# i-CGA pilot process evaluation: phase one study

## Final Report

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## Section 1: Background

### Identifying and responding to complex health and care needs of older people

The prevalence of chronic disease, multimorbidity and frailty increases as age advances. This is also the case with the risk of 'Geriatric syndrome' which is a term frequently used to describe health conditions commonly found in older adults that do not fit neatly into distinct organ-based disease categories and often have multifactorial causes. Examples of these include: cognitive impairment, delirium, incontinence, malnutrition, falls, gait disorders, pressure ulcers, sleep disorders, sensory deficits, fatigue and dizziness. Geriatric syndromes are multifactorial conditions and are common in older adults (Inouye, Studenski & Tinetti et al; 2007). Furthermore, geriatric syndrome is a significant risk factor for frailty (Clegg, Young & Iliffe et al; 2013; Chen, Mao & Leng, 2014) which combines the effects of natural ageing with the outcomes of multiple long-term conditions and a loss of resilience and reserves (Lyndon, 2015). Frailty presents a public health priority in ageing socieities as this can lead to significant consequences for individuals including disability, morbidity, hospitalisation and institutional care (Wang, Shamliyan & Talley et al. 2013; British Geriatric Society, 2014).

Supporting people to age well and to overcome or mitigate the risks that frailty presents has moved to the forefront of the health and social care policy agenda in the United Kingdom (National Health Service; 2019; National Institute for Health and Care Excellence, 2015). As part of this agenda the systematic population-based identification of frailty is promoted on the premise that this could reduce inequalities, improve access to care and enable the needs of individuals to be met through early, proactive targeted and appropriate interventions.

An initiative in the UK in 2017/18 has been a change in the GP (primary care) contract that introduced routine frailty identification of patients who are 65 and over (NHS, 2017). Moreover, support for people with frailty through comprehensive geriatric assessment (CGA), requires health and care service pathways alongside the changes to assessment and identification of frailty in primary care (NHS, 2019; NICE, 2015; BGS, 2015).

CGA has been in existence for more than three decades and is one of the cornerstones of modern care for frail older people, helping to develop a coordinated and integrated plan for treatment and long-term follow-up (Rubenstein, Stuck & Siu et al; 1991). Over the past 30 years, clinical models of CGA have evolved so that they are more appropriate for specific healthcare settings and tailored to individual levels of need: from acute care to hospital care; from hospital care to home-care/community services; from rehabiltation, day hospitals to nursing homes. This differentiated care for older people is aptly labelled 'progressive care' to reflect an increasing intensity of care conducted in different settings depending upon individual needs (Pilotto, Cella & Pilotto et al; 2016).

The need for differentiation of care according to individual need also reflects the complex and multi-dimensional nature of the problems experienced by older people. CGA facilitates

recognition of the specific health conditions that might otherwise go undetected (Ellis, Gardner & Tsiachristas et al; 2017). Furthermore, CGA is not restricted to biomedical considerations, as this process provides a holistic analysis of the conditions that influence health outcomes including functional, socioeconomic, psychological, and environmental considerations. A key point is that without CGA there is the potential to overlook conditions that could threaten to exert a significant and deleterious impact on an individual's quality of life (Devons, 2002; Ellis, Gardner & Tsiachristas et al; 2017).

Most meta-analyses have found that CGA leads to improved detection and recording of problems across biomedical and psychosocial domains (Kuo, Scandrett & Dave et al; 2004; Stuck, Egger & Hammer et al; 2002; Huss Stuck & Rubenstein et al; 2008; Bachmann, Finger & Huss et al; 2010). CGA has also been found to make an effective contribution to reducing institutionalisation and mortality (Kocman, Regen & Phelps et al; 2019)C, therefore CGA is vital at both an individual and societal level.

The multifaceted nature of frailty means that to be comprehensive any assessment needs to cover a broad range of medical, psychosocial, and functional limitations. However, a downside to this is that CGA can be onerous to carry out and the information it can generate can seem overwhelming. It is therefore crucial that any formal assessment tools which are developed remain comprehensive, but optimised to be as time and labour-saving as possible for practitioners. While most General Practice IT systems across the UK have templates to record assessment outcomes these are embedded within the primary care system. Hence data may not be easily shared with practitioners across the health and care economy (British Geriatrics Society [BGS], 2019, p.11). Historically, CGA was delivered by a geriatrician led multidisciplinary team. However, current workforce challenges in geriatric medicine (Dhesi, Moonesinghe & Partridge, 2019), exacerbated by an ageing demographic (Dolls, Doorley & Paulus et al; 2019), means that there is now reliance on non-geriatricians to deliver CGA in a wide variety of different settings. This has prompted the need to deliver an approach to CGA that is easily accessible, user friendly and sufficiently flexible to facilitate CGA by a broader range of practitioners such as frailty nurses, advanced clinical practitioners and community nurses (Silva, Felgueiras, & Oliveira, 2018).

## CGA and digital management systems

As assessment of frailty and completion of CGA results in generation of an enormous amount of clinical patient information there has been a pressing need to develop health digital systems that have high storage and processing capacity. A prime example of digital innovation and development of software in the UK has been the electronic frailty index (eFI). eFI provides an electronic frailty index calculation in electronic medical records systems that has allowed for frailty measures in primary care for millions of older patients (Clegg, Bates & Young et al; 2013; Devereux, Ellis & Dobie et al; 2019). The eFI has robust predictive validity for outcomes of mortality, hospitalization and nursing home admission in older people with different frailty trajectories (Clegg, Bates & Young et al; 2016). Recently, the use of eFI has been extended for utilisation in community healthcare services (Boyd, Nevard & Ford et al; 2019). Electronic screening for frailty has been recommended to identify older adults who would most benefit from a CGA (Turner & Clegg, 2014).

Existing electronic tools  are designed to combine CGA outcomes with other records including co-morbidities and frailty. An example of this is the Computerized Frailty Assessment Tool at Points-of-Care - a Standalone Electronic Comprehensive Geriatric Assessment/Frailty Index (eFI-CGA) (Sepehri et al; 2020). This was developed in a collaboration betweem the Fraser Health Authority (FHA) Community Actions and Resources Empowering Seniors (CARES) program and Nova Scotia Health Authority (NSHA) Geriatric Medicine Research Unit (GMRU) to try to overcome assessment limitations, particularly reliance on paper-based recording and manual data processing which can be time-consuming and error-prone (ibid). eFI-CGA was designed for use on personal computers by frontline healthcare providers. Sepehri et al. (2020) concluded that eFI-CGA supports effective frailty assessment and management by various healthcare providers at points-of-care, facilitating integrated care of older adults.

Other software include The Geriatric 8 (G8) Health Status Screening Tool (Bellera, Rainfray, & Mathoulin-Pélissier et al; 2012) which was updated in 2017. This Tool is useful in identifying older cancer patients who may benefit from a CGA through assessing physical and neuropsychological health. Meanwhile, The Senior Health Calculator (2018) (Beth Israel Lahey Health, BIDMC Division of Gerontology & Song, M.K.) uses the CGA items to produce a deficit accumulation assessment based on the Frailty Index. This Tool includes 50 items that assess medical history, functional status, performance tests, and nutritional status resulting in a frailty calculation.  A further application - The Frailty Group Calculator (2021) (University of Oslo, Norway, 2021) - assesses 21 items from the Charlson Comorbidity Index, Geriatric Nutritional Risk Index, and activities of daily living to produce a frailty score. Finally, The Geriatric Helper (Silva, Felgueiras, & Oliveira, 2018) is currently being tested in Portuguese healthcare units allowing for any clinician to apply the otherwise experts-limited geriatric assessment. It is a smartphone application which acts as a pocket guide that is easy to update remotely with up-to-date information, thus supporting the CGA process.

Despite ongoing advances in the capability and availability of digital tools and systems there remains an unprecedented need for digital tools to support the CGA process and facilitate access to specialist clinical diagnostics and treatment advice (Silva, Felgueiras, & Oliveira, 2018, p.5; Rowland & Fitzgerald & Holme et al; 2020).  A current limitation of existing apps for CGA is that the majority have limited functionality and most fall short of providing the necessary multidimensional evaluation of each patient (Silva, Felgueiras, & Oliveira, 2018, p.5; Theou, Park, & Garm et al. 2017; Rowland & Fitzgerald & Holme et al. 2020).

This supports the rationale and underpinning vision for designing and evaluating the i-CGA digital tool. This Tool aims to make the relatively complex CGA process more streamlined and efficient, avoiding duplicative diagnostics, enabling information exchange and communication in a standardised way between health care professionals and record-keeping systems and ultimately, facilitating good patient outcomes.

## Design and development of i-CGA

The i-CGA tool has been designed by HealthCall in collaboration with North East North Cumbria Integrated Care System and the Ageing Well Network in response to some of the

principal challenges faced by practitioners when completing CGA. While it is well known that CGA is the 'gold standard' for the care of frail older people that realises the best outcomes, CGA can be hindered by common problems, including: lack of co-ordination, delays in treatment and limited sharing of data which combine to adversely affect patient outcomes. The development of  i-CGA is an attempt to address these issues.

CGA is termed 'comprehensive' to reflect its multi-dimensionality as it sets out to capture relevant information about patients' physical, psychological, social and environmental needs and functional status,. The purpose of i-CGA was intended to facilitate an integrated, holistic and multi-disciplinary team approach to CGA within primary and community care settings to be used with adults living with complex needs and problems associated with frailty.

The development of i-CGA was based on an analysis of evidence relating to CGA, in particular the recommendations of the British Geriatric Society CGA Toolkit for Primary Care Practitioners [2019], and co-design with health professionals from a variety of disciplines. The following figure provides a visual representation of i-CGA including a map of the end-user pathway that will be followed as they progress through the Tool (see Figure 1):

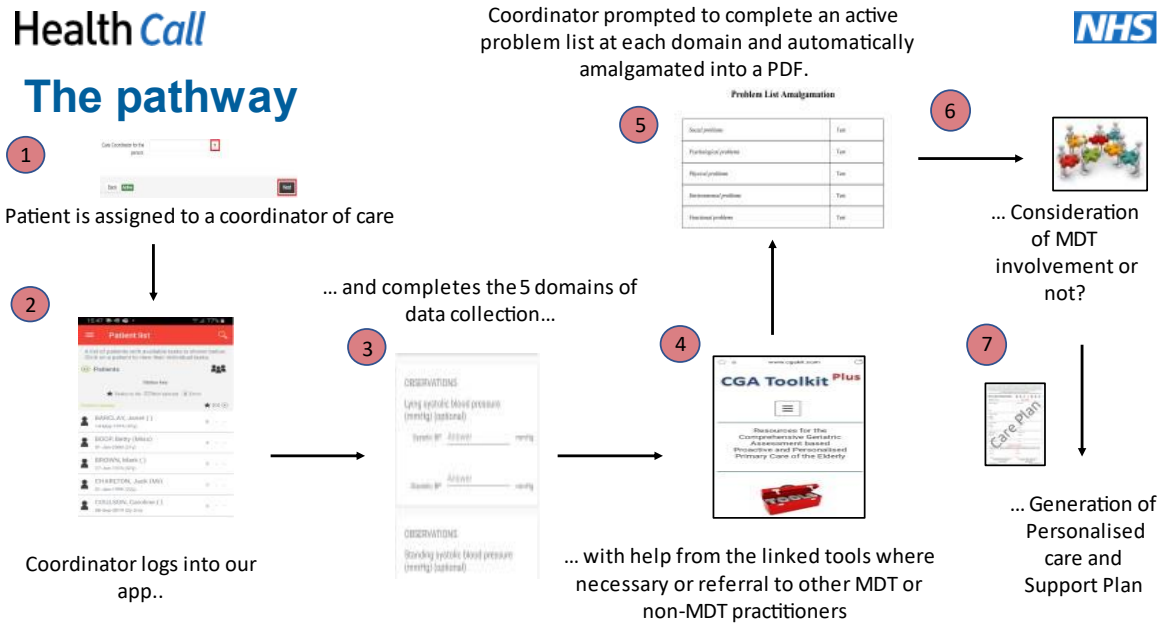



**Figure 1: Diagrammatic representation of i-CGA**

# Section 2: Methods

## Evaluation aims and objectives

The primary aims of this pilot process evaluation study were to:

1. Establish the feasibility and acceptability of using i-CGA in primary care
2. Assess methods to be adopted in a subsequent outcome evaluation of i-CGA during phase two of implementation across the Northeast region.

Secondary objectives were to establish:

1. Whether the i-CGA tool can be used within general practice by multidisciplinary teams
2. If the tool is acceptable to, and usable by, practice and multidisciplinary team staff
3. Explore the barriers to the implementation of the i-CGA tool in general practice
4. Explore whether the tool facilitates the CGA process and supports staff to assess patients with complex needs
5. Assess whether i-CGA has an impact on staff competence to complete a comprehensive CGA
6. Assess the effect that i-CGA has on case-based discussion, referral to others inside and outside of the MDT, care planning processes and care outcomes
7. Assess whether reliable data can be collected in relation to agreed outcome measures including number of signposts/referral to other agencies to support CGA and care planning, changes in medication/medication review, falls identification and intervention, use of primary and A&E services, admission to hospital for non-elective treatment, and stranded patient data
8. Analyse outcome measures and frailty iCare metrics to undertake a budget impact analysis and determine the effectiveness of the i-CGA tool in primary care.

## Method and design

A mixed method approach with a nested assessment of economic outcomes over 4 months of deployment of i-CGA in two general practices in Gateshead between January 2022 and July 2022 was planned. The design of the evaluation included two interrelated work packages: 1) Usability, acceptability and impact of i-CGA in general practice on CGA processes and workforce capability requirements 2) Impact of i-CGA on patient and service outcomes.

## Research sites, sample and recruitment

Two general practices in Northeast England agreed to take part in the initial deployment of i-CGA. Practice staff received training to use i-CGA by HealthCall, the developers of the tool. The training was provided on-site in general practice premises, prior to commencement of the evaluation study. The training was for all i-CGA end-users. The training involved

demonstration of how to register with the portal, how to add patients to i-CGA, how to complete each domain of CGA, and how to generate a pdf document summary report.

Site one was a general practice located in a semi-rural village close to the western border of a large metropolitan county of Tyne and Wear in England. The practice provides linked GP services to a care home that has a range of nursing and residential care services (general nursing, dementia nursing, dementia residential care) for up to 60 residents. A programme of CGA was being undertaken in this care home by a Community Nurse Practitioner, and the link GP. The community nurse practitioner had been in her current role for 2 years conducting CGA, and she also had 3 years' experience of completing CGA in her previous role. These individuals were invited, and agreed, to take part in the evaluation study (*N=2*).

Site two was a general practice, which is part of a medical group, that was located in a suburban area of a large metropolitan county of Tyne and Wear in England. This area consists mainly of residential properties, with a range of predominantly terraced housing. This practice has two part-time frailty nurses who complete CGA for those patients referred from the practice GPs. Both frailty nurses had been in their current role for 7 years. In addition, one frailty nurse had a career total of 19 years' experience conducting CGA while her colleague had a career total of 17 years' experience conducting CGA. These practice frailty nurses agreed to use i-CGA with registered patients who were referred for CGA, and to take part in the evaluation study (*N=2*).

## Work Package One: Usability, acceptability and impact of i-CGA in general practice on CGA processes and workforce capability requirements (addressing objectives 1 to 6)

Objectives 1-6 were addressed by this work package. Both qualitative and quantitative data was generated and equal weighting was applied to all data throughout the analytic process to assess the following focus areas:

1. Usability
2. Acceptability
3. Impact on the CGA process, care planning and workforce competency.

### Data collection

Three data sets were collected to assess the above focus areas.

### Data set 1: Usability data

The NASA Task Load Index (NASA-TLX) (see Appendix 3) is a widely used, subjective, multidimensional assessment tool that rates perceived workload in order to assess a task, system, or team's effectiveness or other aspects of performance. (Hart, 2006). In the health area, it proved successful when evaluating mobile health applications for stroke survivors (Micallef et al., 2016), for falls risk detection (Harte et al., 2017), fitness applications (Alturki & Gay, 2017), or applications designed for people suffering from overactive bladder symptoms (Salai & Baillie, 2019).

To assess performance the participants were asked to complete the following tasks using i-CGA:

> Task 1: Locate personal workload tasks and filter the list so that only 'Capacity and Consent' tasks show
>
> Task 2: Upon completion of the 'Capacity and Consent' task, navigate directly to the task in which you can input information on sight disorders
>
> Task 3: Generate an aggregated 'Active Problem List', then locate and download the 'Active Problem List' pdf
>
> Task 4. Submit a 'Social' assessment for a person you consider to have difficulties managing their household finances, generating and inputting a Barthel Index score and recommendation to discuss at MDT.

