Frailty predicts post-surgery complications like reoperation for infection and 30-day mortality, as well as social cost factors like hospital length of stay and discharge to an advanced care facility. Different frailty evaluation techniques may function differently in people with degenerative spine disease because symptoms of spine illness overlap with phenotypic markers of frailty.

However, cognitive decline and psychosocial isolation, in addition to frailty, may interact with frailty and impact surgical results. Prehabilitation, which has been shown to lower perioperative risk in colorectal and cardiac surgery, may be beneficial to individuals who are considering difficult spine surgery. Physical exercise, nutritional supplementation, and behavioural treatments are common forms of prehabilitation that may provide clinical alleviation even in the absence of surgery.[8]

**Adult spinal deformity (ASD):**

ASD is a disabling disorder that has a significant influence on the health-related quality of life of patients. While there are a variety of causes for ASD, the most common cause appears to be age-related spine degeneration. Between 2000 and 2010, the incidence of ASD and surgical correction quadrupled due to an ageing population. [9] Although ASD correction

surgery has been proven to be effective, working with an older population often entails dealing with individuals who have other comorbidities. Surgical outcomes are determined not only by the success of the procedure, but also by the risk factors identified before to surgery. Several researches have been conducted to assess the impact of frailty and create robust techniques for forecasting risk profile and outcomes in order to solve this issue in ASD correction. [10]

**Frailty indices and spine surgeries:**

In comparison to non-orthopedic literature, the spine literature contains limited studies on frailty indices. The majority of studies on frailty indices are retrospective analyses of prospectively collected databases, in which a frailty index score is retrospectively evaluated using preoperative medical history to associate high frailty index scores with an increased postoperative complication rate. Higher degrees of frailty are associated with a higher risk of death, postoperative complications, longer hospital stays, and more likelihood of discharge to a rehabilitation facility in both general surgery and, specifically, spine surgical populations, according to the data. The effectiveness of a frailty index to predict postoperative problems varies depending on the study population, procedure invasiveness, and frailty index used.[7]

Although multiple frailty indices exist, those leading in the spine literature are as follows:

- modified frailty index (mFI)
- Charlson Comorbidity Index (CCI)
- Adult Spinal Deformity Frailty Index (ASD-FI) and
- Cervical Deformity Frailty Index (CD-FI).

There is no unanimity on which indicators should be utilized to assess the amount of frailty in spine surgery. While some studies have employed a combination of medical, functional, and laboratory parameters to evaluate a frailty score, others have utilised a combination of medical, functional, and laboratory measurements. Given the complex character of

the disease, there is a universal understanding that no one biomarker can be used to assess frailty on its own.

Although both the frailty index model and the frailty phenotypic assessments have advantages and disadvantages, some have concluded that the frailty index model, which quantifies the idea of frailty, is the most versatile and has the greatest relevance for both research and clinical usage.A spine-specific frailty index could be a valuable objective measure for a variety of applications, such as preoperative screening for high-risk patients and assessment of the complication rate for use in multidisciplinary conferences, particularly for high-risk ASD patients.[10]

Preoperative screening utilising a frailty index, followed by a multidisciplinary evaluation of surgical decision-making, has been shown to significantly reduce postoperative mortality in elective surgery.Elevated frailty index scores have been shown as an independent predictor of surgical complications in the spine group. Preoperative screening with a frailty index could identify high-risk patients who would then be eligible for a multidisciplinary conference to review their condition.[11]

The Charlson Comorbidity Index (CCI) is a frequently used comorbidity index that predicts mortality by weighting comorbidities. The CCI, which was created to predict 10-year survival rates, now predicts patients' 10-year death based on 19 comorbidity categories. Each ailment is assigned a value of 1,2,3, or 6 based on the related risk of mortality, with the score increasing by one point for every decade beyond 50.[12]Although some recent studies demonstrate that the CCI can predict significant complication rates in degenerative spine surgery, the results are mixed. Furthermore, no studies have been published that look at how comorbidities affect clinical outcomes in adult spinal surgery.[10]

