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Special Article: From research to bedside: incorporation of a CGA-based frailty index among multiple co-management services

Running head: FI-CGA in diverse clinical settings

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KR has asserted copyright of the Clinical Frailty Scale through Dalhousie University's Industry, Liaison, and Innovation Office. Use is free for education, research, and not-for-profit health care. Users agree not to change charge for, or commercialize the scale. In addition to academic and hospital appointments, Kenneth Rockwood is Co-founder of Ardea Outcomes, which (as DGI Clinical) in the last three years has contracts with pharma and device manufacturers (Hollister, Novartis, Nutricia, Roche, Takeda) on individualized outcome measurement. In 2020 he attended an advisory board meeting with Nutricia on dementia, and chaired a Scientific Workshop & Technical Review Panel on frailty for the Singapore National Research Foundation

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Key Points:

- The FI-CGA can be incorporated in a tailored but standardized way across diverse clinical services
- Ongoing process improvement is vital to maintaining quality of the FI-CGA and disseminating best practices across the institution

Why Does it Matter?

The process outlined can be used by others to introduce and incorporate an FI-CGA

Narrative

The comprehensive geriatric assessment (CGA) is the core tool used by geriatricians across diverse clinical settings to identify vulnerabilities and estimate physiologic reserve in older adults. In this paper, we demonstrate the iterative process at our institution to identify and develop a feasible, acceptable, and sustainable bedside CGA based frailty index tool (FI-CGA) that not only quantifies and grades frailty but provides a uniform way to efficiently communicate complex geriatric concepts such as reserve and vulnerability with other teams. We describe our incorporation of the FI-CGA into the electronic health record (EHR) and dissemination among clinical services. We demonstrate that an increasing number of patients have documented FI-CGA in their initial assessment from 2018-2020 while additional co-management services were established (Figure 2). The acceptability and sustainability of the FI-CGA, and its routine use by geriatricians in our division, were demonstrated by a survey where the majority of clinicians report using the FI-CGA when assessing a new patient and that the FI-CGA informs their clinical management. Finally, we demonstrate how we refined and updated the FI-CGA, we provide examples of applications of the FI-CGA across the institution and describe areas of ongoing process improvement and challenges for the use of this tailored yet standardized tool across diverse inpatient and outpatient services. The process outlined can be used by other geriatric departments to introduce and incorporate an FI-CGA.

Introduction

The core tool of the geriatrician is the comprehensive geriatric assessment (CGA). The CGA is essential to maximizing the well-being and independence of older adults in that it identifies areas of vulnerability and estimates physiologic reserve. Performance of the CGA is an entrustable professional activity of graduating Geriatric fellows, and distinguishes geriatricians from internists and family medicine physicians (1). Furthermore, the detailed assessment performed as part of the CGA can uncover specific factors underlying the physiologic and functional capacity of an individual, which has been described as "staging the aging" (2). It allows for a multi-domain assessment of aging in order to offer care that is aligned with biologic age and provide a geriatric care plan; it also identifies individuals at higher risk for adverse health outcomes.

Information obtained from the CGA may be used to construct a frailty index (FI-CGA) based on the deficit accumulation model of frailty (3,4). The FI-CGA "quantifies" the CGA into a single measure that has been shown to predict a range of clinical outcomes (5–8). This allows the CGA to be used not only as a risk stratification tool but also as a measurement of geriatric domains where interventions can be directed prior to and during treatment plans. In addition to estimating physiologic reserve and vulnerability to acute stressors, a frailty assessment may grade the degree of frailty, allow for more precise prognostication, and facilitate goals of care discussions (9,10). Importantly, estimating the baseline state in frail older adults offers insight into the care plan that can be specifically tailored to patients' and caregivers' needs. However, critics have suggested that it may be too cumbersome to implement in routine clinical practice (11). Although many tools can measure frailty clinically, here we describe how we have been able to sustainably adapt the FI-CGA for use in busy clinical settings, across multiple services at a single institution. Further, we describe multiple iterations of refinement over a 5-

year period and expansion among our embedded co-management clinical services across a diverse range of departments, as well as our challenges and suggestions for future directions (Figure 1).