Following each task, the participants were then asked to complete a rating against each of the following subscales of 1 = least demand to 21 = extremely demanding.

- Mental Demand
- Physical Demand
- Temporal Demand
- Performance
- Effort
- Frustration

Participants were asked to complete the NASA-TLX tool at baseline, following training. The intention was for the participants to complete this tool again at follow-up. This did not occur because access to IT equipment and access to i-CGA had been blocked prior to the pilot study's scheduled complete date.

At the follow-up stage participants were also asked to complete the System Usability Scale (SUS) (see Appendix 3). This is a reliable tool for measuring the usability of a device /application /service (Brooke, 1996). It consists of 10 items with 5 response options for each item that aim to evaluate a wide variety of products and services. Its appropriateness was also based on its successful use in other areas of health. For example, the questionnaire was successfully used when evaluating the usability of mobile phone applications for the reduction of mental burnout in mental healthcare providers (Wood et al., 2017), for stroke survivors (Micallef et al., 2016), or when evaluating the usability of 4 medication management apps (Grindrod et al, 2014).

### Data set 2: Workforce digital capability and competence in CGA

It was considered important that competence to complete a CGA and capabilities in the use of digital health and social care technologies were assessed at baseline so that the evaluation of the tool was not 'contaminated' by variants within the workforce's initial competencies. Establishment of the baseline participant competency in CGA was achieved via a competency gap analysis measured against the CGA components of the specialist level Enhanced Care for Older People (EnCOP) competency assessment framework (Thompson et al; 2017). This tool is a self-assessment of a practitioners' confidence/competence in the following key domains of CGA: initiate or undertake CGA; recommend and utilise valid and

reliable screening, assessment, review, and risk assessment tools; recognise a carer's psychological and practical needs; use digital technology in conjunction with clinical judgement to assess individual needs; work in partnership with the individual and their families and friends; develop a care and support plan which promotes personhood and relationship centred care; recognise the requirement for NHS continuing healthcare checklists; refer potentially eligible older people for full NHS continuing healthcare assessment and co-ordinate assessments; utilise appropriate referral pathways and specialist services; manage safe, effective and timely transfer of care and information during and across care transitions.

Participants were asked to complete the CGA competence assessment questionnaire pre and post use of i-CGA. The questionnaire included items that explored 1) participant's knowledge about CGA 2) participant's self-reported competence and confidence in CGA by using a rating scale from 1 (not competent/confident) to 5 (very competent/confident) (see Appendix 3).

Exploration of digital competence was also undertaken to determine readiness of the participants to use the i-CGA digital tool. To do this, participants were asked to complete a self-assessment of the NHS Digital Capabilities Framework (2018) prior to commencing use of i-CGA (Appendix 3).This tool provides a detailed assessment of digital competence in health care settings and incorporates the comprehensive assessment of six principal domains of digital capability: (i) Communication, collaboration and participation; (ii) Teaching, learning and self-development; (iii) Information, data and content literacies; (iv) Creation, innovation and research; (v) Technical proficiency and underpinning all the above domains is a sixth domain-digital identity, wellbeing, safety and security (NHS Digital Capabilities Framework, 2018, p.5). This Digital Capability Framework provided the basis for an assessment to be drawn up which covered all six principal domains of digital competence that was deemed necessary for individuals who work in a health care context and are in the process of learn to use a newly developed digital tool (see Appendix 3). It was also important to obtain a baseline measure of this key variable at the outset of the study to take account of a potentially significant confounding variable that might determine participants' ability to acquire the skills needed to utilise the i-CGA Tool. The assessment focused on difficulty levels 2 and 3 of the Framework which assess a balanced, moderate level of IT literacy. Level 1 of the Framework was deemed to be a basic, entry level and level 4 at the other extreme-an advanced level of IT knowledge and capability. Neither levels 1 nor 4 were therefore deemed an appropriate and/or necessary level of competency to be able to use the i-CGA Tool effectively.

### Data set 3: Qualitative exploration of the experience of using i-CGA and perceived impact on the CGA process

Individual interviews using a semi-structured interview schedule (see Appendix 4) were carried out with all participants at the follow-up stage to assess the feasibility of adoption of i-CGA in primary care through exploring process factors, including acceptability, barriers and facilitators to implementation. The role of the i-CGA tool in supporting CGA workforce development, and impact on the CGA process, including case-based discussion and care planning were also explored.

### Analysis

The quantitative data generated in WP 1, including survey and usage data, was collated and entered into a statistical package (SPSS) in preparation for descriptive statistics' analysis. This data was regarded as ordinal data as there was no guarantee that the numbers assigned between ratings account for an equal distance e.g., a rating of disagree (2) is not twice as much as a rating of strongly disagree (1).

Audio recordings of on-line interviews were transcribed verbatim. Open coding was undertaken to represent the end users' experiences of i-CGA and to identify changes in the individuals' circumstances. The codes were compared with the outcomes of the quantitative analysis to provide insight to the circumstances that influence the participants' experiences of their use of the i-CGA tool.

## Work Package Two: Impact of i-CGA on patient and service outcomes with an embedded economic analysis (addressing objectives 7 and 8)

### Data Acquisition

The quantitative data for this project was collected from two sources: firstly, from a database of patient data known as EMIS, used by GP practices and associated organisations, and secondly, the data gathered by the i-CGA tool during use by practitioners. Gaining access to each was significantly more difficult than expected, with each presenting a series of challenges that elongated the process of acquisition, necessitating a truncated programme of analysis on the data that was ultimately obtained.

The first group of data collected for this project was collected via Site one general practice.

Searches of CGA patient data were created from the practices' system during an in-person meeting between members of work package 2 and the practice manager.

Patient data was anonymised and only identifiable by EMIS number. Data relating to 'problems' and 'referrals' was collected alongside basic demographic metrics.

The patient searches were exclusive to those who had received a CGA in the past 3 years (N= 52), all other patients were excluded. The first search identified problem data and the included criteria was as follows:

- EMIS number, date of ticket creation, age, gender, ethnicity, problem status, problem significance, episode, problem end date, consultation heading, organisation name, clinical event type and code term.

The diseases included in the searches were as follows:

- Dementia, musculoskeletal chest pain, palliative care, dementia in Alzheimer's disease, depression, lewy body dementia, senile dementia, appendicitis, conjunctivitis, chronic obstructive airway disease, lower respiratory tract infection, chronic obstructive pulmonary disease, urinary tract infection, paroxysmal atrial fibrillation, Alzheimer's disease, asthma, basal cell carcinoma, bilateral cataracts, bile duct calculus, bleeding, mouth candidiasis, chest infection, cholangitis, cholecystitis,

diabetes (type 1 and 2), cor pulmonale, diverticulitis, dysphagia, epilepsy, hypertension, fragility, heart failure, hip pain, infected eczema, joint pain, lung cancer, malignant cancer and tumours, medication, mental health, anxiety disorder, non-alcoholic fatty liver disease, osteoporosis, oral thrush, Parkinson's disease, pain in the spine, peripheral vascular disease, popliteal artery occlusion, pyelonephritis, rectal haemorrhage, rheumatoid arthritis, rib pain, dermatitis, sepsis, small cell cancer, sore throat, sprain, transient cerebral ischaemia, ulcerative stomatitis, vascular dementia, gastroenteritis and vomiting.

The second search identified referrals data. The search criteria were as follows:

- EMIS number, age, gender, ethnicity, date, code term (referral/letter), associated text.

Both searches were lengthy processes as the system did not allow bulk selection of diseases, referral types or health statuses of patients. Therefore, the searches relied on inputting individual diseases, referral types and health status' to yield adequate results.

The second data collection was a direct download from the i-CGA tool itself which was converted into a csv file and sent directly through to the work package 2 team.

The dataset obtained from the team behind the development of the i-CGA tool - collected during the active use of the tool - has not been used within the quantitative analysis. Fundamentally, this is due to the proposed work that would use this data not being possible, an issue that stems from the implementation and subsequent pilot rollout of the tool itself, which impacted the nature of the data that was collected.

The original intention for the data collected through the use of the tool was to enhance and support the understanding of the practical usage of the tool which has been gained through the activities carried out within the qualitative work package. This would have incorporated elements of temporal analysis to determine patterns of use within the period of patient assessment and beyond, through further interactions with practitioners.

However, it became apparent during the rollout period that the tool was not being used as intended. Instead of the i-CGA replacing the use of a conventional CGA when visiting patients, practitioners were instead relying on the paper-based version of the assessment during consultations, before transferring the collected data into the i-CGA at a later time. As a precaution, once data had been collected and distributed, we checked the timings of the tests as they were logged onto the system and it was apparent that tests were being filled in after CGA's had been completed on paper. For example, tests were being logged in a time scale of under 4 minutes, which was confirmed to be far too short for any CGA to be completed in with a patient.

### Data Processing

A process of encoding was completed to "flatten" the dataset, by recording each problem occurrence per patient as a single binary feature attached to a single patient identifier. However, each individual problem recorded separately in this format resulted in a dataset that was too highly dimensional for many forms of statistical analysis to function in a way that would produce insightful results, and so the decision was made to group problems into problem families, with anything from a single recorded instance of a problem within this family being recorded as a binary assignment for the presence of this family within an observation corresponding to a patient. This process was performed with clinical oversight and resulted in dataset containing 20 variables representing classes of problem. Additionally, further data processing was performed to ready the data for use. Gender was encoded numerically, and age was recoded as an ordinal variable, using five-year intervals (beginning from the age of 65) as the basis for the codification (i.e., age bands of 65-69, 70-74, etc.) each represented with a single value ranging from one until seven (with individuals in the lowest age band recorded with a "1").

### Data Analysis

The approach to data visualisation and analysis is detailed in the results section (p .38 – 48) as the approach varied in response to the enquiry outcomes.

## Ethical considerations

Approval for this evaluation study was obtained from Northumbria University ethics committee (13.12.2021) and the NIHR HRA (26.11.2021).

This study sought to evaluate a new digital tool to support CGA in primary care. As this is a novel digital tool there were many unknowns regarding data storage, access and management, and the workforce competency required to use this tool effectively. One of the primary aims of this study was to establish the feasibility and acceptability of using i-CGA in primary care, hence the very purpose of the process evaluation raised ethical concerns. This study was justified with the intent to understand how a tool, i-CGA, could support CGA for frail older people. It is well known that CGA is the gold standard for the care of frail older people that realises the best outcomes. Yet there are significant problems with CGA, including: lack of co-ordination, delays in treatment, limited sharing of data, and this has a negative impact on patient outcomes. i-CGA was developed by HealthCall in collaboration with the Northern region Ageing Well network to address these problems. As there are unknowns with this tool and how it could be used in primary care, the initial deployment of the tool involved 2 general practices in Northeast England to gain understanding of the tool, issues relating to data generated and linked to i-CGA and workforce requirements to use this tool in primary care. The knowledge gained from this small process evaluation was intended to inform the regional roll out of the tool across primary care, and to enable the evaluation team to assess methods that could be adopted in any subsequent outcome evaluation of i-CGA alongside phase two of implementation across the Northern region. It was important that real life testing of i-CGA was undertaken to develop understanding of the impact of this tool on professional practice and patient care. This first deployment of i-CGA was restricted to 2 general practices to enable close monitoring to track the implementation process and outcomes. This approach was adopted

to limit any potential harms and to maximise the benefit that can be achieved through this initial deployment of i-CGA and the related process evaluation study. 3 clinical practitioners who were experienced in CGA and also currently conducting CGA and a practice link GP consented to take part in this evaluation (N = 4), having read and agreed with the participant information sheets outlining the evaluation and their involvement and provided written consent to participate (Appendix 2).

# Section 3: Workpackage one findings: Usability, acceptability and impact of i-CGA in general practice on CGA processes and workforce capability requirements

In this section the findings for strand one of the evaluation are presented. The discussion commences with *Deployment sites and participant capabilities* (3.1) that provides a description of the context where i-CGA was deployed over the five months of the pilot implementation study. We also provide discussion of the participants' capabilities. It is important that competence to complete CGA and capabilities in the use of digital health and social care technologies were assessed at baseline so that any evaluation of the tool was not 'contaminated' by variants within the workforce's initial competencies. This initial discussion is followed by presentation of findings in relation to *Capability development in the use of i-CGA* (3.2). Then *Operating context and barriers and facilitators for use of i-CGA* (3.3) is discussed. The final part of this section of the report examines the *Impact of i-CGA on clinical practice* (3.4).

## 3.1 Deployment sites and participant capabilities

### Implementation of i-CGA in the pilot sites

In site one it was agreed that i-CGA would be used with care home residents that were having a CGA by the key user, a Community Nurse Practitioner. Use of i-CGA commenced in January 2022 with test patients following training. By early March 2022 i-CGA was being used with patients who were registered with the primary care practice and were living in a care home that was registered to provide residential and nursing care services. By the end of the pilot  a total of 31 i-CGA records had been opened, with 6 records incomplete and 25 records completed. It was difficult to discriminate between test records and patient records apart from the date that they were completed, and even that assumes that there was a clear point of transition between working with test records and then moving on to using actual patients. Some of the incomplete records may have been generated during the early 'learning' and practice with the test patients. Of the 25 completed records, 22 related to patients who were living in the care home service. The combination of completion date and patient living arrangement it is highly likely that these 22 completed records were new CGA completed with i-CGA during the pilot evaluation study.

In site two, practice frailty nurses agreed to use i-CGA with registered patients who were referred for CGA. There were delays in commencing use of i-CGA in this site due to lack of digital equipment. This led to a gap between training and commencing use of i-CGA, hence refresher training was provided by the HealthCall team when the frailty nurses were equipped with laptops. Further difficulties were experienced when it became clear that the nurses required access to Wi-Fi to open the i-CGA portal when completing CGA in patients' homes. To address this issue, they were provided with tablets that had remote access to Wi-Fi. By mid-March 2022 the frailty nurses were set up to complete CGA with use of i-CGA in this site. When attempting to use i-CGA in patients' homes, connectivity was regularly lost. This cancelled access to the i-CGA portal. The frailty nurses indicated that data was lost.

This disrupted the CGA process, hence the assessment was continued without the use of i-CGA. Throughout the pilot 24 i-CGA records were opened. Of these 7 were partially completed and 1 completed. In many of the records there was missing data from multiple fields. Some of the incomplete records may have been generated during the early 'learning' and practice with the test patients, and some of these partial records may have been the result of loss of data that the participants reported when they lost connectivity in patients' homes.

### Participants' views of the complexity of completing CGA

The participants brought to the evaluation study a wealth of experience and expertise in undertaking CGA (see Research sites, sample and recruitment, p. 10 for details). Their caseloads varied considerably, with some individuals requiring an assessment to address a particular problem:

> if it's a safety issue or a medication issue, it could be a simple CGA without many identified problems and this may only require a referral to an occupational therapist.

However other patients present with multiple, complex problems across all of the domains addressed through the CGA process. This can be a timely process. Also, the assessment can be challenging when it is difficult to complete assessments with patients with complex problems such as cognitive impairment, communication difficulties, or social circumstances whereby various stakeholders have different perceptions and priorities of the same issue. Understanding the patients' views, and that of carers, of problems and priorities requires intense listening and good use of observation and analytical skills:

> we can just sit in somebody's house and know you're still carrying on the conversation, but you're looking at them and you're writing down things about what you observe – what they can and cannot do and what is causing a problem for them.

> With the CGA you can't always do everything yourself. We have a lot of support from the administration team and a coordinator now as well. CGA is not just 1 person, 1 professional but generally involves a lot of people [MDT].

This input requires referral to a range of professionals, co-ordination of appointments, sharing information across the team, collation and analysis of data to inform decisions about problems, needs and priorities. Once this is achieved there is an ongoing process of intervention, review to address problems, and implementation of the management plan to optimise patient capabilities and outcomes. Hence substantive data is generated throughout the process and multiple people require access to the data to inform patient care decisions. This is not always possible when information can be stored on different digital systems. At the commencement of the evaluation study all participants indicated that they welcomed the development of a digital tool that had potential to store data in one place, whilst enabling access by multiple people.

### Participants' competence in CGA

A factor recognised as highly relevant to participants' ability and confidence in being able to adapt to using the digital CGA tool was their confidence and competence in conducting this complex assessment. The participants completed a self-assessment of their capability and confidence to undertake CGA (see description p. 11 and assessment tool Appendix 3).

