The Accumulating Deficits Model For Postoperative Mortality and Readmissions: Comparison of Four Methods Over Multiple Calendar Year Cohorts

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Background

Frailty is a syndrome characterized by multisystem physiologic and cognitive decline leading to an increased vulnerability to stressors and adverse clinical outcomes.[1] Over the last two decades, there has been an increase in research on the effects of frailty on a variety of outcomes, including surgical outcomes.[2] This research has led to numerous measures of frailty. The measurement instruments having included enumeration of medical deficits, assessment of physical strength and agility, assessment of cognitive function, determination of muscle mass, identification of residence with assessment of activities of daily living, assessment of patient-perceived quality of life or some combination of factors. There are different models of measurement and different types of studies conducted. These have included single- or multi-institutional retrospective medical record cohorts, single- or multi-institutional prospective observational cohorts, and administrative or quality-improvement databases. Some types of measurements are better suited for one type of data-gathering compared to another. For example, assessments requiring individual measurement of cognition or grip strength are not possible from administrative databases. Enumeration of medical deficits, such as the accumulating deficits model, is widely used for administrative database research on frailty. The basis of this model sums medical deficits, which increases the frailty score.

Problem Statement

Can a modified frailty index be applied to a national administrative database to demonstrate postoperative mortality and readmission rates reliably on a year-to-year basis?

Methods

- The accumulating deficits model that has been most studied and in the longest use is the frailty index (FI) of Mitnitski from the Canadian Study of Health and Aging (CSHA). This FI has undergone refinements such that its original 71 items have been reduced to 57 health items, most recently by Rockwood et al.
- The Healthcare Cost and Utilization Project State Inpatient Database for the state of Florida (HCUP-SID-FL) for the years 2011-2015 was used for the source of data for the assessment of frailty. We looked at 30-day postoperative mortality and 30-day readmission rates. Information on procedures and diagnoses are available on the database in the form of ICD9 codes.
- We mapped the 57-item index developed by Rockwood onto over 14,000 ICD9 diagnosis codes. We matched 42 of the 57 items on the database. These 42 matched items are what we refer to as our modified frailty index. The 15 items that did not match were generally indistinguishable from one another (e.g. depression, depressed mood, feeling sad or blue), we decided to only use 1 of the items. We then used this index on over 4 million patients to track their postoperative mortality and readmission rates over the calendar years of 2011-2015.
- We were able to take our 42-item mFI and use it to enumerate 4 different ways of producing a frailty score. In method 1 we used the admission diagnostic codes corresponding to the FI categories, divided by 42. This score produces a fraction. In method 2, because the admission diagnostic codes did not always list all of the patient's chronic conditions, we then used the number of chronic conditions divided by 42. This score also produces a fraction. In method 3 we subtracted the number of chronic conditions on admission from the number of diagnoses upon discharge. This gives us a measure of the increase in accumulated deficits during the hospitalization. This score produces a whole number. Method 4 is the Charlson co-morbidity index, which is simply the number of co-morbidities that are considered important in comparing outcomes of treatments. We used it as another model of accumulating deficits.