Step 1: Identifying a Suitable Frailty Tool

The clinical services offered by the Division of Aging at Brigham and Women's Hospital (Boston, MA, USA) are structured to provide geriatric co-management by geriatricians (including board-certified physicians, geriatric-trained nurse practitioners and physician assistants) for patients receiving care throughout different specialties in both inpatient and outpatient settings, such as Primary Care, Oncology, Orthopedic Surgery, Hospital Medicine, and Trauma Surgery. Each program has an agreed upon trigger for geriatric co-management, for example in Orthopedic Surgery age 70 and above is used while Trauma Surgery and Hospital Medicine use age 70 and above with a positive FRAIL screen (12) or a Geriatric Syndrome as a trigger. Geriatric co-management is a model of care that involves active collaboration between geriatricians and non-geriatrics clinicians, with the goal of active prevention and management of geriatric syndromes (13). The needs of each specialty and clinical setting vary, but frailty can serve as the fulcrum of a comprehensive approach that is not merely disease-based (14).

In 2015, geriatricians in our Division recognized the importance of assessing frailty in older adults in a structured and quantifiable way. However, when selecting a frailty assessment instrument, we found it challenging to identify one that combined clinical ease of use with the simultaneous ability to capture the complexity of the CGA. Given its ease of administration, we initially used the Clinical Frailty Scale (15,16). However, we sought a tool that would better reflect the intricacies of a CGA while allowing for a common language among clinicians. The advantage of this approach is similar to that provided by the Ejection Fraction (EF%) in congestive heart failure or Forced Expiratory Volume (FEV1) in chronic obstructive pulmonary disease, which provides cardiologists and pulmonologists with a standard measure to apply across complex disease processes. Nonetheless, the components of the FI-CGA, as well

as the sum of the assessment, need to be carefully interpreted by geriatricians just like pulmonary function tests and echocardiograms are signed by pulmonologists and cardiologists in the healthcare system.

The FI-CGA, derived from the CGA our geriatricians were already conducting, was identified as a candidate model (17) that could incorporate both objective findings and self-reported health variables in a quantitative manner. The FI-CGA could then be easily reported, interpreted, and communicated among clinicians.

To learn more about the FI-CGA and find ways to adapt it from a research tool to a practical assessment for clinical use, geriatricians from our division met with co-author Dr. Kenneth Rockwood and colleagues from Dalhousie University to understand the foundations of the FI-CGA and how it could be applied in clinical practice. Our Dalhousie colleagues reviewed the history and construction of the FI-CGA, mathematical formulae, and considerations for adaptation to different populations of older adults. Our division then systematically met with stakeholders in the Departments of Medicine and Surgery (initially Orthopedics and Trauma), hosted a Medicine Grand Rounds on frailty and collaborated with new specialties, thus breaking new ground in geriatric clinical innovation at our institution. Meanwhile, the FI-CGA was iteratively refined in collaboration with the Dalhousie team, as described below.

Step 2: Development of FI-CGA for Clinical Care

Once a sustainable FI-CGA was identified, the next step was to construct a local institutional frailty index based on a standard procedure for validity and reliability (18), with the original clinical FI-CGA used as the foundation (19). The original FI-CGA contained 70 variables (15). Over time, frailty indices ranging from 20 to 130 variables have been validated (20–22) and have been shown to predict adverse outcomes in different populations (6,23,24).

Our primary goal was to make the FI-CGA useful for clinical practice. We selected variables for the FI-CGA according to the principles of constructing a valid FI (18), namely, that health deficits included should be age-related and associated with adverse outcomes, but must not saturate too early. Health deficits should also cover multiple organ systems, and enough variables should be included to capture multiple domains of health (e.g., not just cardiovascular health). Also important would be to determine how to score each deficit: for example, for a functional variable such as "feeding," 1 point is assigned for "dependent," 0.5 points for "assist," and 0 points for "independent." Once it had been measured in 169 of our patients, we continued close collaboration with the Dalhousie team in validating the FI-CGA , by determining which of 62 potential variables to include, how to code and score each variable, how to set a maximum score for counted comorbidities (set at 18), and which comorbidities to include in order not to exceed the limit of 30% of the FI-CGA score (to avoid a "comorbidity index") (18). The final FI-CGA contained 60 variables (Table 1) to calculate a FI-CGA score (with a minimum of 30 variables for any given assessment to ensure stability of the measurement) (18). A score was generated for each patient by counting the number of deficits and dividing by the number of items measured (Table 1). All variables were based on information that could be readily obtained from a bedside geriatric assessment and objective physical exam, such as cognitive evaluation, chart review, or patient self-report. In addition, we chose to use a separate Social Vulnerability Index (SVI) (25,26) that can be combined with the FI-CGA for measuring social determinants of health.

Using this new, standardized construct to summarize the CGA and measure frailty was well-accepted among Division of Aging geriatricians. The first iteration of our institutional FI-CGA was calculated using a Microsoft Excel file which we found created a barrier to clinical implementation and documentation. Therefore, our priority was incorporating the FI-CGA into the electronic health record (EHR).