The results indicated that all participants had fairly high to very high self-assessment scores. The scores ranged from 49-59, with 60 being the highest score that can be achieved with this scale. P1 had a mean score across all twelve domains of 4.94 (99%). Mean score for P2 was 4.08 (82%), and P3 had an overall mean score of 4.67 (93%) across all twelve domains. These results suggest that achievement of this level of performance at the ENCoP specialist level would fully enable someone to co-ordinate, carry out and contribute to a skilled CGA, and address the stratified problem list and management plan.

### Participants digital capabilities

The digital capability of the participants could have impacted on their ability to acquire the skills needed to utilise the i-CGA Tool. Hence, they completed the self-assessment of difficulty levels 2 and 3, a moderate level of I.T. literacy in healthcare. The results revealed a relatively wide range of digital capabilities amongst the participants. P1's high score (94% overall) contrasted with P2's overall lower score (49%) and P3's overall moderate score of 66%. On aggregate, participants demonstrated most competence in relation to domain 2: Teaching, learning and self-development (Mean aggregate score = 78%). This is relevant given that this domain includes the ability to use digital technologies and tools for personal learning and professional development which is closely aligned with the challenge participants faced of utilising new technology within their clinical practice. They also assessed themselves as having a high level of competence in domain 1: Information, data and content (Mean aggregate score = 78%). They were secure in their ability to find, manage, organise, store and share digital information, data and content, and to critically analyse, evaluate and/or interpret information, data, content and their sources. They also perceived that they could champion the effective, secure, appropriate and innovative use of information, data and content in order to solve problems, make decisions and to achieve successful outcomes for specific goals and objectives. One individual suggested that her ability to use a wide range of technical devices in a personal and professional context was less well developed. All participants had used a wide range of digital devices and applications in the clinical practice, including regular completion of the older person's assessment template on EMIS. They suggested that this previous experience enhanced their confidence that they would be able to use i-CGA following the training, and subsequent practice with test patient.

## 3.2 Capability development in the use of i-CGA

### Formal training and practice

Whilst the participants were competent in CGA and indicated that they had good digital capability skills, they nevertheless felt that practice was required to gain familiarity with

i-CGA. They indicated that initially at least, learning to use the Tool presented some challenges:

> At first, because it was new and I didn't have a clue what I was doing.
>
> It's a handy tool [the i-CGA Tool] which I used yesterday. It takes time to use it for the 1st time, but it'd get better over time, once you're well into it.

Participants indicated that they would welcome the opportunity to engage in longer training sessions that specifically includes use of the iPads as well as lap top and desk top computers. They also wanted to be able to develop the skills needed to carry out i-CGA at their own pace and the opportunity to make their own notes as the training progressed:

> If we'd had it set up from the beginning and they spent a couple of hours showing us exactly what it is we should be doing.
>
> I was already lost where I was up to because it was a system that I wasn't familiar with. I tried to take notes and review them myself [later] and it didn't really make sense.

Clinicians stated a preference for 'hands-on' training in which they used the iPads themselves, rather than simply being shown how to use the Tool:

> Physically showing me doesn't really sink in. I have to be doing it with someone guiding me

Such 'hands on' training could also be delivered remotely to make it easier to arrange training where clinicians may have limited time available to travel to venues. This would also enable trainers to arrange more sessions. Remote learning also need not detract from good interaction between trainer and trainees and arguably, professionals have by now become quite familiar with this mode of knowledge and skills exchange as the pandemic has endured:

> A lot of the learning I got and the confidence was actually via Teams…with your guide printed off in front of you, the app open and then Teams…that might be a little bit better because sometimes when you're sat in that classroom kind of setting, it can sometimes be 'death by Powerpoint'. You're just sitting there listening, aren't you? Whereas doing it via Teams, it's going to have you much more engaged and interacting because you're completing it and going through it. "Right, here's your test patient. Have a little play around." And then, "Right-how did you get on there?"

Participants further recommended that training be organised in small groups to increase the instructor: learner ratio, encourage open discussion and facilitate learning from each other:

> The smaller the groups the better. You can interact a lot better and have better conversations and learn from each other and you're more likely to open up about something you've found a bit difficult.

Participants also preferred training that included using iPads, to mirror as closely as possible the situation they would be facing once they transferred their newly acquired skills to 'real world' scenarios:

> She was able to show us on the PC, but it's not the same as doing it on the iPad.

Participants also suggested that an on-line i-CGA help guide should be permanently available. In the following example the participant recommended uploading on-line tutorials to a commonly shared access hub:

> I'd also recommend having an on-line tutorial that anyone can tap into at any time…a lot of people are going to need some teaching as well, e.g., GP Team Net which all the practice staff can get on to in order to access training.

Such a resource would facilitate clinicians carrying out their own refresher training and/or use the tutorials to problem solve any unexpected issues or answer any queries they may have about a particular aspect of the Tool.

### A Training manual or 'How to' step-by-step guide

The participants suggested that the training manual or 'How to' step-by-step guide should have clear illustrations that were easy to follow:

> I wanted…screenshots with arrows for what I'm clicking on because I'm a visual learner and telling me what to do just doesn't really sink in…giving them that step-by-step visual Tool instructions guide because I think that's the easiest way…it was my picture guide. That's when it really made sense to me…you can physically see in a picture what your page should look like and what you're looking for to click on. I think it's a much quicker and easier set of instructions to follow.

> Once you know what you're doing with the Tool, it's very easy to use…you just need to be taught those instructions.

One participant further suggested that such a guide could also include patient case studies to illustrate how the Tool has been effective in different clinical situations, thus bringing the potential of the Tool 'to life' for those using it for the first time and to assist learning:

> I love hearing about positive stories in training sessions. I feel I can really remember something important from hearing a case study, e.g., when the CGA has been beneficial. So, I think something like that in there [User Guide]-maybe some examples-for me, that's really important.

Clinicians also saw the training manual/guide as an opportunity to highlight how the Tool can be used collaboratively, i.e., with the involvement of a multi-disciplinary team (MDT):

> To know who can be involved in it-to know who should be part of the MDT. The importance of the MDT should be part of the training…Someone is going to actually

> use the information that's taken that time to complete. And it's going to be much better 'joined up' working.

This also affords an opportunity at the same time to promote and encourage the idea of perceiving and using i-CGA in a multi-disciplinary setting, as was intended when it was designed. This can also assist in reducing some of onus felt by clinicians who are new to the Tool:

> I think that would take away a lot of the stress from the person who's completing it-that they may just think, "it's just me completing all of this!"

While on-line tutorials/Help Guide may assist with initial or refresher training, one participant further recommended there be some form of technical support available on an ad hoc basis to assist practitioners with any technical or procedural problems they may encounter while working with the Tool:

> But I think you're going to have to have some kind of response [to any issues], whether that be a helhp-line or an Email response. So, it's looking at how quickly you would need to respond.
>
> It was purely down to the support from the [i-CGA] Team, that got me familiar with the Tool and I knew they were always at the other end of the phone or email to ask them.

### A separate Training manual for practising with 'test' patients

There may be some benefit also of developing a separate training manual to be used specifically by trainees who were practising with 'dummy/test patients', perhaps with the inclusion of set exercises to practise skills and procedures likely to be required when using the Tool in practice settings:

> If I was referring to a physiotherapist and it wouldn't go through to them [with a test patient]-it wouldn't put my 'To Do' list together until that was inputted. So yes, at this stage that would have to be in the instructions. But obviously, when it's up and running it shouldn't.

One participant further advocated for the provision of a Reviewer to monitor clinicians' performance using the Tool during a 'probationary' period:

> We need some reviews as well because I'd want someone to look through some of my assessments to ensure I was completing them appropriately.

### Informal training and practice

The opportunity to practise using the Tool with 'dummy/test' patients was popular with clinicians, allowing them to gain skills and experience in their own time and at their own pace, but safe in the knowledge that they could conduct this in a 'trial and error' fashion in which any mistakes that were made would not prove critical:

> It was good to have that opportunity to play around in the system and know that you weren't going to do anything wrong because it wasn't a real patient…That was REALLY good to get comfortable with the system…I learned from playing around with the test patients.

With repeated practice, one participant acquired the skills needed to use i-CGA effectively:

> It was through that repetition-I knew that once I'd added them on [a new patient]-I found I was quickly working my way through the system quite easily.

The same participant reported that they had good retention of skills using the Tool once these skills had been acquired:

> I think that if you used it all the time on your two days, you would be able to pick it up the next two days [the following week] and use it.

Developing familiarity with i-CGA was facilitated by having opportunities to use the Tool with a test patient. Through entering test patient data, clinicians were able to explore each domain and the resources embedded in the tool. However, they did suggest that the process of entering artificial patient data differed to what would happen in practice:

> It is not until you're actually using the Tool with real patients that you become aware of the actual flow through the system.

Here this participant indicates that use of i-CGA requires incremental development of knowledge of the tool and skills to use i-CGA. Some of the design features of the current version impeded use of i-CGA, however it is clear that this individual could confidently make suggestions to improve the usability of the tool for use in clinical situations:

> I also noticed that when you click on each section/domain, sometimes you can forget which domain you're doing [working in]. I thought it'd be really useful to have at the top [of the screen] to put in e.g., 'Social' etc. [the domain] because some of the [CGA] questions do overlap, you see.

They were also confident that as they gained competence in use of i-CGA, they would then be able to use i-CGA in complex situations with their patients:

> Once you're used to it, it'll probably get better because you're finding ways to tackle some of these problems, e.g., working with people face-to-face.

Participants also acknowledged the Tool's potential as an asset to CGA once formal and informal training had been completed:

> I think there is definitely potential there, yes…it does have potential to be really useful and not only for the clinicians and people working with it, but actually the patients themselves.

## Acceptability of i-CGA

The participants were highly experienced in completing CGA. They stressed the importance of having a '*natural conversation'* with the patient and '*following the patient…if they talk about a particular problem, it is important to understand how this affects their life.'* In comparison the conversation that they had when using i-CGA was considered rigid and did not reflect the natural conversation that they attempted to have with patients:

> It was too rote…The patient had probably told you lots of things before you'd even started & while you were setting up your Tablet.
>
> They're not the sort of questions I'd be asking the patient when I'm in their home.
>
> …if you sit with the Tool in front of you and you're writing it, you can't have that conversation and it would be very stop-start.

The importance of sustaining a natural flow when conversing with patients is highlighted here. During CGA patients are asked about sensitive topics or issues relating to how they manage advancing disease and decreased functional ability. Furthermore, some individuals are very frail and quickly experience fatigue, hence undertaking assessment with a smooth flow of communication to expedite the process is required. Participants indicated that use of i-CGA required them to '*unnecessarily repeat tasks*,' which added to their perceptions of the increased workload associated with i-CGA. In the context of a hefty workload any additional time required to complete and record individual assessments was considered '*off-putting*.'

They were also frustrated with many aspects of CGA being completed through systematically ticking boxes:

> I'm driven by what the patient says and what I find with the patient. I'm not one of those nurses who likes to tick all the boxes.
>
> You just need boxes so then you can just type in. Not ticking boxes, etc. I think it'd be much easier just doing it freehand.
>
> Yes, put 'Breathlessness' in but then ask the patient how they became breathless.

Here this nurse had ticked the box to indicate that the patient experienced breathlessness, yet her real interest was in the circumstances when the patient was breathless and in understanding what eased the problem. This latter information enabled her to identify more than the problem – it had potential to inform care planning. Others suggested that all sections should include an option to include free text:

> there wasn't anywhere to put some info-there were a couple of places where it gave you the tick boxes, but it didn't give you the option to write in and sometimes that wasn't very helpful. Tick boxes need to have the option to write something in-to provide more info about WHY you're ticking that box.

Some participants had used digital tools to record and manage the outcomes of CGA:

> it'd have been much better if someone had looked at the CGA tool that we use on EMIS and you could just log on, put a patient in like I did in the care homes [historically] using the laptop.
>
> it's much easier for us to take a bit of paper and a pen and do a CGA and coming back and putting it on EMIS.

In all situations, during the pilot implementation of i-CGA the participants had reverted to writing the outcomes of the assessment and then uploading data to EMIS and where possible i-CGA on their return to the office. This use of i-CGA was prompted by lack of Wi-Fi to use i-CGA with patients, drop out of connection during the CGA process and loss of patient data, additional time required for use of i-CGA with patients, or use of the tablet/lap top to access i-CGA contributing to the patient exhibiting anxiety.

The perceived usefulness of technology to enhance job performance is a powerful determinant of whether technology will be adopted in the workplace. Though the participants understood that i-CGA was at an early stage of development, they had intent to use i-CGA, and their actual use of i-CGA enabled them to provide an evaluation of how i-CGA could potentially impact on their job performance. These are key considerations that affect acceptability of technology. There are indications here that use of i-CGA was a distractor during the execution of their role, it appeared to require more effort than traditional modes of recording CGA outcomes. As an individual's motivation to use an emerging technology is higher if the technology is easy to use the following section addresses usability.

## Usability of the i-CGA Tool

> It does seem straightforward how to use it in your practice.

The initial impression of i-CGA was positive and the participants anticipated that having all of the patient's assessment results, the problem list, referrals to other professionals and care planning in one place would be helpful in their professional practice. Participants completed the NASA-TLX on four separate i-CGA tasks that had different levels of complexity (see p. 10 in data collection methods for full description). Only 2 participants completed NASA-TLX at base-line, with one participant lacking access to IT equipment. This assessment was not completed at follow-up as access to IT equipment and access to i-CGA had been blocked. P1 completed the entire NASA TLX assessment at baseline with the following results:

(i) Overall mean score for mental demands made by the 4 tasks = 6.5 (where 1 = very high demand) = relatively high demand.

(ii) Overall mean score for physical demands made by the 4 tasks = 5.5 (where 1 = very low demand) = relatively low physical demand.

(iii) Overall mean score for temporal demands made by the 4 tasks = 4.0 (where 1 = very low demand) = low temporal demand.

(iv) Overall mean score for level of performance on the 4 tasks = 20 (where 21 = very successful) = very successful in completing the 4 tasks.

(v) Overall mean score for effort required of the 4 tasks = 3.0 (where 1 = very low effort required) = low demand made by the tasks.

(vi) Overall mean score for level of frustration generated by the 4 tasks = 1.0 (where 1 = very low) = very low level of frustration completing the 4 tasks.

Mean overall score for P1 = 37 out of a possible total subjective workload of 504 = 7.3% demanding overall. P1 perceived that using the i-CGA Tool even from the outset was not particularly onerous.

P2 completed 3 out of 4 of the NASA TLX assessment tasks with the following results:

(i) Overall mean score for mental demands made by the 4 tasks = 9.0 (where 1 = very high demand) = moderately high demand.

(ii) Overall mean score for physical demands made by the 4 tasks = 7.0 (where 1 = very low demand) = relatively low physical demand.

(iii) Overall mean score for temporal demands made by the 4 tasks = 14.3 (where 1 = very low demand) = moderate demand.

(iv) Overall mean score for level of performance on the 4 tasks =10.6 (where 21 = very successful) = moderately successful in completing the 4 tasks.

(v) Overall mean score for effort required of the 4 tasks = 11.0 (where 1 = very low effort required) = moderate demand made by the tasks.

(vi) Overall mean score for level of frustration generated by the 4 tasks = 12.6 (where 1 = very low) = moderate level of frustration completing the 4 tasks.

Mean overall score for P2 = 64.6 out of a possible total subjective workload of 378 = 17% demanding overall.

These scores suggest that of the 4 tasks both end-users were successful in their performance for 3 of the tasks. They indicated that with practice and familiarity with i-CGA they would become competent in performing all of these tasks:

> but it's just getting into the swing of things and getting used to something new, isn't it?
>
> I think that once you've used it [i-CGA] a couple of times, you would know what's in each domain. Once you got comfortable with it and were using it all the time, I think you'd find things easily.

All of the participants experienced difficulty when initially registering and assigning a patient within i-CGA. The preliminary set-up tasks were perceived as 'onerous.' In contrast concerns about working with i-CGA were quickly overcome through practice with a Test patient**:**

> it was good to have that opportunity to play around in the system and know that you weren't going to do anything wrong [laughs], because it wasn't a real patient…That was really good to get comfortable with the system…I learned from playing around with the test patients….it was through that repetition-I knew that once I'd added them on, I found I was quickly working my way through the system quite easily.

