FRAILTY: What Is It and How Might Aquatics Change Its Outcomes

Marty Biondi, PT DPT, CSSC, CEEAA

Historically, frailty has been juxtaposed with old age, but recently in medical literature it includes those affected by various debilitating conditions. And while it remains predominantly a geriatric syndrome caused by loss of reserve capacity in multiple physiological systems, it also represents an important predictor of adverse health outcomes. The magnitude is shown statistically since in the USA, 15.3% of *non-nursing home* 65 years and older adults are clinically frail; 45% are considered pre-frail.[1] Additionally, frailty is the leading cause of death for older adults (27.9%).[2]

Frailty is considered a syndrome that: (1) identifies individuals at high risk for dependency; (2) constitutes a condition of greater risk for adverse health outcomes; (3) can be reversed with implementation of nutritional assistance + **specific exercise program;** and (4) includes biomedical + psychosocial aspects.[3] It equates to significantly decreased ability to manage the environment, to accomplish ADL's and that a seemingly insignificant stressor leaves the individual totally "out of commission". The struggle to define it has persisted with a current focus on function; a study by Dr. Linda Fried et al at Johns Hopkins University developed an operational definition—the Frailty Phenotype Assessment Tool-- that both assesses current status and also provides predictive validity.[3-4] It resulted in defining frailty if 3/> criteria listed below are present; pre-frail is denoted if 1-2 criteria are met.[3,4]

1. Unexplained weight loss (> 5% body weight or 4.5 kgs over 1 yr.)
2. Slow walking speed: time/15'; slowest 20% by gender/height
3. Exhaustion: Noted if participant answered **often** to both "In the last week I felt that everything I did was an effort," and "In the last week I could not get going."
4. Reduced physical activity (<383kcal/wk.)
5. Reduced Grip Strength: lowest 20% by gender/height

While there are other tools currently utilized to assess frailty---and this is part of the problem---this assessment tool is accurate, reliable and easily managed in a clinical setting.

Physiologically, a multiplicity of events are associated with frailty and commonly represent age-related accumulation of the effects of inactivity + inadequate nutrition + unhealthy environment + disease/MEDS resulting in sarcopenia, malnutrition, bone loss, increased effort to move and exhaustion.[3-4, 6-7] It bears a discussion of such events as both a means to understanding the process, more importantly, to defend exercise as an amelioration of frailty's effects.

Think in terms of the on-going processes that occur in our cells, and specifically what happens with the Krebbs Cycle where there is energy released—ATP--- but at the expense of by-products that build up within the cells and need to be somehow transported out. We have anti-oxidant defenses that protect biological systems from the free radical toxicity associated with these by-products. However, due to constant

exposure to such oxidative stresses, there is an imbalance between formation and removal of these free radicals. This impaired ability to remove dysfunctional mitochondria from cell is a **KEY FACTOR** in the entire degradation of these various systems. Ultimately, the inefficiency of these processes represent pathologies associated with cell damage including: cardiovascular diseases, acute/chronic kidney disease, neurodegenerative diseases, biliary diseases, musculoskeletal diseases, cancers; all commonly associated—although not exclusively-- with old age.[8-11] In considering why frailty is expressed in terms of decreased strength, exhaustion, slowed gait speed, it is obvious that all of these are intimately associated with cell damage.

Maintenance of Skeletal muscle mass depends on a delicate balance between anabolic and catabolic factors. Since the skeletal muscle consumes large quantities of O2 it can generate great amounts of free radicals. These are mainly generated in mitochondria—the cell's powerhouse-- during normal respiration. Muscle loss results from a disproportionate decrease in muscle protein synthesis and/or increase in protein breakdown. With oxidative stress we see these changes within the muscle themselves and at the myoneural junctions. This oxidative injury poses a greater threat to Type II fibers which constitute our fast-twitch fibers—the power generating fibers. Response time is slowed due to decreased motor units + cell's inability to remove dysfunctional mitochondria so that there is less ability to perform protein synthesis; the power component of muscle contraction is impacted significantly. Muscle contractions cause free radical generation by the mitochondria and there is increased dysfunctional mitochondria so less is getting done. Power—task of Type II fibers-- is decreased as there is less of these fibers and there is an overall decrease in motor unit potential. It is no wonder that as one ages, there is decrease in power, speed and strength---not to mention that exhaustion factor due to damaged cardiovascular system. Additionally, those physical responses which keep one from falling are deleteriously affected at the cellular level. Of equal importance is the fact that **strength deficits precede loss of muscle mass**, which, if you think about it, really makes sense since cellular damage occurs—decreased action potential, decreased number + activity of motor units and decreased acetylcholine----prior to evidence of sarcopenia.[10-12] We currently address sarcopenia but we fail to connect the dots leading to frailty.