Step 3: Incorporation into the EHR and Dissemination among Clinical Services

Passive electronic FIs (eFIs) have been developed, mostly relying on diagnosis codes, labs, vitals, and Medicare Annual Wellness Visit functional assessment when available (27). While these eFIs have the advantage of being based on previous data and readily available measurements, essential information on current and especially changes in cognition, mood, detailed daily function and mobility are unavailable. The FI-CGA overcomes this limitation because it is based on clinical geriatric assessment conducted at bedside. A combination of information generated from EHR together with clinical evaluation is the most valuable and ultimately, the goal.

After using the FI-CGA manually and refining the variables, we sought to incorporate it into the electronic health record (EHR) in a manner that would be accessible to all geriatricians. This was crucial to improve usability of the FI-CGA in practice, streamline assessments, reduce documentation burden, and communicate our FI-CGA with other clinicians, including interprofessional teams. Fortunately, our institution was in transition to a new EHR "EPIC" which enabled many modifications. This was accomplished through six one-hour meetings with the information technology team over a span of a year, the FI-CGA was programmed into a layout that included all the variables and their relative weights with an integrated calculation of a final FI-CGA value. The FI-CGA was then embedded into our local institution's EPIC "Flowsheets" function, which allows the user to enter an FI-CGA in the current patient encounter, track serial FI-CGAs, and pull the FI-CGA into the clinical note. From a systems perspective, this was critical to ensure that the FI-CGA could be routinely and uniformly used by all geriatricians. In addition, this led to standardization of clinical practice for frailty assessments and improved communication among geriatricians in the division (Supplementary Table 1). Once this was completed and refined over a year's time, the clinical team expanded the use of the tool across all geriatric co-

management services. This led to rapid dissemination across geriatricians and services, and continued input and innovation from the team. The next step was to refine and update the FI-CGA to best fit our clinical services and diverse patient populations.

Step 4: Refining and Updating the FI-CGA

After the FI-CGA was incorporated into the workflows of the geriatric co-management services, we continued to refine and update the FI-CGA to best fit our clinical services and unique patient populations. New patients underwent a CGA according to our usual practice, which was then documented in the EHR-embedded FI-CGA and communicated to the interprofessional team. However, there were still important challenges to address that included the feasibility of use during clinical practice (e.g., completion time, documentation burden), and inter-rater reliability. Although inter-rater reliability was not explicitly performed, our educational process for administration of the FI-CGA was consistent over time as a single geriatrician (HJ) taught how to perform the FI-CGA to all the other geriatricians and fellows. This was conducted by specifically teaching over a 6-week period how to elicit and count the deficits in health. In addition, to address these challenges, our team developed working groups inviting all geriatricians in the division to participate (n=11) and met monthly over a period of 6-8 months, so areas of low agreement were discussed and adjudicated as discussed below.

The working groups reviewed each FI-CGA variable and there was opportunity for comments among team members. Items were updated only when group consensus was reached. For example, the initial iteration included a total count of comorbidities, but did not specify which age-related co-morbidities should be included or excluded, so we created a close-ended list of comorbidities that were selected based on their adherence to the deficit accumulation criteria (18). In addition, some patient-reported items were felt to be highly variable, such as reported low mood; these were removed to improve reproducible measurement within and across patients. Other components, such as validated

cognitive assessment tools and anxiety and depression screening tools were added to improve assessment reliability among geriatricians. Additionally, to standardize assessments performed by different geriatricians, we added clarifying language, including descriptive taglines in the electronic FI-CGA calculator, (Table 1). It also became clear that measuring frailty at steady state requires agreement about the time frame in which a possible deficit is assessed. For example, in the acute setting, a patient's status in the 2 weeks prior to admission is often used to measure frailty, while in the outpatient setting it may be longer (19).

As we were refining the FI-CGA, we shared our success with hospital leadership, secured increased funding used to hire additional faculty geriatricians for introduction of new geriatric co-management programs that were integrated into the hospital medicine service and oncology services at the Dana-Farber Cancer Institute. Since its incorporation in 01/01/2018, documentation of the FI-CGA in our EHR rapidly increased over time and has been sustained in both inpatient and outpatient settings (Figure 2). In a recent survey completed by 12 of 14 geriatricians in our Division, 100% reported always using the FI-CGA when assessing a new patient, with none reporting impediments to workflow (see questionnaire responses, Supplementary Table 2). Moreover, the vast majority of clinicians reported that the FI-CGA informs their clinical management. Together, these data support the acceptability and sustainability of incorporating the FI-CGA and its routine use by geriatricians. The next step was to explore additional applications of the FI-CGA within our institution.