Results

FRAILITY INDEX – FLORIDA 2011-2015
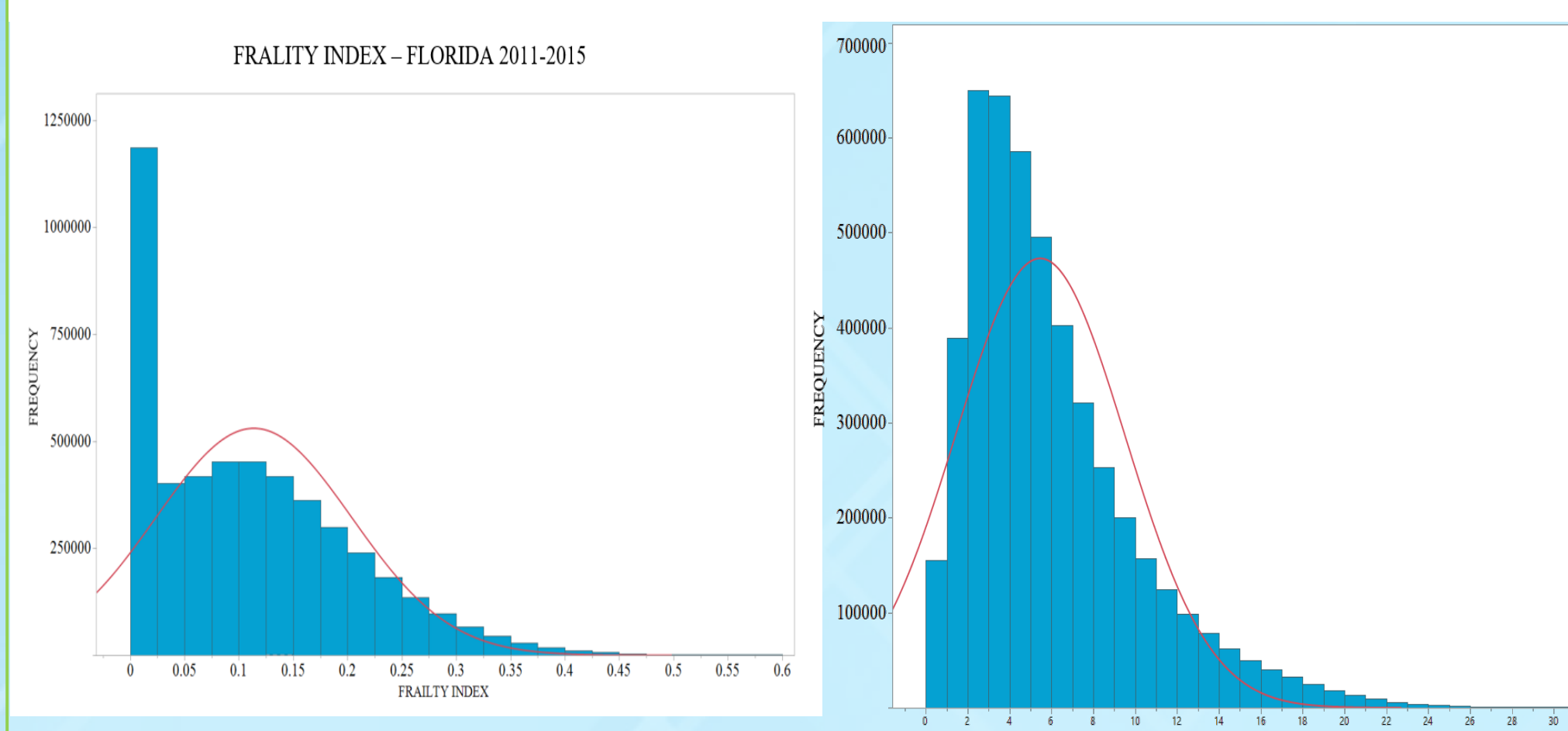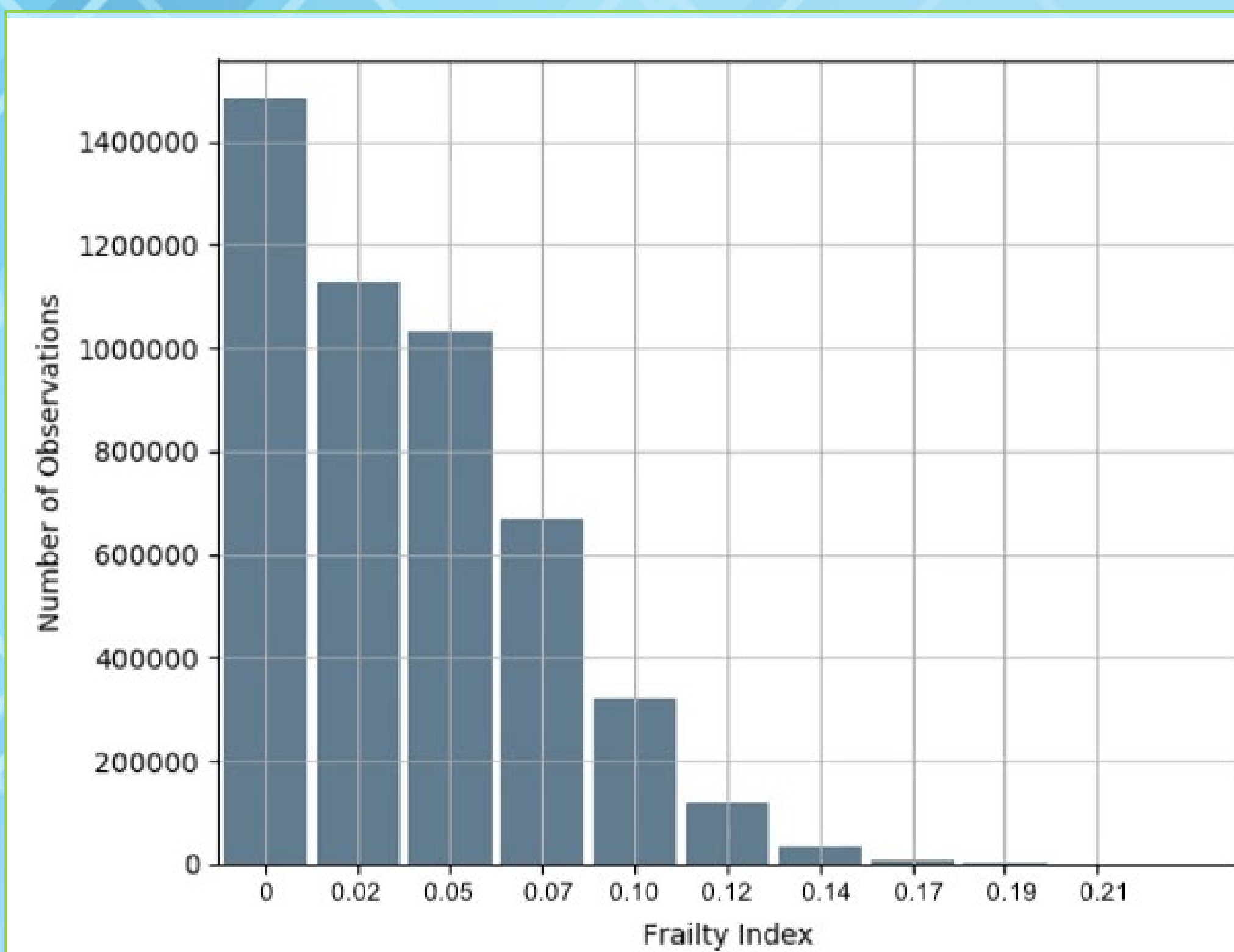
Mortality		
Survived	98.61%	4729466
Died	1.39%	66540
Readmission		
No Readmits	92.36%	4429382
Readmits	7.64%	366624