Thus, it is the mitochondrial dysfunction that is a primary contributor of aging because of its proximity to primary source of oxidants which results in increased free radicals that equal cell death. Aging equates to loss of homeostasis because of this chronic oxidative stress. Additionally, because these radicals are not be moved from the cell efficiently, it prompts an immune system activation that induces an inflammatory state which becomes chronic. These elevated levels of inflammatory markers inversely correlate with poor physical activity, muscle weakness, disability, and also affect insulin response. In summary, there occurs a decrease in muscle strength due to the loss of muscle mass (quantity) as well as an intrinsic loss of force production capability (quality) followed by a cascade of deleterious factors including: disrupted homeostasis, insulin resistance that blunts protein synthesis, altered endocrine response that decreases growth hormone release, increased mitochondrial death all that **results frailty due to a multi-system disruption of homeostasis.**[12-14]

It has been shown that **"Vigorous physical activity that is carried out at least once a week appears to be the most effective means to reduce the progression of frailty in older people….Physical Activity is the driver of frailty differences between different age cohorts."**[15] Small number of randomized controlled trials (RCT) do tentatively suggest that physical improvement can occur with a tailored program, and since there is neither an agreed upon definition of frailty nor specified core measurements to assess frailty, attempts to validate optimal interventions remain to be seen. In a 2019 study by Kidd et al that assessed RCT's it was found that interventions combining resistance + balance were most successful in treating physical symptoms associated with frailty, reducing falls, maintaining health.[16] A summary guide in the management of frailty from multiple RCT's is summarized here with the stipulation the research is still urgently needed.[17-23]

- Target resistance training to improve physical strength+ muscle mass.

Strength training is safe for all
30-40% of IRM positively impacts frail- builds strength
Moderate intensity *does not appear to benefit those non-frail 50-65 y/o's*

- High intensity interventions are more effective than low intensity +have greatest positive outcomes for function

Significantly decrease frail trajectory

- **Combining resistance + balance training is most successful in managing symptoms associated with frailty**

Appropriate combinations may provide greater support in decreasing falls + maintaining health benefits
Prevention intervention is still urgently needed

Thus, based on the above-mentioned guidelines, in addition to being able to satisfy the requirements for managing frailty with exercise, water brings several unique components to the table, perhaps the most important being the safety aspect related to falls. It effectively provides for the key components of:

- **Safety: No risk for fall and fracture**
- **Strength Training: Adaptable intensity per individual tolerance + increased intensity**
- **Postural Support**
- **Can provide cardiovascular benefits with exercises**

One can incorporate a structured aquatics program bearing in mind the specific properties of water which assist with balance and posture, effectively challenge strength while providing regulated dose related to response, initiate power training and incorporating directional changes with speed to assist with balance. In conclusion, aquatics, while not considered mainstream therapy for frailty, can be not only a viable component, but a preferred component of the rehabilitation process when used appropriately and with logical progressions.