Application of the FI-CGA across the Institution

Two new initiatives at our institution required geriatric expertise and offered an opportunity for further dissemination of the FI-CGA. The first is the Geriatric Surgery Verification (GSV) Program (12,28) and the second is the Age-Friendly Health Systems certification process. In order to achieve GSV

recognition, our institution built multidisciplinary teams including geriatricians, surgeons, anesthesiologists, palliative care clinicians, and nurses to implement various aspects of best geriatric practices. By uniformly using the FI-CGA, geriatric team members were able to efficiently communicate complex geriatric concepts such as reserve and vulnerability with care teams prior to surgery. This is an example how the division has now expanded the FI-CGA across the continuum of care for older adults, from the pre- to post-operative setting.

In 2020, our institution embarked on the Age-Friendly Health Systems certification process, an initiative from the Institute for Health Care Improvement and John A. Hartford Foundation to improve care for older adults. The framework consists of four evidence-based elements of high-quality care, known as the "4Ms": Mobility, Matters Most, Medication, and Mentation. The standardized CGA which captures these four domains and more, has become an important element of care provided by the division across multiple hospital sites and services. The FI-CGA serves as a method for detailed documentation to capture delivery of geriatric care in our health system and communicate this care to health professionals in multiple settings.

Areas of Ongoing Process Improvement

The process of introducing, standardizing, and disseminating the FI-CGA tool among multiple geriatric team members across multiple services took years of collaboration and continuous improvement within and outside of our institution. The process continues as additional co-management services are established. The integration of services into Primary Care and Hospital Medicine have improved geriatrics exposure and educational opportunities for Internal Medicine residents and other trainees. Additionally, increasing collaboration with nursing staff, physician assistants, nurse

practitioners, physical therapists, case management, and social work have expanded educational opportunities on the CGA with the entire multidisciplinary team.

There were several challenges throughout this iterative process. First, the need for expertise from geriatricians to guide appropriate use of the FI-CGA and avoid over-simplifying geriatric care is necessary. While the FI-CGA generates a single numeric score, the nature of health deficits for a given individual is important. For example, two different patients may have the same frailty index, but one patient's individual health deficits may be largely modifiable while the other patient's deficits are not, highlighting that frailty assessment and management are related but distinct concepts. Additionally, having a single cutoff without nuanced interpretation may advance "Frailism," or biased treatment of patients considered frail by the FI-CGA. Second, to use our FI-CGA the CGA should be performed in a uniform way, which means that geriatricians need to conduct assessments in a tailored yet standardized manner. Third, a major challenge is defining cutoff values for different degrees of frailty. Population studies, like the Canadian Study of Health and Aging, have tried to define categories of frailty (FI>0.20) and severe frailty (FI≥0.45) in community dwelling adults, and have demonstrated an association between frailty and mortality (29). Other studies in different populations, such as cancer patients, have suggested that frailty should be defined by using higher cutoff values, such as FI≥0.35 (23). Whether these cutoff values are valid for particular specialties and clinical environments is yet to be determined. In unpublished work, our group has demonstrated that FI-CGA is useful in assessing and grading frailty as well as predicting surgical outcomes in two different surgical populations.

There were several limitations throughout this process. First, we did not use a specific implementation strategy to this ongoing process but rather used a focused needs assessment that provided the information needed for adaptation and implementation in this

environment. Second, this is a single center experience that needs to be implemented elsewhere. Third, we were not able to separate inpatient and outpatient FI-CGAs.

Opportunities have also arisen for the FI-CGA. Throughout the COVID-19 pandemic we have relied on telemedicine to continue delivering patient care to vulnerable older populations. The FI-CGA was easily adapted to a telemedicine format without losing the comprehensive approach (30). By using the FI-CGA, our team was able to continue providing best geriatric assessment and care, with some minor changes in the assessment of certain geriatric domains. In addition, this has provided an essential communication tool across services that was found to be crucial during these unprecedented times.

In summary, we demonstrated the iterative, ongoing process of constructing and incorporating a FI-CGA as a useful clinical tool in diverse service lines, while highlighting challenges and opportunities for continuous process improvement.

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Supplementary Material: Effect of incorporating FI-CGA into workflow at institution.

Supplementary Table S1. Outcomes of incorporating FI-CGA into the EHR.

Supplementary Table S2. Anonymous electronic 3-point Likert scale assessing acceptability of FI-CGA among BWH geriatricians (n=12/14).