A difficulty that all participants experienced was in remembering what was included in each domain. For example, when asked to add information about sight problems they had difficulty in working out whether to access the physical or function domain. They suggested that it would be helpful if they had a list in front of them [i.e., the Template sign posting to 'Sight disorders']:

> Not without the list in front of me…Normally when you complete the task and send, it'll then bring up the rest of the domains.

This suggests that clinicians may have to do some searching to find the sub-domain they are looking for. To navigate i-CGA efficiently and speedily, users need a detailed understanding of each domain. This can be difficult and the participants indicated that some signposting is required. One suggestion was to display all of the domains with a list of contents on the user interface. A search function for each domain was also considered helpful.

When working within a domain the participants found that it was difficult to recall which domain they were assessing. They suggested some changes to the design that would enable them to identify the domain at a glance:

> I'd quite like to see at a quick glance which domain I was actually in…this would give me the prompt for when I'm developing the problem list.
>
> I did find that to get this you do have to go into a few different areas to get the list. Whereas I would've quite liked something maybe at the bottom to have all your summaries to just click on. Rather than have to open up several tabs to find the info I was looking for.
>
> If there was a branch coming off it [the domain title] saying what you'd find in e.g., 'Physical assessment' and the kind of questions they [the Tool] will be asking you and in the 'Social' the same, etc. that would be quite good because then you'd know what was in each one. E.g., if you only wanted to enter data about a certain topic, then that'd be really helpful.

A further issue that impeded navigation through i-CGA whilst completing the CGA was the inability to move from one domain to another. The participants spoke of the way that patients tended to jump from one topic to another during their assessment. When recording information on i-CGA it was not possible to track the information that is provided by patients:

> if I've got my list in front of me on my notepad, I will often jump from each domain to the next. But with the i-CGA you're not. You're going into each domain separately.

> You gain your info from what they [patients] tell you. They tell you things at different times to when YOU want to put things down.

Participants suggested that usability of the tool could be enhanced if it was possible to move around between different domains. This could result in an end-user erroneously not completing domains, therefore they suggested that a visual indicator to display how much of an i-CGA domain had been completed would address this problem.

Participants indicated that they were unable to open the resources embedded in the Tool:

> But Barthel will not let me open it on it [the Tablet]. So, I have to open that up on my own personal mobile [phone]. Then complete it. Then put the score on.

This currently means there is an additional task to carry out before the main task can be completed. It also assumes that clinicians have been issued with a work-based mobile phone which may not always be the case. A key recommendation made here is for commonly used URLs to be embedded a priori within the Tool with permissions already granted to allow clinicians to quickly and directly use the Tool to access to all the relevant tools associated with CGA, such as the Barthel score:

> But I can do it. It would've been a lot nicer to able to use all of those links [within the Tool]. Going back to the I.T. and what needs to be done beforehand. All of those links need to be okayed by I.T. so I can use them, because I cannot. They're all locked.

> It's 'Restricted' 'Unsafe'. That's what flashes up straight away. Yes, it just needs the permissions. I'm sure that'd be straight forward, for them to have the links we need for i-CGA to be put on the recommended list of things we can use.

### Usability of the i-CGA Tool as assessed by the System Usability Scale (SUS) at the end of the Pilot period of the study

A System Usability Scale (SUS) was completed by participants at the follow-up stage of the evaluation. The SUS provides a useful a means of garnering participants' views regarding 10 separate dimensions of an app/tool's usability. Q1 received a mixed response manifest in fairly high standard deviation and overall neutral mean score for usability. Although one participant felt confident that they would like to use the app frequently, a more muted response was expressed by the other participants (Table 1).

A similar pattern of polarised results was obtained for Q2 and Q3 with the majority view that in its current form, i-CGA was considered unnecessarily complex to use and tending towards not being easy to use. These results contrast with the positive views about ease of use of i-CGA that were expressed at the early stage of the evaluation study. Responses to Q4 further revealed that on balance, clinicians who were new to the i-CGA Tool would need the support of a technical person to be able to use it. This point is also borne out by the qualitative findings from interviews with participants where this recommendation is expressly made.

| System usability scale results at follow-up [A score of 5 = Maximum Usability. 1 = Minimum Usability] | P1 | P2 | P3 | Mean | S.D. |
|---|---|---|---|---|---|
| Q1: Would like to use the app frequently | 5 | 2 | 2 | 3.0 | 1.73 |
| Q2: Found the app to be unnecessarily complex | 5 | 1 | 1 | 2.3 | 2.30 |
| Q3: Thought the app was easy to use | 5 | 1 | 1 | 2.3 | 2.30 |
| Q4: Would need the support of a technical person to be able to use the app | 4 | 2 | 1 | 2.3 | 1.52 |
| Q5: Found the various functions in the app were well integrated | 4 | 3 | 4 | 3.6 | 0.57 |
| Q6: Thought there was too much inconsistency in the app | 4 | 2 | 2 | 2.6 | 1.15 |
| Q7: Would imagine most people would learn to use the app very quickly | 4 | 3 | 3 | 3.3 | 0.57 |
| Q8: Found the app to be very cumbersome to use | 4 | 4 | 1 | 3.0 | 1.73 |
| Q9: Felt very confident using the app | 4 | 3 | 1 | 2.6 | 1.52 |
| Q10: Needed to learn a lot of things before getting going with the app | 3 | 4 | 1 | 2.6 | 1.52 |

**Table 1: System Usability Scale results at follow-up**

Responses to Q5 revealed that overall, clinicians found the various functions in the Tool tended towards being fairly well integrated (mean score 3.6/5).

While one participant in response to Q6 felt that there was consistency in the app, the other participants found the opposite to be the case from their viewpoint.

Responses to Q7 and Q8 indicated that participants were undecided (mean = 3.3/5) about whether people would learn to use i-CGA very quickly at this stage of development or whether it was cumbersome to use (mean = 3.0).

Responses to Q9 demonstrated that only one participant felt confident using i-CGA by the end of the evaluation study.

Q10 produced a mixed response with wide variation between respondents (S.D. = 1.52) that ranged from 'Not needing to learn a lot of things before getting going with the Tool' to 'Very much needing to'.

The mean total score for the SUS assessment was 2.76/5, indicating that overall, participants summative view was that they were undecided or neutral regarding their perceptions of the usability of i-CGA, in its present design.

## 3.3 Operating context and barriers and facilitators for use of i-CGA

### Internet connectivity

A key issue which delayed the use of i-CGA with patients in the pilot sites was access to the internet. In one site the assessment occurred in a care home and in the other patients' own home. Whilst it may have been possible to connect to the Internet through a care home's

Wi-Fi, this is not practical in a patient's home since it cannot be automatically assumed that patients (many of whom are older and frail) would have an internet connection, and if they did, whether they would be agreeable to use of their Wi-Fi:

> I used 4G which worked fine. I loaded it up in advance, while I was still at home. I then clicked on to it once I'd arrived at the patient's home. It worked quite quickly. It definitely worked in the area I was working in. But we'll find that in the future when we go to other people's homes, such as the flats and crowded areas. We've used computers for a long time but we've had to stop that because we don't always have any access [to the internet] in the patient's home. When I've used it on an actual patient, straight away we've come up with those issues which we wouldn't have found on a test patient.

Hence the real-life deployment of i-CGA was helpful in identifying connectivity problems. The participants also expressed concern about the security of a patient's home network, especially given the private and confidential nature of the data being inputted to i-CGA:

> I don't know why they thought some of the patients our age would have Wi-Fi…And for safety and security reasons we didn't do that either.

A workaround solution was for clinicians to utilise computer hardware, which was not available until later in the pilot:

> I couldn't use i-CGA because I didn't have a dongle last week.

They also attempted to use local Wi-Fi 'hot spots' to gain internet access and achieve full functionality of i-CGA. Despite this being a good solution in some settings it was unreliable in others:

> There are certain areas in Gateshead where you know you're not going to get much of a connection.

This problem also occurred in their workplace:

> When I try to log in at the surgery, I had no chance of finding a hot spot.

One participant used their work mobile phone to access the local Wi-Fi 'hot spot.' This worked well. However, the other participants were not issued with a work mobile phone, therefore they could not adopt this solution. Overall, connectivity problems overshadowed the pilot evaluation, which limited the participant's access to and use of i-CGA.

### Saving data

Participants indicated that they wanted assurance that any data entered to i-CGA was being was being saved as they progressed through the assessment. Losing data or becoming anxious about the possibility of losing data was a concern when using i-CGA and they argued that this was a potential barrier to future use of the Tool:

> If it crashes or you're half-way through you sometimes just lose it when you've done half an assessment.
>
> It can be a bit scary when you're putting lots of information into the Tool for the potential that it will not save.
>
> It froze…I couldn't get it back to where I was without losing the information - it froze before it had saved.

They also suggested that receiving an explanatory pop-up alert to inform users of the reason why the i-CGA device had locked, such as interruption to the internet connection, would have been helpful. Their experience was frustrating:

> It kept freezing…it may've been timing itself out…I don't know whether it was losing 4G or whether it had timed itself out. I never knew why it was doing it.

Whilst understanding why i-CGA was not working would enable them to trouble shoot when working in the community, having to focus on such issues was perceived as a barrier to use. They had time constraints on their time to complete CGA and deliver the management plan. To do this they needed to be free from anxiety about loss of data or about encountering impediments to the timely completion of the assessment.

### Hardware for use of i-CGA

Throughout the pilot the participants were able to use i-CGA with a tablet, lap top and desktop computer. They compared their experiences and suggested that they would prefer different hardware in different circumstances. They welcomed the opportunity to be able to select the hardware that they considered appropriate for the task they intended to complete:

> When I'm doing my day-to-day work in the community, I always use my Tablet and I don't like using my laptop to do those assessments. I find that it's more user friendly…But in the care home I never use the Tablet. I always use the laptop, but I think that's because I've got more information on that [device].
>
> I've just been using i-CGA on the desktop-getting all my information together and I just sat in the office and completed it.

Also, while the smaller size of an iPad lends itself to portability, participants reported some drawbacks with this:

> It's very sensitive…if there are certain things you press you lose things…you could just touch it by mistake.

The pilot study was undertaken in the midst of the COVID-19 pandemic and in all clinical settings practitioners were mindful of the need for infection control measures in their practice. They were therefore concerned about the requirement to be able to thoroughly clean equipment without damaging hardware. They spoke of cleaning products and their need to be advised of what to use:

> The cleaning of it would be another thing because you're taking it into somebody's house. So, there would be chemicals, etc. on the Tablet-that's something they'd probably need to look at.

Another issue concerned the safe transport of equipment during the pandemic. They had adopted practices to limit contamination from one environment to another:

> COVID, we take everything into the house in a plastic bag and not in a sturdy bag that we would've used normally and everything needs washing when we leave. So, the plastic bag and the Tablet were a little bit heavy and plastic bags aren't that strong, so that was another thing to think about.

Though some of these issues are not directly related to use of iCGA, they are important consideration when using computer hardware in community and primary care settings.

### The influence of setting on use of i-CGA

During the pilot evaluation i-CGA was used in patient's own homes, care home and primary care surgeries. It was clear that the setting had an influence on the way the participants used i-CGA:

> Using i-CGA in a care home is different because you've got the staff and you've got files-that you can look through.

In a care home setting the practitioner conducting CGA can access the older residents' records and discuss the residents needs with the individual and staff. Also, equipment such as Tablets or lap tops are equipment that is present in this setting. Whereas in a patient's own home computer hardware is being brought into the environment. The CGA process can be stressful for patients and skilled practitioners spend time building a therapeutic relationship to decrease anxiety and optimise sharing of information. If an assessor is focused on accessing i-CGA this can shift the focus from the patient to the tablet. One participant described the use of i-CGA with a patient with dementia:

> For patients with dementia or those who look like they are…The Tool was really difficult to use with them because they were very on their guard and they didn't really understand. They were uneasy with it and with me.

This was not an isolated incident:

> A lot of my patients have advanced dementia. I just felt it wasn't appropriate…because they weren't able to share that information with me.

In particular, the participants spoke of the need to continually switch their attention between the iPad and the patient. This contributed to a failure to maintain good eye contact and they suggested that this contributed to the patient becoming irritated and uncooperative:

> Trying to maintain a conversation with her while also tapping on the computer. There is an older age group who don't understand why you're doing all this tapping.
>
> It was off-putting for the patient, not being able to maintain eye contact with me while I was entering data. The patient became more agitated.

In both settings individuals with advanced dementia were being assessed. However, in the care home setting there was less concern about the use of a tablet or lap top. Whilst this setting is the residents home it is also a work environment. Residents are familiar with staff completing work related activities. In contrast in a patient's home practitioners bring their equipment with them. They are entering the patient's personal space and in some situations the participants reported that use of computer equipment added to the challenges of completing the assessment.

### Interoperability of digital healthcare systems

The participants identified the need to ensure that i-CGA can be seamlessly inter-linked with the most commonly used clinical record-keeping systems to achieve good inter-operability that enables pushing and pulling of patient data:

> Ideally, you'd end up having an electronic document that is shared across both sets of EMIS [Practice and Community] that we can ALL see, whether it's here [at the Practice], SALT looking at it, etc. So, it can be viewed by all. But, that's not where we are at the moment with it.

This participant argued that within primary care, ideally both EMIS systems would have good interoperability with i-CGA. This would enable access to patient data that would inform the CGA process and enable sharing of data. One participant had to use primary care and community EMIS and she envisaged that i-CGA could offer one portal to support the CGA process:

> [i-CGA] needs to be somewhere on our EMIS [Practice EMIS] and the Community EMIS. So, it needs to be on both because some people will be using EMIS and some will be using Community EMIS.

Practitioners also identified the need to ensure that any new i-CGA or ongoing i-CGA is visible to all members of the multidisciplinary team. This would enable them to take appropriate actions:

> If I didn't know it was happening-what was going on-I don't think as a GP working in this practice and looking after the patients-I don't think I'd have known it was happening…the other GPs in the practice-I don't think they're aware of it.
>
> I want to be able to see clearly in a patient's record that CGA has been started and that I can maybe just click on something easily and see that summary of where the CGA is at and anything outstanding…if I was having any interaction with that

> patient, whether it was a home visit request and I was looking at the patient's records before going out to see them. Or I was doing a meds review. Anything like that.

Making the title of the i-CGA record visible in a location in EMIS (or System one) would ensure that all members of the healthcare team were ware of the assessment:

> At the moment I don't think that it was clear even to myself when I first saw it-what it was (record of the completed i-CGA)…it comes up as 'Elderly assessment from WL CNP 5.' So, unless you actually know, you have no idea what that is. Even when I knew about it and I went into it…the first time I saw it, I said, "oh! What's this? So, yes, it is there, but unless you know what it is and you're looking for it, you're not going to find it.
>
> If it's [i-CGA] in our 'Documents' it would need to be under…'Elderly assessment' for the document TYPE-I think that's okay. But the actual document title should be a full title that says 'CGA' and that's made clear…it needs to say that, rather than just 'Elderly assessment' or use different acronyms.

One practitioner suggested that a code and further information should be added to an i-CGA record:

> I think I'd want it [i-CGA] maybe [listed] as a Problem, the date it was started…We'd have to be coding that, so that if we were receiving…a copy of the [i-CGA] assessment, ideally, we'd be receiving this electronically and then it would go to the coders and the coders would add that.

The addition of a code ensures that the document is managed in a similar way to the management of other clinical documents:

> That's the same way we do it with all of our documents-whether it's discharges and what the outcome was of the discharge or the appointment. So, we're used to looking for the information in 'Documents'.

An alert to flag up newly created i-CGA file would bring the document to the attention of those professionals who would potentially take action in response:

> Some people will prefer pop-ups [alerts] indicating an i-CGA has been commenced…but it's having them at the right time and place.

The most essential information which the i-CGA contains and associated baseline data might also be presented first and highlighted to increase its saliency to viewers:

> The baseline information is useful, but also what action has been taken because I don't want to be doing the same action that has already been done…This is a significant change. We're going to have to look at what's been happening.

Similarly, clinicians indicated that it would be useful for the i-CGA Tool to be prepopulated with previous patient data to allow comparisons to be made between the patient's present and previous condition:

> If we didn't take a print-out from EMIS at the surgery, we just took the iPad, we wouldn't know what meds they were taking…

More specifically, the following documents were highlighted as useful to include as part pf the pre-populated data held by the i-CGA Tool:

> The meds list, the Problem Sheet and the last three consultations from the surgery…

This essential information could be included in a concise pdf summary:

> You can then you can go into the pdf/summary of the assessment. That'd be useful information.