References

1. Bandeen-Roche K. Seplaki CL. Huang J. et al. Frailty in older adults: a nationally representative profile in the United States. *J Gerontol: Medical Sciences.*2015;70(11):1427-1434. DOI: 10.1093/geronal/glv133.
2. Clegg A. Young J. Iliffe I. et al. Frailty in older people. *Lancet.*2013; 381(868):752-762. DOI:10.1016/S0140-6736(12)62167-9.
3. Fried LP. Tangen CM. Walston J. et al. Frailty in older adults: evidence for a phenotype. *J Gerontol: Medical Sciences.* 2001;56A(3):M146-M156.
4. Lang P-O. Michel J-P. Zekry D. Frailty Syndrome: a transitional state in a dynamic process. *Gerontology.*2009;55:539-549. DOI: 10.1159/000211949.
5. de Villers L. Frailty. 355 *CME.*2013;31(10).
6. Clegg A. Young J. Iliffe I. et al. Frailty in older people. *Lancet.*2013; 381(868):752-762. DOI:10.1016/S0140-6736(12)62167-9.
7. Buckinx F. Rolland Y. Reginster J-Y. et al. Burden of frailty in the elderly population: perspectives for a public health challenge. *Arch Public Medicine.*2015;73:19-26. DOI: 10.1186/s13690-0068-x.
8. Bisset ES. Howlett SE. The biology of frailty in humans and animals: understanding frailty and promoting translation. *Aging Medicine.*2019;2:27-34. DOI: 10.1002/agm2.12058.
9. Soysal P. Isik AT. Carvalho AF. et al. Oxidative stress and frailty: a systematic review and synthesis of the best evidence. *Maturitas.*2017;66-72. DOI: 10.1016/j.maturitas.s017.01.006.
10. Gomes MJ. Martinez PF. Pagan LU. et al. Skeletal muscle aging: influence of oxidative stress ad physical exercise. *Oncotarget.*217; 8(12):20428-20440.
11. Liguori I. Russo G. Bulli G. et al. Oxidative stress, aging and disease. *Clinical Interventions in Aging.*2018;13:757-772. DOI: 10.2147/CIA.5158513.
12. El Assar M. Agulo J. Rodriguez-Manas L. Frailty as a phenotypic manifestation of underlying oxidative stress. *Free Radical Biology and Medicine.*2019. DOI: 10.1016/j.freeradbiomed.2019.08.011.
13. Szentesi P. Csernoch L. Dux L. Changes in redox signaling in skeletal muscle with aging. *Oxidative Medicine and Cellular Longevity.*2019. DOI: 10.1155/2019/4617801.
14. Faller JW. Pereira DDN. deSoreza S. et al. Instruments for the detection of frailty syndrome in older adults: a systematic review. *PlosOne.*2019;14(4). DOI: 10.1371/journal.pone0216166.
15. van de Bergh JP. van Geel TA. Geusens PP. Osteoporosis, frailty and fracture: implications for case finding and therapy. *Nat Rev Rheumatol.* 2012;8:163-172. DOI: 10.1038//nrrheum.2011.217.
16. Kidd T. Mold F. Jones C. et al. What are the most effective interventions to improve physical performance in pre-frail and frail adults? A systematic review of randomized control trials. *BMC Geriatrics.*2019;19:184. DOI: 10.1186/s12877-0196-x.
17. St-Jean-Pelletier J. Pion CH. Leduc-Gaudet J-P. et al. The impact of ageing, physical activity, and pre-frailty on skeletal muscle phenotype, mitochondrial content, and intramyocellular lipids in men. *J Cachexia, Sarcopenia and Muscle.* 2017;8:213-228.DOI: 10.1002/jcsm.12139.
18. Cesari M. Vellas B. Hsu F-C. et al. A physical activity intervention to treat the frailty syndrome in older persons—results from the LIFE-P study. *J Gerontol: Medical Sciences.* 2015;70(2): 216-222. DOI: 10.1093/geronta/glu099.
19. Bettis T. Kim BJ. Hamrick MW. Impact of muscle atrophy on bone metabolism and bone strength: implications for muscle bone cross-talk with aging and disuse. Osteoporosis International. 2018;29(9):1713-1720.
20. van de Bergh JP. van Geel TA. Geusens PP. Osteoporosis, frailty and fracture: implications for case finding and therapy. *Nat Rev Rheumatol.* 2012;8:163-172. DOI: 10.1038//nrrheum.2011.217.
21. de Labra C. Guimares-Penherro C. Maseda A. et al. Effects of physical exercise interventions in frail older adults: a systematic review of random clinical trials. *BMC Geriatrics.*2015. DOI: 10.1186/s12877-015-0155-4.
22. Rogers NT. Marshall A. Roberts CH. Et al. Physical activity and trajectories of frailty among older adults: evidence from the English Longitudinal Study of Aging. *PlosOne.* 2017;12(2). DOI: 10.1371/jounralpone.0170878.
23. de Vries NM. von Ranevsberg CO. Hobbelen JS. et al Effects of physical exercise therapy on mobility, physical functioning, physical activity, and quality of life in community-dwelling older adults with impaired mobility, physical disability and/or multi-morbidity: a meta-analysis. *Aging Res Rev.*2012;11(1):136-149. DOI: 10.1016/j.arr2011.11.002.