Figure Legends

Figure 1. Conceptual overview of the expansion of the FI-CGA (frailty index-comprehensive geriatric assessment) and geriatric co-management services at Brigham and Women's Hospital. EHR: electronic health record.

Figure 2. Measurements of FI-CGAs over time among geriatricians at Brigham and Women's Hospital (BWH). Q: designates quarter of the fiscal year.

Table 1. Comparison of the original FI-CGA to the BWH FI-CGA and patient examples.

List of variables used by the Canadian Study of Health and Aging for FI-CGA (19)	**List of variables used by the BWH to construct a clinical FI-CGA, 2015**	**Revised variables used to construct a uniform FI-CGA, 2020**	Patient A	Patient B
List of conditions- list the number of conditions/comorbidities.	Comorbidities- list a number of conditions/diseases. Max- 18	Out of 18 listed comorbidity domains	5	1
List of associated medications	Number of medications- in 3 groups; 0-4, 5-9, >9	Specific instructions:	5-9	0-4
ADL*	independent, assist, dependent	Not changed	Independent, assistance with bathing, grooming	Independent in all ADL's
Mobility- transfer, walk, aid independent, assist, dependent	independent, assist, (slow) dependent	Not changed	Independent, slow, cane	Independent, no aid
IADL**- independent, assist, dependent	independent, assist, dependent	adapted to Lawton IADL scale	Independent but needs assistance in cleaning, finances	Independent, assistance in driving
Under "emotional"	Low mood- yes, no	Removed	-	-
Emotional- WNL, mood, depression, anxiety, fatigue, other	Depression- yes, no Anxiety- yes, no Fatigue	PHQ-2, PHQ-9, GDS GAD-2*** fatigue	Yes - Yes	No Yes No
Health attitude and motivation excellent, good, fair, poor, couldn't say	Health attitude- excellent/good, fair, poor, high, low	Not changed	excellent/good high/usual	excellent/good high/usual
Weight and appetite- good, under, over, obese and appetite	Weight- good, under, over, obese and weight change.	Not changed	No WNL	Yes Fair
Not included	Aerobic and resistance- able to walk a block, climb flight of stairs	Not changed	Unable Able	-
Sleep- normal, disrupted, daytime drowsiness	Sleep- good, disturbed, drowsiness	Disrupted sleep- yes/no	-	No

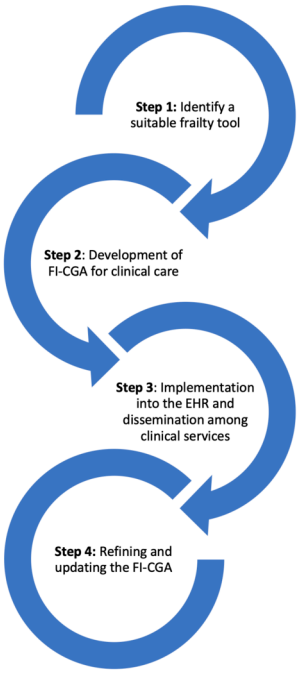
In cognitive status	Delirium- yes, no	Not changed	CAM^ negative	CAM^ negative
	MiniCog score	MOCA/MMSEψ	1 (score 2 or less)	0.33 (min-cog 4/5)
Cognitive status	Cognitive status	Not changed	MCI¥	MCI¥
Balance- normal impaired	Impaired balance	Fear of falling	Yes	Yes
Falls- Y/N and number	Falls in the past 6 months, 0,1,>1	Falls in the past 12 months only	Yes	Yes
Bowel and urine continent, constipation, incontinent	Not changed	Not changed	Continent for BM, urine incontinence	Continent
Sensory: Vision, hearing, dentures-	WNL, corrected, impaired	Vision- normal, impaired (corrected=normal)	Normal vision, impaired hearing, dentures	Normal vision and hearing, implants
	Strength- WNL, week	Strength removed, Added Nagi & Rosow-Breslau Activities	-	-
Speech- WNL, impaired	Speech- WNL, impaired	Removed	-	-
Numerator/ Denominator			17.66/54	7.33/54
Frailty index score			**0.33 moderately frail**	**0.14 pre-frail**

*ADL- activities of daily living;**IADL- instrumental activities of daily living;*** PHQ-2, PHQ-9, GDS

GAD-2- Patient Health Questionnaire-2, Patient Health Questionnaire-9, Geriatric Depression Scale,

Generalized Anxiety Disorder-2; ^CAM- confusion assessment method; ΨMOCA,MMSE-Montreal

Cognitive Assessment, Mini-Mental State Examination; ¥MCI- mild cognitive impairment;



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