### i-CGA pre-populated with relevant assessment tools

The participants also strongly advocated for the inclusion of pre-installed assessment tools within i-CGA. At present a barrier to using i-CGA to its fuller potential is the lack of embeddedness of a comprehensive battery of assessment tools. This currently leaves clinicians with the onerous and time-consuming task of contacting the right I.T. and managerial authorities to gain permission to add relevant URL's to enable them to access assessment tools. The process of gaining the right permissions also meant clinicians were in unchartered territory and uncertain how to resolve this key issue:

> The longest process for me was getting the permissions from my Trust and the I.T. Department to allow me to put the i-CGA on my devices…a lot of chasing up…lots of Emails and telephone calls…From I.T. at the Trust I had to request a document which gave permissions to upload these systems on to my devices. Because they're not my devices-they belong to the Trust. They need to know they're virus free, etc, and are trustworthy. Once I'd completed that Form and submitted it to the I.T. system, they then got permissions higher up.

Lessons were learned regarding how the permissions process could be expedited. However, pre-installation of URL's would be a more ideal solution in the longer-term:

> Rolling this out to other Trusts, you need to have your Area Manager on board, the paperwork ready to complete…basically a Form where you complete what it is you want, what devices you want it [the software] on and why-what's it going to do.

### Co-ordination of the i-CGA process

Closely related to the need for good interoperability is the requirement for good co-ordination of the i-CGA process. Achieving this might be facilitated by Specialist nurses:

> I would see that going to be the Specialist nurses, e.g., the ANPs, like KM, but then other Specialist nurses as well…e.g., Parkinson's nurses & respiratory nurses-those

types of nurses-would actually be really good. They're doing this as part of their assessments…and then involving the other professionals as well.

[i-CGA] It's a good thing. I think that it's work that KM was already doing, but that she was having it in one place and doing it all in a co-ordinated way is beneficial. Ideally, you'd end up having an electronic document that is shared across BOTH sets of EMIS [Practice & Community] that we can ALL see.

I think it [the i-CGA] is the right idea, it's just…actually making that data that is collected visible and easily accessible…and the push and pull of information-that's vital.

Optimal use of i-CGA can only be achieved when the digital systems are integrated. Though this is the intended plan for the future, it needs to be recognised that at this stage of development entering data into two systems required significant additional effort from the participants.

## 3.4 i-CGA and clinical practice

### Enhanced data collection with i-CGA

Whilst the participants clearly spoke of the challenges that they experienced when using i-CGA, they also indicated that there was potential for enhanced data collection with use of this tool:

There are more areas [fields] with the Tool for you to write in, e.g., the Physical side of it [the i-CGA] lets you record 'How many cataracts does the patient have?' We can record this and it's there to be able to recall it if we're asked about this again. But it could do with a box there as well as the 'Yes' and 'No's, so that you can add information, like we would do when inputting information to care plans.

I tend to write quite a lot in the free text about people's mobility. For example, those with dementia require use a Zimmer frame to enhance their mobility, but they may forget to use it. Understanding how and when they use the Zimmer frame is important when completing the assessment and developing the care management plan. It is a complex assessment with care home residents.

This participant highlights how a detailed, comprehensive assessment is vital to determine the nature of the problems that frail older people experience. This information informs the development of the problem list:

I noticed that the more patients' data you put in, it generates your 'Problem lists' but actually, my Problem lists are becoming much better. Not having used the Tool [i-CGA] before, I hadn't appreciated how well it could be used. So, even though during my own practice I'll draw up my plan/problem list, so to speak, the summary at the end can be added to my 'To do' list. But that didn't become obvious until I was actually using it.

Rather than rely on recall this participant suggested that i-CGA supported systematic development of the problem list. Hence all problems were drawn into the list, limiting the possibility that some problems would be missed:

> I found that at the beginning the Problem list was very basic. Whereas now, because I've been using it and having that continuity and familiarity with the Tool, that now my Problem lists are much more comprehensive. There is more of a plan in there. There's not just a Problem list. It can be a list of problems but with a plan.

### Potential to share patient data within the practice team

At this stage of the development of i-CGA, there is no integration of i-CGA with the EMIS digital system, hence a work around was developed by one participant to enable sharing of data with the GP responsible for the care home residents. In this situation a PDF summary of the i-CGA assessment was created and this was stored in the patients EMIS record:

> Yes, we knew that we were going to have to do that. The GP can see the PDF summary of CGA that is attached to the patient's record. It's much more comprehensive because of the i-CGA…… if she wants to go more in depth into that assessment, she can log in herself and see exactly where it is…she's an i-CGA User.

Whilst sharing of information between members of the practice team was rather limited in this small evaluation study it is clear that the participants could see value in sharing information included in the i-CGA record. This has potential to facilitate clinical decisions and delivery of holistic care by members of the multidisciplinary team.

### Clinical assessment with i-CGA

The findings that have been previously presented portray CGA as a circuitous process. The participants spoke of their efforts to listen carefully to patients and then probe their description to gain understanding of their capabilities, needs and problems. In contrast their experience of undertaking CGA with the digital tool was more linear:

> It was making sure that you do complete and have the information at hand for the next step on to set your goals and to refer on to [other] people. Whereas quite often you think, "Oh, I should've brought that or I should've done that." So, I think it would be good…

This participant describes how she systematically worked through each domain as she progressed through the assessment. Yet information that was later revealed caused her to pause and reflect that more detail was required for aspects of the earlier part of the assessment. In other situations, they suggested that the digital tool inhibited the natural flow of the conversation that they were having with patients. Patients tend to jump from one topic to another and these practitioners preferred to follow the patient to enable them to delve into their experiences. Hence their approach to CGA was iterative and

interrogative rather than the linear and systematic approach required for completion of i-CGA.

When reflecting on completion of CGA with use of the EMIS template or i-CGA they spoke of the completeness of the i-CGA record:

> There is the potential with CGA via EMIS that I could forget something that I've identified as an issue. But because with the i-CGA I'm completing each [separate] domain at a time and there's an opportunity to look back through before you submit it, there's no room to miss anything because I'm reviewing as I progress through the assessment.
>
> I've probably got a much more comprehensive plan…because I'm not missing anything.

Whilst this participant was highlighting the completeness of the i-CGA record, by the end of the pilot study she was making written records of the assessment within the care home and then transferring the assessment outcome to i-CGA in the office away from the clinical situation. There were a number of reasons for this such as connectivity problems and the need to move across domains when completing the assessment with the patient. When she had all of the information, she was then able to systematically upload information to i-CGA.

Another difficulty that she experienced when completing an assessment with a patient was having to access assessment tools and scales through a different portal as the URL's embedded in i-CGA would not open due to lack of relevant permissions. When she completed the scales and returned to i-CGA to upload data the portal had closed, and data was lost. Such experiences contributed to the decision to make written records when conducting CGA and uploading information at a later time point. These experiences led the participants to conclude that i-CGA and the operating context required further development for successful deployment in practice. They were positive that with development there could be a place for i-CGA in the future:

> I think there is definitely potential there, yes…it does have potential to be really useful and not only for the clinicians and people working with it, but actually the patients themselves.

# Section 3a: Workpackage two results and discussion

## Establishing a Baseline

Data from 52 patient records was extracted from study site one (Table 2). All of these patients had had CGA without the use of i-CGA. The average referrals to health services for these patients are presented in table 3.

| Descriptive Statistics | |
|---|---|
| Average age | 83.7 (84) |
| Male/Female | 17/35 |

**Table 2: Patient demographic data**

Average referrals per patient

| | Hospital | Community | GP | Other |
|---|---|---|---|---|
| Mean | 2.82 | 4.22 | 0.02 | 0.86 |
| SD | 3.647958333 | 4.734089142 | 0.14 | 2.236157418 |
| Median | 2 | 2 | 0 | 0 |
| 25% Quartile | 0 | 1 | 0 | 0 |
| 75% Quartile | 4 | 5 | 0 | 1 |

Average referrals by age group

| 60 to 79 | | | | |
|---|---|---|---|---|
| | Hospital | Community | GP | Other |
| Mean | 4.642857143 | 6.214285714 | 0.071428571 | 0.357142857 |
| SD | 5.393211909 | 5.930292349 | 0.257539377 | 0.811272621 |
| Median | 3 | 4 | 0 | 0 |
| 25% Quartile | 1.25 | 2.25 | 0 | 0 |
| 75% Quartile | 5 | 8 | 0 | 0 |
| **80 to 89** | | | | |
| | Hospital | Community | GP | Other |
| Mean | 3.625 | 4.708333333 | 0.041666667 | 0.208333333 |
| SD | 4.679854877 | 5.511194416 | 0.199826313 | 0.644151035 |
| Median | 2.5 | 2.5 | 0 | 0 |
| 25% Quartile | 0 | 1 | 0 | 0 |
| 75% Quartile | 5 | 5.5 | 0 | 0 |
| **90 to 109** | | | | |
| | Hospital | Community | GP | Other |
| Mean | 5 | 6.833333333 | 0.083333333 | 0.333333333 |
| SD | 5.715476066 | 6.162160516 | 0.276385399 | 0.849836586 |
| Median | 3 | 4.5 | 0 | 0 |
| 25% Quartile | 1.5 | 2.75 | 0 | 0 |
| 75% Quartile | 5.25 | 10.25 | 0 | 0 |

**Table 3: Referral to hospital, community. GP and other services**

It is evident from the data that community referrals are in the highest proportion throughout age groups and generally. The frequency of referrals is also, with a mean of 8 (7.92) per patient.

Within the data, there are clear trends that highlight the prevalence of certain problems within the cohort. Four families of problem are much more common than others:

- neurological and cognitive conditions
- musculoskeletal conditions
- problems with the ear, nose, and throat
- renal infections.

The prevalence of the key problem families identified through the descriptive statistics is confirmed through the production of the plot below, illustrating the relative frequency of problem occurrences.

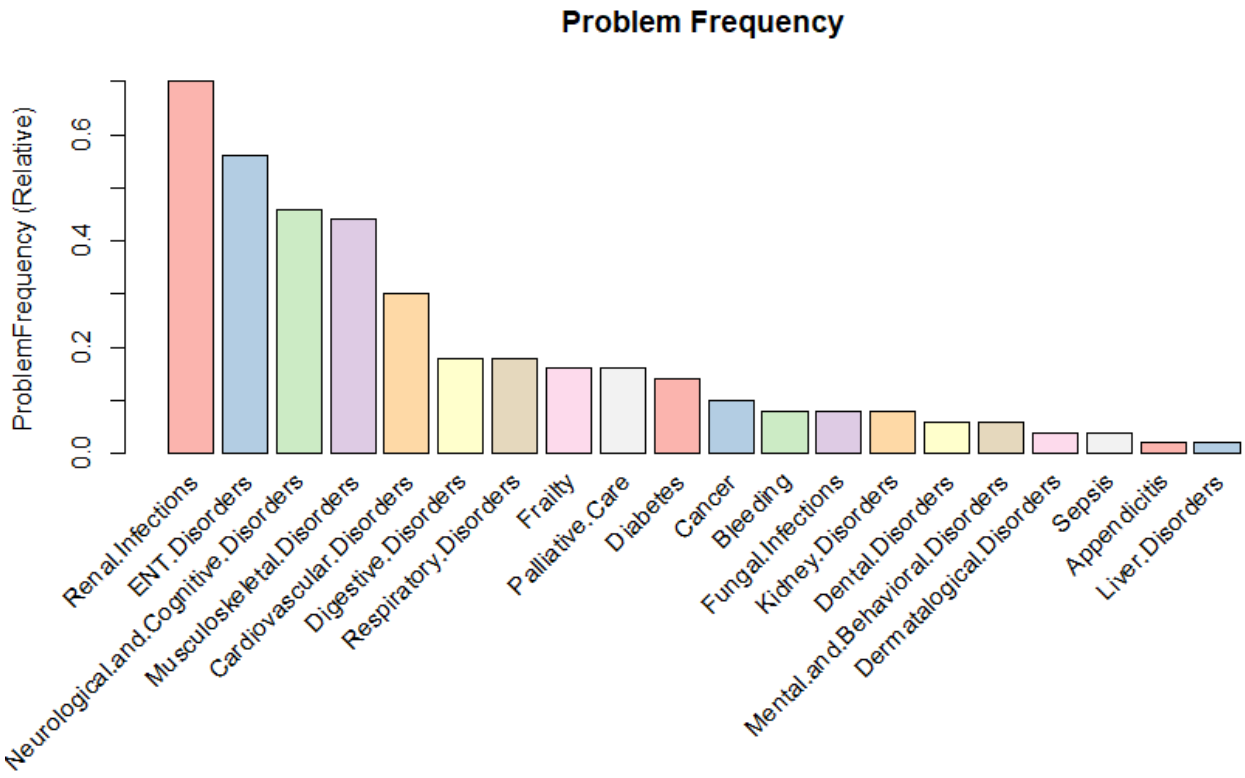



**Figure 2: Relative prevalence of each problem within the cohort**

Although this analysis of the overall composition of the dataset has found that there was a clear set of trends and patterns throughout the data, it could also be seen from the variable mean and variance (VMV) plot that there are some variables within the data where there is greater variance. While we are therefore able to build a good single baseline of a “typical” patient within the cohort, the presence of substantial variance necessitates further analysis of the data.

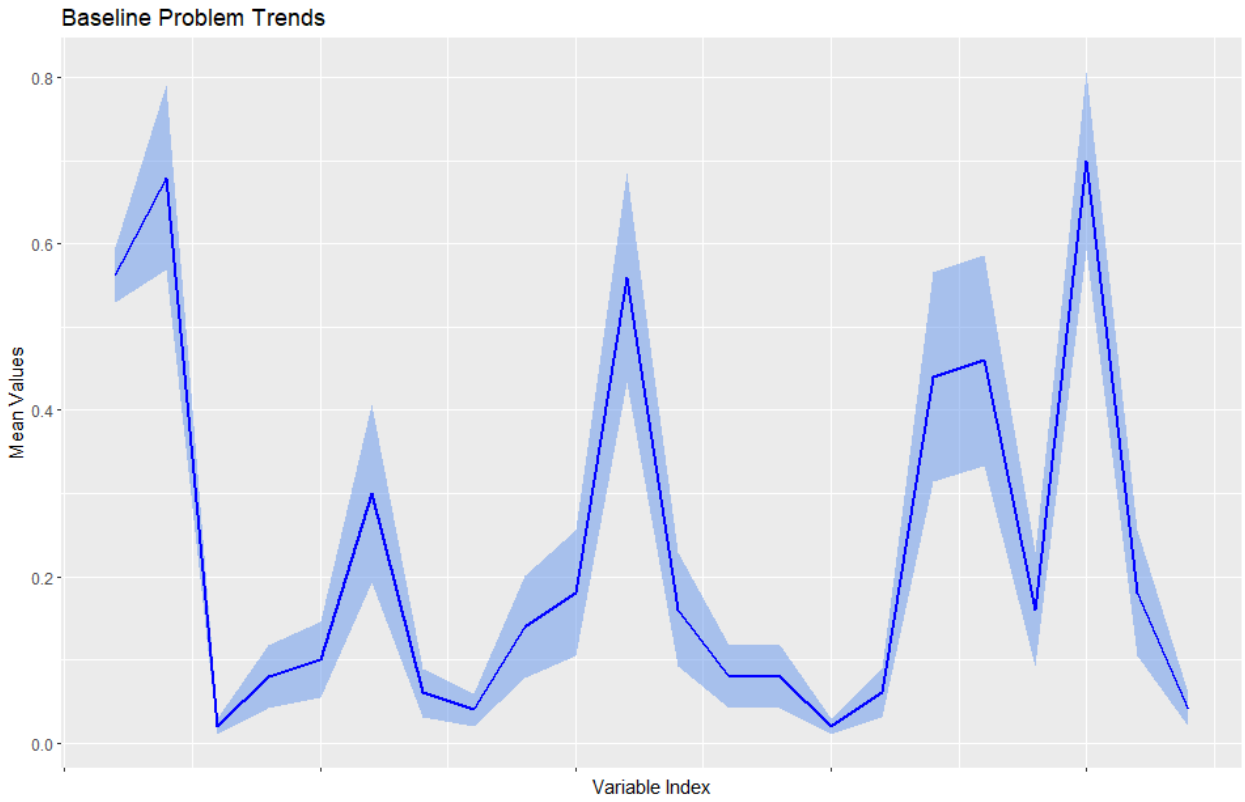



**Figure 3: A variable mean and variance plot for the problems dataset**

Due to the nature of a CGA, we assumed that any patient undergoing a CGA would be deemed to be frail. Therefore, we interpret the low incidence of frailty in the above report to be due to the fact the patient would indeed need to be frail already, therefore it may not be highlighted unless it was a direct consequence of the problem the patient was experiencing e.g. sarcopenia related disease/injury.