	mFI (NChronic)		mFI(Dx)		mFI(DxIn)		CCI	
Year	Median	IQR	Median	IQR	Median	IQR	Median	IQR
2011								
Not Readmitted	0.095	0.142	0.02	0.05	4	5	1	2
Readmitted	0.142	0.119	0.07	0.05	6	6	2	3
Survived	0.095	0.142	0.02	0.05	4	5	1	2
Died	0.190	0.119	0.05	0.05	11	7	3	3
2012								
Not Readmitted	0.095	0.142	0.02	0.05	4	5	1	2
Readmitted	0.142	0.119	0.07	0.05	6	6	2	3
Survived	0.095	0.142	0.02	0.05	4	5	1	2
Died	0.214	0.119	0.05	0.05	12	7	3	3
2013								
Not Readmitted	0.095	0.142	0.02	0.05	4	5	1	2
Readmitted	0.142	0.119	0.07	0.05	6	6	2	4
Survived	0.095	0.142	0.02	0.05	4	4	1	2
Died	0.214	0.119	0.05	0.05	12	8	3	3
2014								
Not Readmitted	0.095	0.142	0.02	0.05	4	5	1	2
Readmitted	0.142	0.119	0.07	0.05	7	6	2	4
Survived	0.095	0.119	0.02	0.05	5	5	1	2
Died	0.214	0.119	0.05	0.05	12	7	3	3
2015								
Not Readmitted	0.095	0.119	0.02	0.07	5	5	1	2
Readmitted	0.166	0.119	0.07	0.05	7	7	2	3
Survived	0.119	0.142	0.02	0.05	5	5	1	2
Died	0.214	0.119	0.05	0.05	13	7	3	3