Because only variables with the strongest link to poor outcomes are selected, specialty-specific indices, such as the Metastatic Spinal Tumor Frailty Index, could predict postoperative outcomes with more accuracy. The development of a spine-

specific frailty index, which includes radiographic and/or pertinent laboratory markers, could have enhanced the connection between index score and complication rate.[7]

**Impact of frailty on spinal surgery:**

As value-based healthcare models become more common, risk stratification in terms of perioperative complications and long-term outcomes is becoming more relevant. With an ageing population and an increase in the number of patients receiving spine surgery each year throughout the world, it's more crucial than ever to be able to accurately anticipate surgical outcomes. Frailty is a metric that is increasingly being used in a variety of surgical disciplines. Frailty indices can take into account the severity of existing co-morbidities and functional limitations to provide a more accurate picture of a patient's surgical risk profile. [13] Frailty indices for prognostication in spine surgery are a new concept that has gained popularity in recent years.

With an increasing senior population, spine surgeons are seeing elderly patients more frequently, resulting in a higher demand for risk assessment and cost-benefit analysis. The focus has always been on how age influences surgical results. In other surgical disciplines, the focus has shifted to frailty rather than age. The impact of frailty on outcomes following spine surgery is currently understudied.[14] One vital part of the decision-making process is understanding how frailty affects risk stratification in spine patients. We need to understand how frailty affects patient outcomes in order to correctly assess costs versus benefits in the aged and frail population.

Frailty is predicted to become more common and significant to this population as the likelihood of complications following spine surgery rises and the average age of patients receiving spine surgery rises. Despite these potential consequences, nothing is known regarding the frequency of frailty in the spine surgery population, or how frailty affects postoperative outcomes in this vulnerable group.[15] A study by Flexman et al suggested that frailty is an important predictor of postoperative

outcomes following degenerative spine surgery. Furthermore, the authors concluded that preoperative recognition of frailty may be useful for perioperative optimization, risk stratification, and patient counselling.[16]

**Summary:**

Inpatient head and neck surgery, as well as surgical intervention for adult spinal deformity and degenerative spine disease, frailty has been shown to be a predictor of morbidity and mortality.The currently known frailty indicators are competent for predicting perioperative complication risk and could be beneficial in preoperative screening and surgical management of geriatric spine patients.

**References:**

1.Buta BJ, Walston JD, Godino JG, et al. Frailty assessment instruments: Systematic characterization of the uses and contexts of highly-cited instruments. Ageing Res Rev. 2016; 26:53□61.

2. Street JT, Lenehan BJ, DiPaola CP, et al. Morbidity and mortality of major adult spinal surgery. A prospective cohort analysis of 942 consecutive patients. Spine J. 2012; 12:22-34.

3. Eliyas JK, Karahalios D. Surgery for degenerative lumbar spine disease. Dis Mon. 2011; 57:592□606.

4. Rubin DI. Epidemiology and risk factors for spine pain. Neurol Clin. 2007; 25:353-371.

5. National Spinal Cord Injury Statistical Center, Facts and Figures at a Glance. Birmingham, AL: University of Alabama at Birmingham, 2020.

6. Laufer I, Rubin DG, Lis E, et al. The NOMS framework: Approach to the treatment of spinal metastatic tumors. Oncologist. 2013; 18:744–51.

7. Simcox T, Antoku D, Jain N, et al. Frailty syndrome and the use of frailty indices as a preoperative risk stratification tool in spine surgery: a review. Asian Spine J. 2019;13(5):861.

8. Mohamed B, Ramachandran R, Rabai F, et al. Frailty Assessment and Prehabilitation Before Complex Spine Surgery in Patients With Degenerative Spine Disease: A Narrative Review. J Neurosurg Anesthesiol. 2021.