## Cluster Analysis

To investigate this further, we elected to utilise unsupervised machine learning methods to identify whether the variance within the data could be attributed to smaller sub-classes within the data, or whether it was instead found more clearly at the observation-level. K-means clustering is a method through which the natural groupings of a dataset can be identified (should there be any natural groupings to identify), an approach well-suited to the aims of this phase of the work. K-means clustering uses the positioning of data objects (representations of the observations within the dataset) within a n-dimensional feature space (where n is the number of variables being used within the analysis) to allocate points of centrality – known as centroids – within groupings of data objects, with proximity to a particular centroid indicating the class membership of a particular data object.

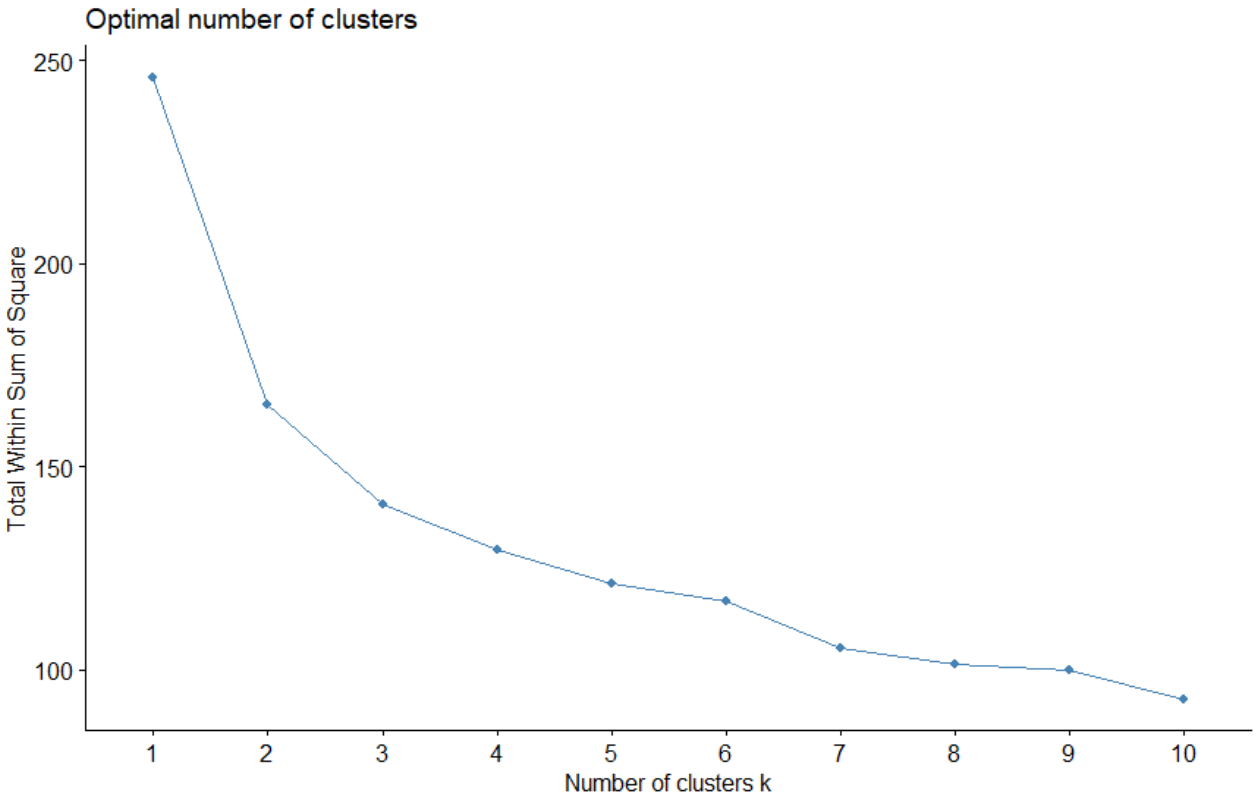



**Figure 4: Scree plot produced to identify optimal number of clusters**

As the number of clusters increases, the variance (measured in this case by the within-cluster sum of squares) decreases. The purpose of the scree plot is to identify the point at which a balance can be reached between the number of clusters and the level of variance that is explained. In the absence of a clear “elbow” within the curve (i.e., the point at which there is an obvious significant change in the arc of the line), several attempts were made, using values for k of two, three and four. Out of these, a value of k=3 was deemed to provide the best balance of cluster separation. The positioning of the centroids relative to each variable is recorded in the cluster means table below.

| Cluster | Age Code | Gender Code | Appendicitis | Bleeding | Cancer | Cardiovascular Disorders | Dental Disorders | Dermatological Disorders | Diabetes | Digestive Disorders | ENT Disorders |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.25 | 1.92 | 0.00 | 0.08 | 0.17 | 0.25 | 0.00 | 0.08 | 0.00 | 0.08 | 0.75 |
| 2 | 2.36 | 1.64 | 0.00 | 0.07 | 0.07 | 0.29 | 0.07 | 0.07 | 0.14 | 0.29 | 0.57 |
| 3 | 4.63 | 1.58 | 0.04 | 0.08 | 0.08 | 0.33 | 0.08 | 0.00 | 0.21 | 0.17 | 0.46 |

| Cluster | Frailty | Fungal Infections | Kidney Disorders | Liver Disorders | Mental & Behavioural Disorders | Musculoskeletal Disorders | Neurological & Cognitive Disorders | Palliative Care | Renal Infections | Respiratory Disorders | Sepsis |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.08 | 0.25 | 0.00 | 0.00 | 0.17 | 0.42 | 0.42 | 0.25 | 0.58 | 0.08 | 0.00 |
| 2 | 0.21 | 0.00 | 0.00 | 0.07 | 0.00 | 0.50 | 0.50 | 0.07 | 0.79 | 0.14 | 0.07 |
| 3 | 0.17 | 0.04 | 0.17 | 0.00 | 0.04 | 0.42 | 0.46 | 0.17 | 0.71 | 0.25 | 0.04 |

**Table 4: The centroid positions (denoted by cluster mean) for each problem family**

All variables in the table exist within a range of 0 to 1, apart from the age code (which spans 1 to 7) and the age code, which can hold a value between 1 and 2 (with 1 indicating a greater volume of males within the cluster, and values closer to 2 indicating the reverse). Most variables have cluster means that are tightly packed. Key areas of separation, where the clusters are most distinct (with a range of more than 0.2 - or equivalent value - between all cluster means), are found in the following variables:

- Age Code
- Diabetes
- Digestive Disorders
- ENT Disorders
- Fungal Infections
- Renal Infections

As a general pattern of behaviours, each typical user in each cluster can be represented as follows:
Cluster 1: Higher age grouping;
Cluster 2: Lower age grouping;
Cluster 3: Mid age grouping;

Using the cluster membership identified through the process of k-means clustering, the dataset was split and another VNV plot produced, this time with the overall trends between clusters displayed for comparison. From this plot, we can note the differences between clusters identified through the values for cluster means, but chiefly, we can observe that all three clusters follow broadly the same trends (the per-cluster pattern labelled for each problem family can be seen in Figure 5).

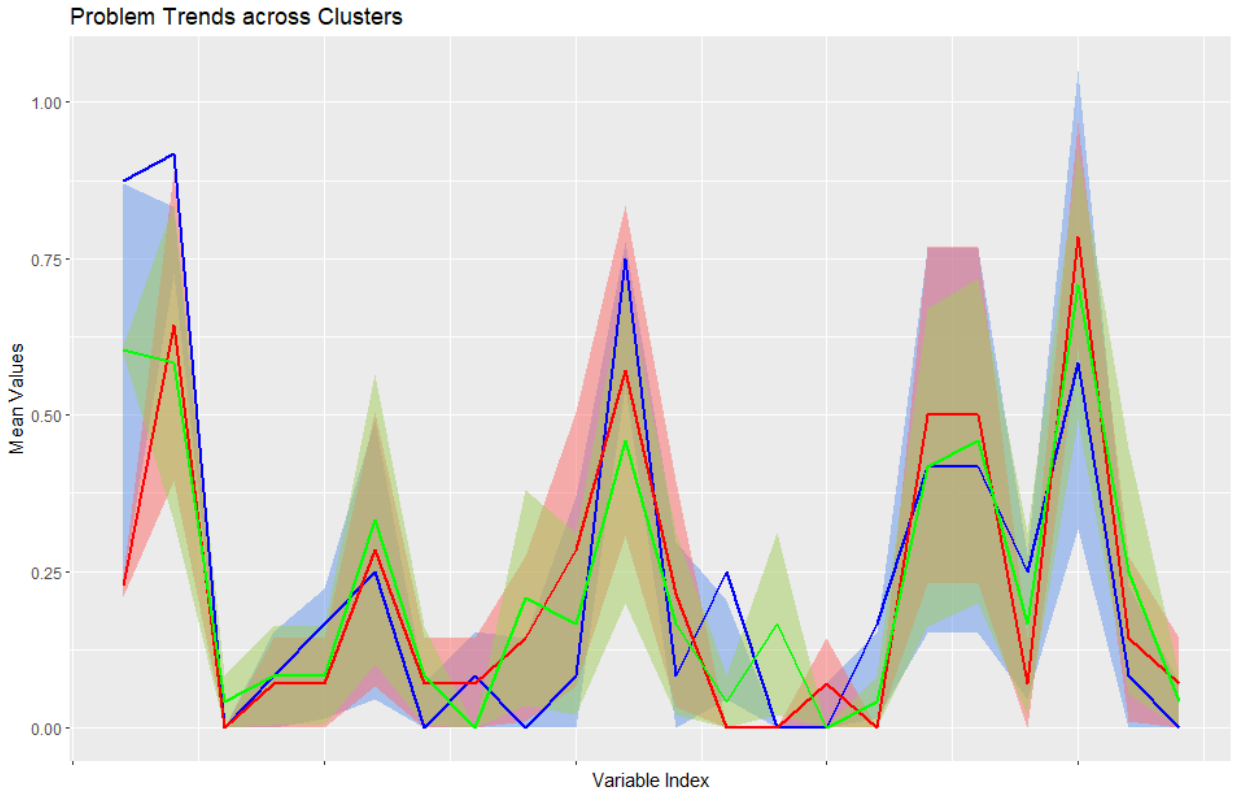



**Figure 5: A variable mean and variance plot showing, split along the lines of cluster membership**

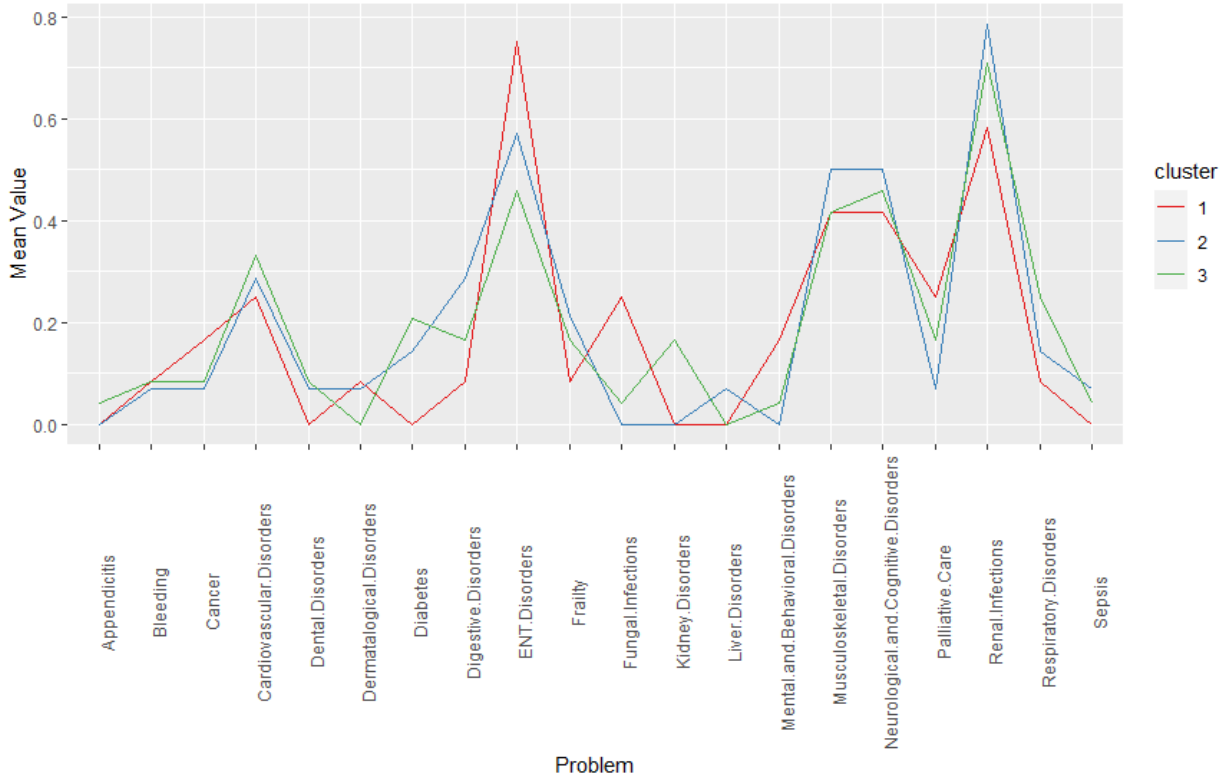



**Figure 6: A plot showing the mean values for each cluster for each problem family**

By observing the above plots, it can be seen that while there remains some clear differences between the clusters, overall, the patterns found within the data are consistent enough to allow for a single set of baseline trends to be relied upon to provide a satisfactory description of the cohort.

## Association Rule Mining

Association rule mining is method of statistical analysis that is used to identify strongly associated variables within a dataset, with these associations known as rules. A rule is displayed through the form:

$$\text{LHS} \rightarrow \text{RHS}$$

Through the left-hand side (LHS) represents the antecedent, and the right-hand side (RHS) denotes the consequent, in that the occurrence of the RHS is associated with the presence of the LHS. Multiple items can be part of the LHS, whereas the RHS is restricted to a single consequent. One of the most widely used algorithms for rule mining is the Apriori algorithm, which has been used in this case to explore common associations that exist between families of problems occurring within the cohort.

Two principal metrics are used when assessing the strength of rules: support and confidence. Support is a measure of frequency, i.e., how frequently a particular combination of items (the term used to represent the presence of a particular problem) occur relative to the dataset as a whole. Rules with a higher value for support are more frequently occurring that those with a smaller support value. Confidence is a measure of conditional probability between the items within the rule; the higher the confidence value, the greater the probability of the items within the rule cooccurring.

| LHS | RHS | Support | Confidence |
|---|---|---|---|
| ENT Disorders | Renal Infections | 0.44 | 0.79 |
| Renal Infections | ENT Disorders | 0.44 | 0.63 |
| Neurological & Cognitive Disorders | Renal Infections | 0.38 | 0.83 |
| Renal Infections | Neurological & Cognitive Disorders | 0.38 | 0.54 |
| Neurological & Cognitive Disorders | ENT Disorders | 0.34 | 0.74 |
| ENT Disorders | Neurological & Cognitive Disorders | 0.34 | 0.61 |
| Musculoskeletal Disorders | ENT Disorders | 0.30 | 0.68 |
| ENT Disorders | Musculoskeletal Disorders | 0.30 | 0.54 |
| Musculoskeletal Disorders | Renal Infections | 0.30 | 0.68 |
| ENT Disorders; Neurological & Cognitive Disorders | Renal Infections | 0.30 | 0.88 |

**Table 5: The top 10 rules by support**

The results of the association rule mining further reinforce the previous findings, as the top 10 rules (by support) confirm the prevalence of four key families of problem among the cohort. More interestingly, the nature of the concurrence of these problems can be seen, demonstrating that individuals within the cohort frequently suffer from more than one issue.