Discussion

There are many ways to measure frailty. All have been associated with higher rates of postoperative morbidity, mortality and readmission. Of the many ways to measure frailty, the "accumulating deficits" model as developed by Rockwood and colleagues can use easily accessible data from a variety of data sources[3,4]. In this study, we used the HCUP -FL database. Rockwood's FI is advantageous in that not all of the 57 items listed need to be recorded in the record to produce a reliable FI. They noted that any 10 items can be used to determine an FI[5]. However, what was not known is if the type of data points to enumerate the accumulating deficits matter. Also, it was not clear whether these methods of enumerating the deficits would be stable from year to year in any given database. We have shown that the FI, as modified for the 42 items mapped on to it from the HCUP-FL database using the different classes of data points, as well as the CCI, can discriminate between patients who ultimately suffer a postoperative mortality and readmission. Since our mFI can be determined with patient history alone, it can be easily implemented on administrative databases and electronic health records. Additionally, we believe our mFI demonstrates reliability because the discriminatory ability is stable on a year-to-year basis. Therefore, it appears that the concept of accumulating deficits is robust and stable in a variety of settings. This project can be applied to 2 SELECT competencies; health systems and values-based patient centered care. Our modified frailty index provides an additional measure, which can be used pre- intra- and post-operatively to help guide decisions. Pre-operatively, the index can inform surgeons and anesthesiologists the risk of operating, guiding the decision to operate. Intra- and post- operatively, the index can guide special considerations relating to that specific patient, for example, whether to reserve an ICU bed after the procedure. This proposes a direct change in health systems because it adds a tool that incorporates considerations of risk-benefit analysis, health care delivery settings, and quality patient care. Our project can also be applied to values-based patient centered care because it aids in the management of the patient by using shared decision making in the care of the patient. Our index can be used as a tool in discussion between physicians and patients to appropriately manage expectations pre- and post-operatively.

Conclusion

In conclusion, the mFI's based on Rockwood's FI and the CCI are stable from year to year in the state of Florida HCUP database. Overall and year to year, postoperative deaths and readmissions where consistently associated with higher mFI and CCI scores, independently of which and how the deficits were enumerated. Our mFI can be used as a tool to help guide decision making for physicians pre- intra- and post-op, as well as acting as a tool for shared decision making between the physician and patient.

REFERENCES

1. Ko FC. The clinical care of frail, older adults. Clin Geriatr Med 2011;27:89-100
2. Ko FC. Preoperative frailty evaluation: A promising risk-stratification tool in older adults undergoing general surgery. Clin Ther 2019;41:387-399
3. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. Sci World 2001;1:323-336
4. Rockwood K, McMillan M, Mitnitski A, Howlett SE. A frailty index based on common laboratory tests in comparison with a clinical frailty index for older adults in long-term care facilities. J Am Med Dir Assoc 2015;16:842-847
5. Rockwood K, Andrew M, Mitnitski A. A comparison of two approaches to measuring frailty in elderly people. J Gerontol A Biol Sci Med Sci 2007;62:738-743
6. Charlson MEM, Pompei P, Ales KL, MacKenzie CR. A method of classifying prognostic co-morbidity in longitudinal studies: Development and validation. J Chronic Dis 1987;40:373-383
7. Velanovich V, Antoine H, Swartz A, et al. Accumulating deficits model of frailty and postoperative mortality and morbidity: its application to a national database. J Surg Res 2013;183:104-110
8. Gondal AB, Hsu CH, Zeeshan M, et al. A frailty index and the impact of frailty on postoperative outcomes in older patients after bariatric surgery. Surg Obes Relat Dis 2019;15:1582-1588
9. Monaghan TF, Wagg AS, Bliwise DL, et al. Association between nocturia and frailty among elderly males in a Veterans Administration population. Ageing Clin Exp Res 2019 Nov 23 [Epub ahead of print]
10. Artiles-Armas M, Roque-Castellanos C, Conde-Martel A, Marchena-Gomze J. The comprehensive complication index is related to frailty in elderly surgical patients. J Surg Res 2019;244:218-224
11. Schaller MS, Ramirez JL, Gasper WJ, et al. Frailty is associated with an increased risk of major adverse cardiac events in patients with stable claudication. Ann Vasc Surg 2018;50:38-45
12. Sirois M-J, Griffith L, Perry J, et al. Measuring frailty can help emergency departments identify independent seniors at risk of functional decline after minor injuries. J Gerontol A Biol Sci Med Sci 2017;72:68-74
13. Blogett J, Theou O, Kirkland S, et al. Frailty in NHANES: Comparing the frailty index and phenotype. Arch Gerontol Geriatr 2015;60:464-470
14. Armstrong JJ, Mitnitski A, Lauer LJ, et al. Frailty in the Honolulu-Asia aging study: Deficit accumulation in a male cohort followed to 90% mortality. J Gerontol A Biol Sci Med Sci 2015;70;125:131
15. Vairaktarakis C, Tsiamis V, Soursou G, et al. A computer-aided diagnosis system for geriatric assessment and frailty evaluation. Adv Exp Med Biol 2015;820:69-77