9. McCarthy I, O'Brien M, Ames C, et al. Incremental cost effectiveness of adult spinal deformity surgery: observed quality-adjusted life years with surgery compared with predicted quality-adjusted life years without surgery. Neurosurg Focus.2014;36(5):E3.

10.Laverdière C, Georgiopoulos M, Ames CP, et al. Adult Spinal Deformity Surgery and Frailty: A Systematic Review. Global Spine J. 2021:21925682211004250.

11. Shin JI, Kothari P, Phan K, et al. Frailty index as a predictor of adverse postoperative outcomes in patients undergoing cervical spinal fusion. Spine. 2017;42(5):304-310.

12. Chaudhry S, Jin L, Meltzer D. Use of a self-report-generated Charlson Comorbidity Index for predicting mortality. Med care. 2005:607-15.

13. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. J Am Coll Surg 2010;210:901-8.

14. Kweh B, Lee H, Tan T, et al. Spinal surgery in patients aged 80 years and older: risk stratification using the modified frailty index. Global Spine J. 2021; 11(4):525-32.

15. Sankar A, Johnson SR, Beattie WS, Tait G, Wijeysundera DN. Reliability of the American Society of Anesthesiologists physical status scale in clinical practice. Br J Anaesth 2014;113:424–32.

16. Flexman AM, Charest-Morin R, Stobart L, e al. Frailty and postoperative outcomes in patients undergoing surgery for degenerative spine disease. Spine J. 2016;16(11):1315-23.

# CHAPTER – 20

## Conclusion

Older adults are a diverse collection of people. Their health and functional status vary dramatically throughout their lives, based on genetic, biological, and environmental factors, as well as other physical, psychological, and social aspects. As a result, people of the same chronological age can have biological ages that differ.Frailty is gaining traction in the scientific community as a tool to better understand health disparities among the elderly. Because of the similarities and high coexistence rate of these descriptive categories, the terms frailty, ageing, disability, and comorbidity were practically interchangeably employed in the past. Frailty, ageing, disability, and comorbidity, on the other hand, have distinct characteristics. To begin with, advanced age does not always imply vulnerability to the bad health consequences associated with frailty. Frailty is connected with poorer socioeconomic position in adulthood and is at least partly programmed in early life. Second, frailty is defined as a state of reduced physiological reserve and diminished ability to maintain homeostasis as a result of several, compounded deficiencies caused by ageing. When exposed to an internal or external stressor, frail elderly persons are especially sensitive to negative health effects. Third, whereas frailty refers to instability and the possibility of losing function, disability is defined as a loss of function that is generally measured by difficulty or dependency in doing activities required to live freely.Finally, having two or more medically diagnosed diseases is referred to as comorbidity. Frailty, on the other hand, is distinctly distinct from advanced age, disability, and comorbidity.

**Identifying and Measuring Frailty:**

There are several indices to identify and grade the severity of frailty. The following table summarizes the various indices (Table 1).

**Table 1: Some of the Frailty indices**

| |
|---|
| Frailty index given by Rockwood and Mitnitski |
| Rockwood-Robinson Frailty Index |
| The Simple "FRAIL" Questionnaire Screening Tool |
| Fried Frailty Phenotype (FFP) and Frailty Index (FI) |
| Modified Frailty Index (mFI) |
| Risk Analysis Index(RAI) |
| Edmonton Frail Scale (EFS |
| Cumulative Deficit Model (CDM) |
| Comprehensive Assessment of Frailty (CAF) |

**Clinical Implication of Frailty:**

Frailty is very common, and it's linked to worse outcomes and higher health-care expenses. Frailty's global influence is projected to grow as the world's population ages. As a result, dealing with weakness is a pressing public health issue. The response should be a collaborative effort of older adults, health-care professionals, researchers, and policymakers in both high-income and lower-middle-income countries, where the population is ageing at a faster rate than in many high-income countries, and where resources are limited and health-care access is restricted.