While dependency and causation should not be implied when using rule mining, there are some associations that are so strong (when evaluated by confidence) that some link may be speculated upon. Through ranking the top rules by confidence are shown table 6.

| LHS | RHS | Support | Confidence |
|---|---|---|---|
| ENT Disorders; Neurological & Cognitive Disorders | Renal Infections | 0.30 | 0.88 |
| Neurological & Cognitive Disorders | Renal Infections | 0.38 | 0.83 |
| ENT Disorders; Musculoskeletal Disorders | Renal Infections | 0.24 | 0.80 |
| Musculoskeletal Disorders; Renal Infections | ENT Disorders | 0.24 | 0.80 |
| Neurological & Cognitive Disorders; Renal Infections | ENT Disorders | 0.30 | 0.79 |
| ENT Disorders | Renal Infections | 0.44 | 0.79 |
| Neurological & Cognitive Disorders | ENT Disorders | 0.34 | 0.74 |
| Musculoskeletal Disorders | ENT Disorders | 0.30 | 0.68 |
| Musculoskeletal Disorders | Renal Infections | 0.30 | 0.68 |
| ENT Disorders; Renal Infections | Neurological & Cognitive Disorders | 0.30 | 0.68 |

**Table 6: The top 10 rules by confidence**

There is a strong level of occurrence between three problem families: ENT disorders and neurological and Cognitive Disorders with renal infections, with the presences of the latter occurring with a probability of 0.88 given the presence of the former.

## Discussion

In addition to identifying a baseline to be used in future instances of evaluative practice, the second principal aim of the pilot was to establish what could be measured in more prolonged future instances of the i-CGA tool being used. While the usage data presents little practical value for analysis in terms of the content, it does allow for insight to be gained into what sort of analysis may be, where a greater volume of data collected within conditions that are reflective of the intended use-case.

That includes:

- Patterns of use
- Users of the system

Additionally, through exploring the data that is available through the EMIS system, many additional avenues of analysis have been identified, which when pursued, would provide an even greater level of understanding. One avenue to explore is:

- Disease identification vs Referrals:

Could an increased efficiency in patient referrals presenting with ENT disorders, neurological and cognitive disorders and renal infections improve quality of life outcomes for patients and healthcare providers?

We hypothesise that with the development of a tool such as the i-CGA; when used correctly and functioning in its full capacity, which flags certain disease associations in patients records to health care professionals, could decrease unnecessary repeated referrals, saving time for health care professionals and shortening the time in which appropriate care or management can be distributed, in turn bettering quality of life for patient's. There are strong correlative links between renal infections, ENT disorders/infections and the development of cognitive and neurological disorders such as Alzheimer's and Dementia in the elderly. This association could be used to identify the development of cognitive and neurological disorders early on.

As part of the analysis from available data we identified a case study which we used for our hypothesis above.

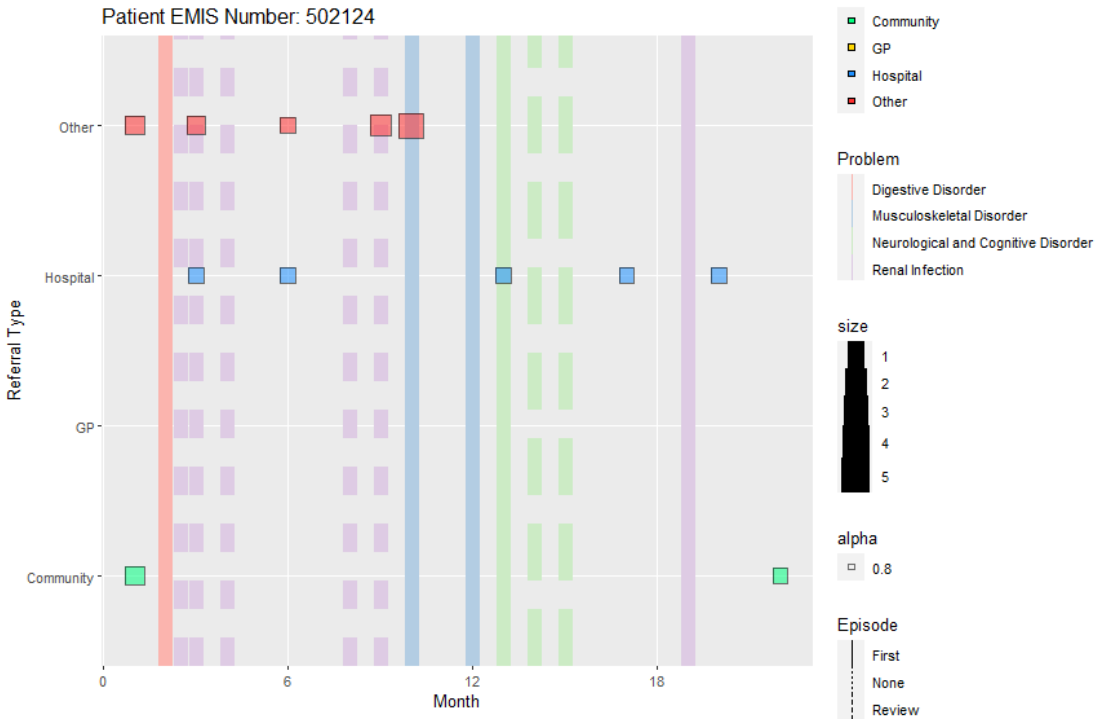



**Figure 7: Worked case study**

We identified that patients presenting with ENT disorders, neurological disorders and renal infections also had a high incidence of referrals. There was a pattern of UTI infection presentations/referrals, shortly followed by ENT infections and then neurological disorders; usually Alzheimer's. Using this particular patient above, it could be speculated that with a system in place like an i-CGA tool that may flag repeated UTI or ENT infections to necessary departments for a neurological assessment, Alzheimers or other neurological disorders could be identified earlier.

Quality of life scores for both clinicians and patients could be assessed from this data which could then be used in economic evaluations. An economic evaluation was intended for this study however, we would need a thorough understanding of the impact of the tool on resources of which we were unable to obtain. Should we have been able to obtain that information however, we would next research to make appropriate assumptions of the expectations of the tools impact on these, e.g. less ambulance call outs and more elective care. After this research, we would have to design a data capture form to collect this information. Cost associated with implement the tool at a site, e.g. training, would also be calculated.

In this case, it has been agreed that we would use indicators such as the ED-5Q-5L quality of life standards to establish whether the tool has impacted the end-users. We would also look at the cost consequences of the tool if it worked efficiently e.g., cost benefit analysis. However, due to the current useability of the tool and the lack of data we have, we would not be able to do this without a further study taking place.

## Section 4: Key learning points for the implementation and development of i-CGA

For any deployment of new technologies, it is absolutely essential that the infrastructure for deployment is well established to enable optimal performance of equipment, applications and tools. Deficiencies in the infrastructure did contribute, over a sustained period of time, to lack of use or suboptimal performance of i-CGA. The findings suggest that participants had to work very hard to develop the operating environment for i-CGA. This included making IT requests, gaining clinical lead support for use of i-CGA, procurement of equipment and access to Wi-Fi for use of i-CGA in health service estates and patients' homes Furthermore it was not until later in the deployment of i-CGA that it was understood that use of the URL's embedded within i-CGA required completion of a separate IT request process. The consequence being that a participant had to use a second device to access assessment tools and scales that should have been readily available through i-CGA. In the context of a hefty workload, any additional time required to set-up, complete and record individual assessments was '*off-putting*.'

The usefulness of technology to enhance job performance is a powerful determinant of whether technology will be adopted in the workplace. There are indications in the findings presented here that use of i-CGA was, at times, considered to be a distractor during the execution of their role, and use of i-CGA appeared to require more effort than traditional modes of recording CGA outcomes. The participants acknowledged that i-CGA was at an early stage of development, and interoperability with other clinical data management systems was lacking. This contributed to duplication of effort (i.e., in uploading data to i-CGA alongside traditional modes of record keeping), and incapacity to pull data into a patient's CGA and push data to other clinical management systems. In any future deployment of i-CGA there is an imperative to ensure that i-CGA has the functionality to connect and communicate with other systems, devices, applications or products in a coordinated way, without effort from the end user.

Furthermore, the findings suggest that achievement of performance at the ENCoP specialist level enables a practitioner to co-ordinate, carry out and contribute to completion of a thorough CGA, and address the stratified problem list and management plan. The participants portrayed CGA as a circuitous process and spoke of their efforts to listen carefully to patients and then probe their description to gain understanding of their capabilities, needs and problems. In contrast their experience of undertaking CGA with the digital tool was more linear. During their initial use of i-CGA they experienced frustration: when they commenced an assessment, they worked through the domains presented on i-CGA, however as the assessment progressed and the patient revealed further information about problems discussed earlier, they found that they were unable to return to domains that had been completed previously. In other words, they were not able to navigate back and forth across the domains to record information as the assessment progressed. The lack of alignment between their practice and what was required for use of i-CGA contributed to the participants recording the results of CGA on paper and then later entering data to i-CGA. The participants suggested that i-CGA required further development to enable an end user

to move within and across domains, reflecting the way that they conduct CGA in the real world. The future design of i-CGA needs to balance the suggestion of these participants to align the flow through i-CGA with clinical decision-making processes, and the positive outcome of the evaluation that i-CGA provides a systematic, linear approach to the CGA process. This ensures the CGA is conducted in a similar way each time, addressing each domain sequentially. The advantage being that it would be less likely that any key questions or aspects of the assessment would be missed.

There were other design issues that the participants suggested could be improved. The previous discussion highlighted concerns about navigation through i-CGA. Participants wanted to be able to move between and across domains with a clear indicator of progress made within a domain. A suggestion was to for a user interface to display each domain with the domain elements and as the end-user progressed through the assessment the display would indicate which elements had been completed and the percent of elements to be completed (see figure 8). The visual display of progress in a particular domain would prompt the assessor to return to the domain to complete outstanding assessments. The participants also suggested that some aspects of the assessment could be located in more than one domain, therefore a listing of the domain elements and a search function for each domain would be helpful to navigation through i-CGA.

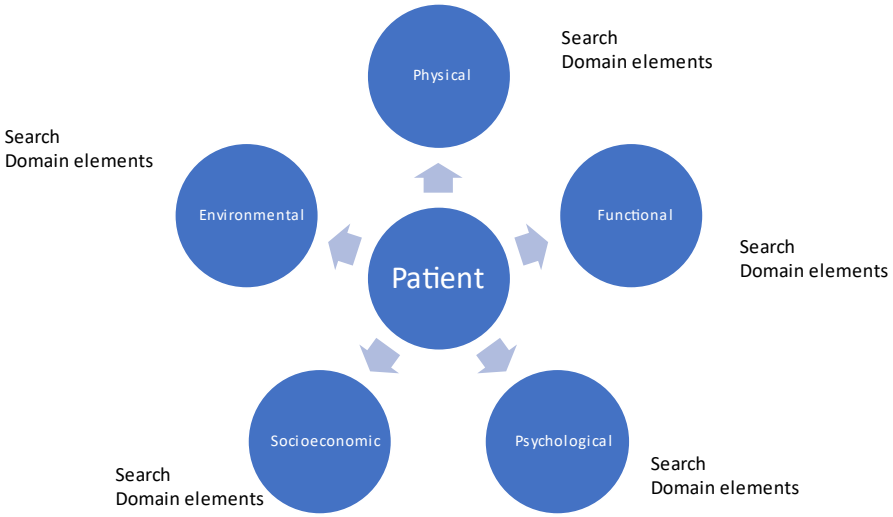



**Figure 8: Proposed i-CGA interface**

A notable point made by participants was the scarcity of a 'save' function, and the participants indicated that they had experienced loss of data when they lost connectivity during an assessment. This finding chimes with a key outcome from a recent review of electronic based applications used in geriatric health: that the least developed feature was data saving (Chang, Low & McDonald et al; 2021). It is essential that any inputted data can be saved, preferably automatically at set intervals of time to prevent data loss. For example,

Sepehri et al.'s (2022) e-CGA Tool can store data locally on the hard disk in comma separated value (CSV) format, which can be readily accessed with Microsoft Excel or a text editor available on all computers. In addition, their e-CGA Tool takes a screenshot of the e-CGA form so that an image is recorded that allows subsequent recovery of user input and comparison of different assessments are saved in separate files with time stamps. In addition, the application automatically saves the data once every 3 minutes but when the Tool is closed, it is still important to hit the "Save Records" button to ensure no data is lost. Pressing the "Saving Records" button on the e-CGA Tool will save any checked "action required" items to a spreadsheet for clinical follow-up purposes, save the current state of the e-CGA into a pdf picture with the patient ID as its name. However, a limitation of the e-CGA Tool is that it will not save a completed form itself for reopening at a later time, i.e., users cannot reopen the CGA with the items already filled out. Instead, it is recommended to fill out the entire form and save a record before closing the form (Song, 2022, p.19).

Throughout the evaluation the participants were keen to stress that whilst they did experience frustration with features of i-CGA, they anticipated that further, future development of the i-CGA tool, including improved connection and communication with other health digital systems, there was potential for i-CGA to enhance job performance regarding CGA. In a world where advancement in digital technologies is occurring at a rapid pace it is important that digital tools are developed to meet end-user requirements and can be readily adopted in practice.

## Challenges and limitations of the evaluation

Whilst this pilot process evaluation provided an opportunity for deployment of i-CGA in a real life setting, it is clear the underdevelopment of the operating context and of the tool itself hampered what could be achieved. Lack of interoperability of i-CGA with other clinical management systems and the additional workload that this created resulted in the tool not being used as intended. We would strongly argue that further deployment of i-CGA should only occur when the IT infrastructure and issues of interoperability have been addressed.

This was a very small pilot evaluation study, and of the 55 i-CGA records that were created only 23 were completed. Furthermore the data entered to i-CGA was primarily text based, suggesting that many of the questions did not capture the information that the experienced practitioners knew was essential to a quality CGA. In any future metric assessment and economic analysis this would be a factor that must be considered. The workpackage two team had significant difficulty in identifying and extracting data from i-CGA and EMIS and the quality of data should be given consideration in future evaluation studies. This said interesting findings were identified in the analysis conducted, that offer new lines of enquiry for future research.

# Recommendations

## Workforce recommendations

1. Competence in CGA, or competence equitable to ENCoP specialist level, should be a prerequisite for effective use of i-CGA.

2. Work based learning is required for competence development to use i-CGA. Small group training should be available to clinical staff for initial introduction to i-CGA, followed by assessed simulation learning with test patients.

3. A workforce development approach should be adopted to ensure that all professionals involved with CGA or being referred to following CGA are competent and confident i-CGA users.

4. Practitioners should be provided with a user manual that includes both text and i-CGA screenshots that they can refer to when using i-CGA. i-CGA end users should have access to an i-CGA support/helpline to provide real time support, particularly during the first 6 months of using the tool.

5. Staff should be provided with devices and access to a stable internet connection to enable them to use i-CGA. Further research is warranted to gain understanding of the impact of lap top/tablet usage when undertaking CGA and how any negative impact can be moderated.

6. Assess whether i-CGA has an impact on or in any way hinders staff capacity to complete a CGA and make adjustments accordingly, e.g., allocating more time to set up the i-CGA with new patients' data prior to conducting CGA.

## Infrastructure recommendations

1. IT governance and set-up should be in place prior to implementation of i-CGA in primary and community care services including approval for use of i-CGA in the service, and all URL's embedded within i-CGA.

2. i-CGA must be interoperable with other clinical computer systems (EMIS and SystmOne) to enable push and pull of data between systems.

3. For effective use of i-CGA, health staff require a stable internet connection.

4. i-CGA end users should have access to an i-CGA support/helpline to provide real time support.

5. A comprehensive implementation plan is required in health settings for the adoption of i-CGA.

## Design recommendations

1. Automatic generation of the problem list is beneficial and ensures a robust outcome from the CGA process. However, a limitation of this list is that it is not clear to all end users what actions are agreed to address problems therefore an addition of the action plan linked to each problem would drive problem resolution.

2. i-CGA should have the function to convert records to different formats to optimise use by different end-users.

3. It is essential that any inputted data can be saved, preferably automatically at set intervals of time to prevent data loss. Other similar systems automatically saves data once every 3 minutes and also when the system closes or resets, which should be considered in the further development of i-CGA.