In the last few decades, significant progress has been accomplished. Frailty research has exploded, and frailty awareness is now common across medical fields. Nonetheless, translating research into clinical practise will continue to be a difficulty in the future years. The on-going dispute about frailty assessment instruments isn't helping matters. The development of a few particular tools for certain situations, based on frequently gathered data, could potentially increase the acceptability and feasibility of frailty screening in clinical practise.

Longitudinal research, including analyses of trends and trajectories, as well as randomized controlled trials concentrating on therapies for older persons with frailty, is a high priority for the frailty research agenda. The use of a life-course approach may help us better understand how frailty and its risk factors emerge during earlier stages of life, as well as contribute to the creation of public health measures targeted at preventing frailty and its negative health consequences. This study will eventually lead to an increase in the well-being of frail older persons.

**Frailty and Anesthesia:**

Frailty is an important factor to notice in older surgical patients, and it can be quantified using a variety of tools. The FFP and the CDM are the two most used ways to assess frailty. Frailty is linked to increased surgical mortality and morbidity, and it may influence the perioperative anaesthetic strategy employed. In the literature and in clinical practise, the use of general anesthesia (GA) against regional anesthesia(RA) is fiecrcely contested, with no clear consensus. Individual deficits, probable complications, and surgical goals should all be addressed in a perioperative treatment plan for the frail patient. The advantages of RA for surgery and postoperative analgesia should be evaluated, and the anaesthetic approach used should be tailored to the patient. There is some evidence that CGA can improve results in the preoperative environment.

**Prehabilitation in Frailty:**

Prehabilitation is a relatively new idea that is increasingly being utilized to intervene on frail patients and improve their physical function and mental state prior to elective surgery. Collaboration between the treating teams and the patient is critical in developing a perioperative care plan that includes everything from preoperative planning to acute medical admission, rehabilitation, and discharge planning. The time has come to adopt a systematic frailty assessment in older

surgical patients, as well as paths for tailored management, which should include a discussion of the possibility of long-term unfavourable outcomes and non-operative treatment options.

In handling the ageing and frail surgical population, clinicians across the spectrum of care encounter new challenges. Frailty is a useful risk classification measure for elderly individuals because it better depicts their condition of increased susceptibility. It can make it easier to identify patients who would benefit from specific interventions. Nevertheless, multimodal prehabilitation is a practical and promising technique to addressing these issues, but larger-scale researches are needed before it can be widely used.

**Frailty and Surgery:**

Independently and through increased complications, frailty is a significant risk factor for readmission after elective, outpatient surgery. Frailty was linked to higher mortality, post-operative complications, a longer length of stay, and discharge to a residential care facility in patients over 75 years old. Frailty and 30-day mortality had the strongest indication of relationship. Regardless of the type of surgery conducted, the connection remained similar across multiple frailty instruments.

In summary, elderly patients undergoing any type of surgical procedure, frailty predicts mortality, postoperative problems, and institutional discharge. According to various researches and the data available, certain characteristics of frailty may be responsive to intervention, which could potentially lessen negative effects.

**Take home messages:**

- Frailty is linked to a variety of negative outcomes and higher health-care expenses.
- Frailty can affect humans of any age, but it is more common among the elderly.

- Frailty's global impact is predicted to grow as the world's population ages, particularly in low- and middle-income countries.
- A wide range of socio-demographic, clinical, lifestyle-related, and biological factors all have a role in the onset of frailty.
- In primary, secondary, and tertiary disease prevention, taking into account a person's degree of frailty in clinical practise could result in more patient-centered treatment and the avoidance of harm.
- Despite the fact that the notion of frailty is becoming more widely employed in primary, acute, and specialised care, translating research into clinical practise will remain a problem in the future years; specificity and standardization of frailty measurements are critical for advancement.
- Longitudinal research on trends and trajectories, as well as randomized controlled trials focused on frailty prevention or therapy, are high priorities on the frailty research agenda.
- Taking a life-course perspective could help us better understand how frailty and associated risk factors develop in early stages of life, as well as contribute to the development of new treatments.

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