4. The design of i-CGA could also be improved by responding to the following recommendations:

- Include a header in each domain so it is clear which aspect of CGA is being completed
- Include a time stamp for tracking completion of tasks – this could be a column down the right-hand side of the record with a summary of the previous record and the date of entry
- Navigation through i-CGA should be responsive to the end-user. One suggestion was for the navigation system to enable the end-user to move between and across domains with a clear indicator of progress made within a domain
- I-CGA should enable entry of data retrospectively, to support continuous review and monitoring and updating of assessments/records. This is important as assessments are often completed over more than one session and/or supplementary information needs to be added to patient records
- A search function should be included to enable end users to move within and across domains
- Incorporate (i) Introduction Sliders (ii) an i-CGA tutorial and (iii) a user manual all within the i-CGA tool
- The addition of the action plan linked to each problem would drive problem resolution
- Minimise any differences in structure and format between the traditional version of the CGA familiar to practitioners and the i-CGA
- i-CGA would benefit from being pre-populated with patient data held in medical records – this could be achieved through integration of i-CGA with other clinical management systems and pushing and pulling data between systems
- All relevant URLs for assessment questionnaires and scales should be embedded within i-CGA and IT requests to support access to the URLs be approved prior to deployment of i-CGA in clinical settings
- Consideration should be given to a graphic user interface that is appealing to the end-user and invites regular usage

- Consideration should be given to development of i-CGA to promote ease of use by practitioners and inclusion of labour-saving functions such as: check boxes, radio buttons, text boxes, and drop-down lists that exploits the fuller digital capability of
- i-CGA over paper-based recording.

## Summary

This small pilot evaluation study provided insight to the use of i-CGA in two primary care services. It is clear that development of i-CGA and the service infrastructure is required for it to be widely adopted. For future evaluation research of a redesigned i-CGA it would need to working to its full capacity, interoperable with other digital systems, and to be used as intended. Many of our barriers with data analysis, reported here, have been a direct consequence of the tool not being used as intended.

Though this study was undertaken at an early stage in the innovation cycle it is clear that digital systems are needed, and have potential, to manage data and co-ordinate the multidisciplinary effort that is necessary for CGA. Such early stage deployment and evaluation studies are essential to discern acceptability and usability because it cannot be simply assumed that new technologies automatically offer improvements over traditional methods of clinical assessment. This pilot found evidence that with regard to i-CGA, "…there is definitely potential there…to be really useful and not only for the clinicians and people working with it, but actually the patients themselves." However, to realise this potential it is recommended that current factors related to workforce, infrastructure and design be addressed.

# Appendices

# Appendix 1: List of figures and list of tables

## List of Figures



## List of Tables

# Appendix 2: Information sheets and consent forms

## Participant information form

Northumbria University NEWCASTLE

**i-CGA pilot process evaluation: phase one study**

**Introduction**
You are being invited to take part in a study designed to find out your experiences and opinions of use of the i-CGA tool. Before you decide if you would like to participate it is important for you to understand why the study is being done and how it is going to be done. Please take time to read the following information carefully. Ask me for more information if there is anything you are not clear about. Take time to decide whether or not you wish to take part. You may wish to discuss the study with family or friends before you decide to take part.

**Purpose of the evaluation study**
i-CGA is a digital tool that has been developed by Health Call in collaboration with North East North Cumbria ICS and the Ageing Well Network to facilitate an integrated multidisciplinary team approach to comprehensive geriatric assessment within primary and community care. This tool has recently been introduced to two general practices in North East England. Alongside the introduction of i-CGA in these practices, a pilot process evaluation study will be undertaken to establish the feasibility and acceptability of using i-CGA in primary care; and assess methods to be adopted in a subsequent outcome evaluation of i-CGA during phase two of implementation across the region.

**Who is undertaking the study?**
This study is led by Professor Glenda Cook, Dr Akhtar Ali, Dr David Hastings and Professor Peter McMeekin who work in Northumbria University.

**Why have you been invited?**
You are working in a general practice where the i-CGA tool has been introduced and you are using i-CGA in your professional practice.

**What are you being asked to do?**
You are being invited to complete four questionnaires that will: 1)Assess digital capability; 2) Explore your competence in comprehensive geriatric assessment; 3 and 4) Measure the usability of the i-CGA tool. You will be asked to complete all questionnaires at the beginning of the evaluation. You will also be asked to complete questionnaires 2, 3,and 4 at the end of the study, approximately 4 months later.

You will also be asked to take part in an individual interview at the end of the study. The interviews will be audio-recorded on an electronic recording device. The recording will be then transcribed verbatim. You will be asked about your views and opinions of i-CGA; how easy or difficult it was to use this digital tool; and the impact

that it had on your practice of conducting comprehensive geriatric assessment (CGA). The interview should be no longer than one hour.

We will arrange with you where all of these activities will take place – either in your place of work or via on an on-line platform if it is necessary to reduce social contact in compliance with COVID-19 requirements.

**Do I have to take part?**
No. It is up to you whether you would like to take part in the study. This information sheet is being provided to help you make that decision. If you do decide to take part, you can stop being involved in the study whenever you choose, without telling us why. If you choose to take part, then withdraw from the study, the information that you have already provided will be included in the study. Deciding not to take part in the study will not affect your employment in any way.

**Benefits of taking part?**
You will have the opportunity to participate in the development of the i-CGA tool through taking part in this study.

**Disadvantages of taking part?**
Some individuals may have concerns that participation in the evaluation may highlight gaps in competence in undertaking comprehensive geriatric assessment (CGA) and limited digital competence. To address these issues, competence assessment for CGA will be anonymous. Any identified gaps in competence will be addressed through workforce development training for the practice workforce and not at an individual level. Any identified gaps in digital competence will be addressed through further development of the i-CGA training programme and not directed at individuals.

**What will happen to the information that is gathered?**
- Your name will never appear in any documentation.
- All information will be kept confidential and stored in a secure place.
- The information that is gathered will be analysed (including if you choose to withdraw from the study).
- Only the research team will handle the information gathered and it will be destroyed after a 5-year period.
- The research findings will be reported to the company that has developed the i-CGA tool and the team that has funded this evaluation. This will inform future development of the digital tool. The findings will also be reported in professional and academic publications. This will include examples of what participants said, but you will not be named and no identifying information will be used. No participants will be named in any reports about the research.

**Will my responses be kept confidential?**
Anything said in the interviews or questionnaires will be kept completely confidential. In the final written project, all participants' names will be changed and substituted with numbers and no identifiable characteristics or information will be used. The consent form you have signed will be stored separately from your other data.

**How will my data be stored, and how long will it be stored for?**
All paper data, including the typed-up transcripts from your interview and your consent forms will be kept in locked storage. All electronic data, including the recordings from your interviews, will be stored on a Northumbria University OneDrive file, which is password protected. All data will be stored in accordance with University guidelines and the General Data Protection Regulation (GDPR).

**What will happen to the results of the study and could personal data collected be used in future research?**
Anything participants say in this study will be kept strictly confidential and anonymised (see 'confidentiality' for further details). Any participants who would like a summary of the findings can request one from the Principal Investigator – Professor Glenda Cook (contact details are provided below).

**Who has reviewed this study?**
Permission was obtained from Northumbria University and the Health Research Authority to do this study.

**What are my rights as a participant in this study?**
Minimal personal information is collected in this study (gender, role). The purpose of collecting this is to provide a background in the report about the viewpoint that is being presented. You have a right of access to a copy of the information about the personal data we have collected about you (to do so you should submit a Subject Access Request to the data protection office at Northumbria University. A member of the research team can explain how this is done). If you are dissatisfied with the University's processing of personal data, you have the right to complain to the Information Commissioner's Office. For more information see the ICO website.

**If you have any questions or would like further information about the project please contact:**
Professor Glenda Cook
Telephone: 01912156117
Email: Glenda.cook@northumbria.ac.uk

**For concerns about data protection please contact:**
Duncan James (Data Protection Officer at Northumbria University)
Telephone: 01912437357
Email: dp.officer@northumbria.ac.uk

# Consent form

**i-CGA pilot process evaluation: phase one study**

**Consent to participate**

| | |
|---|---|
| I understand and agree that I will accept interview discussions and responses to questionnaires being recorded. | **Yes** ☐ **No** ☐ |
| I have read and fully understand the participant information sheet (version 3: 4.2.22) and have had the opportunity to ask any questions I may have in relation to this study. | **Yes** ☐ **No** ☐ |
| I understand that I can withdraw from the study at any time and that, in relation to this study, I will not be contacted again if I choose not to be involved. | **Yes** ☐ **No** ☐ |
| I understand that I will not be named in any report and that anything I say will be treated with confidence. | **Yes** ☐ **No** ☐ |
| I understand that any information collected will be securely stored. | **Yes** ☐ **No** ☐ |
| I understand that information collected will be managed only by the study team and will be destroyed after a period of five years. | **Yes** ☐ **No** ☐ |
| I understand that I will be given access to the final summary of the study report. | **Yes** ☐ **No** ☐ |
| I agree to take part in the above study. | **Yes** ☐ **No** ☐ |

**Information about the study has been discussed and fully understood**

**Signature of participant.....** **Date.....**

**Signature of researcher.....** **Date.....**

**If you have any questions or would like further information about the project please contact:**

Professor Glenda Cook e-mail: Glenda.cook@northumbria.ac.uk

# Appendix 3: Data collection tools

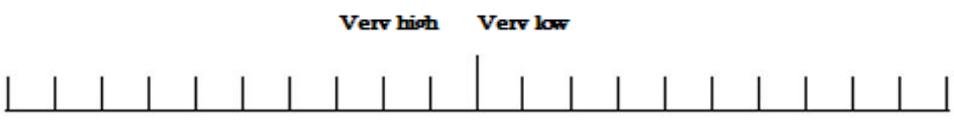
## NASA Task Load Index (TLX) Questionnaire

***During the task you have just completed you may have experienced some difficulties and constraints. You will be asked to evaluate this experience through 6 different factors, which are described in the table below. Please read each factor and its description & ask the experimenter to explain anything you do not fully understand.***

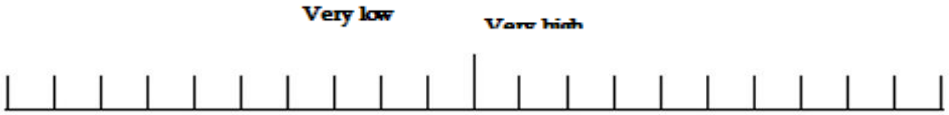
| Factor | Description |
|---|---|
| **Mental Demand** | *How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting of forgiving?* |
| **Physical Demand** | *How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?* |
| **Temporal Demand** | *How much time pressure did you feel due to the rate or pace at which the task or task elements occurred? Was the pace slow and leisurely or rapid and frantic?* |
| **Performance** | *How successful do you think you were in accomplishing the goals of the task set by the experimenter? How satisfied were you with your performance in accomplishing these goals?* |
| **Effort** | *How hard did you have to work (mentally and physically) to accomplish your level of performance?* |
| **Frustration Level** | *How insecure, discouraged, irritated, stressed, and annoying versus secure, gratified, content, relaxed, and complacent did you feel during the task?* |

***For each factor you will be required to rate the level of constraint felt during the test on a scale from "very low" to "very high" across 21 gradations with regard to the driving task.***

**Mental Demand** **How mentally demanding was the task?**



**Physical Demand** **How physically demanding was the task?**

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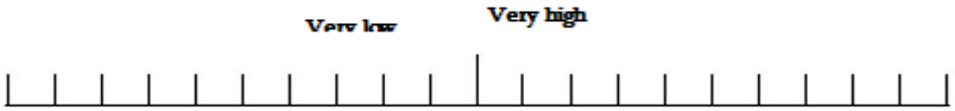
**Temporal Demand** **How hurried or rushed was the pace of the task?**

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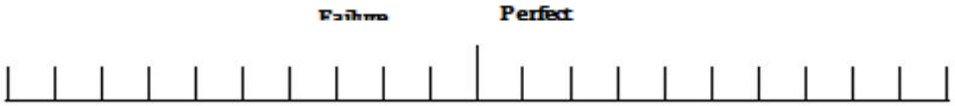
**Performance** **How successful were you in accomplishing what you were asked to do?**

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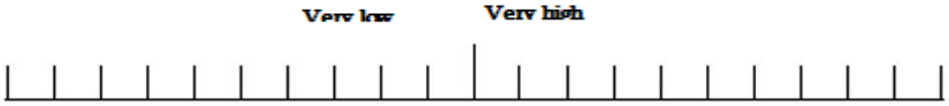
**Effort** **How hard did you have to work to accomplish your level of performance?**



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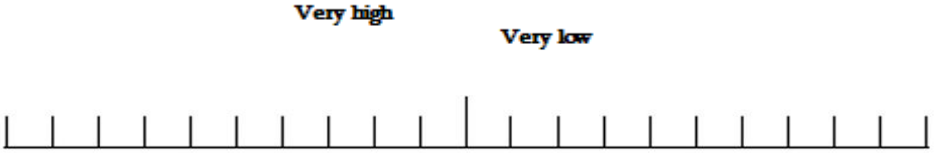
**Frustration** **How insecure, discouraged**, *irritated, stressed and/or annoyed were you?*



## System Usability Scale Questionnaire (Overall)

*Please select the correct option.*

| | | | | | |
|---|---|---|---|---|---|
| 1. | I think that I would like to use this application frequently. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 2. | I found this application to be unnecessarily complex. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 3. | I thought this application was easy to use. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 4. | I think that I would need the support of a technical person to be able to use this application. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 5. | I found the various functions in this application were well integrated. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 6. | I thought there was too much inconsistency in this application. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 7. | I would manage that most people would learn to use this application very quickly. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 8. | I found the application to be very cumbersome to use. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 9. | I felt very confident using this application. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |
| 10. | I needed to learn a lot of things before I could get going with this application. | **Strongly disagree** | **Disagree** | **Neither agree or disagree** | **Agree** | **Strongly agree** |

## CGA Competence Assessment

***Using the scale provided, please indicate how confident and competent you are regarding the following statements about CGA.***

| | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| I feel confident/competent to be able to initiate or undertake comprehensive geriatric assessment (CGA) which is multidimensional & multi-professional & encompasses physical, psychological, environmental, functional, social & medication review elements relating to the older person's health and wellbeing | | | | | |
| I feel confident/competent to be able to select, recommend & utilise valid & reliable screening, assessment, review, & risk assessment tools in conjunction with clinical judgement to assess individual needs, e.g., mobility/balance; falls/fractures; confusion/delirium; mental capacity; urinary incontinence; weight loss. | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| | | | | | |
| | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| I feel confident/competent to be able to use digital technology in conjunction with clinical judgement to assess individual needs. | | | | | |
| I feel confident/competent to be able to work in partnership with the individual & their families & friends in alignment with comprehensive assessment to identify a Problem List & goals through shared decision-making. | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| I feel confident/competent to be able to develop a care & support plan which promotes personhood & relationship centred care. | | | | | |
| I feel confident/competent to be able to recognise the requirement for NHS continuing healthcare checklists. | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| | | | | | |
| | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| I feel confident/competent to be able to refer potentially eligible older people for full NHS continuing healthcare assessment& to co-ordinate assessments. | | | | | |
| I feel confident/competent to be able to utilise appropriate referral pathways & specialist services. | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| | | | | | |
| | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| I feel confident/competent to be able to manage safe, effective & timely transfer of care & information during & across care transitions, e.g., urgent response, institutional or caseload admission or discharge. | | | | | |
| I feel confident/competent to be able to recognise a carer's psychological & practical needs. | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| | | | | | |

| | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| I feel confident/competent to be able to demonstrate understanding of issues that may arise when the needs & priorities of carers differ from those of the older person. I can effectively manage these situations. | | | | | |
| I feel confident/competent to be able to recognise when to repeat/review CGA to capture & respond to changes & deterioration in physical, psychological, cognitive, functional & social health. I can then formulate a management plan & use a range of clinical interventions & appropriate referrals &/or escalation plans. | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
| | | | | | |

**Thank you for taking the time to complete our questionnaire.**

## Digital Capability Assessment

**Name: _____** **Date: _____**

**Digital literacy is person-centred and can be divided into a range of different capabilities based on: (i) Information, Data and Content (ii) Teaching, Learning and Self-Development (iii) Communication, Collaboration and Participation (iv) Technical Proficiency (v) Creation, Innovation and Research (vi) Digital Identity, Wellbeing, Safety and Security.**

**For each digital capability that is listed, please tick the most appropriate Self-Assessment box ('Strongly Agree', 'Agree', 'Neutral', 'Disagree' or 'Strongly Disagree').**

| Capability | Self-Assessment | | | | | Any further comments to add about your capability in this domain |
|---|---|---|---|---|---|---|
| 1. I can use digital tools to search & locate information, data & content through a simple search in digital environments, e.g., search engines & I can navigate between information, data & content in different digital environments. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L2 |
| | | | | | | |
| 2. I can use a range of digital tools & techniques to organise & share information, data & content for personal and/or professional purposes, e.g., emails, blogs, project management tools, using a variety of data formats appropriate for different contexts, audiences & needs, e.g., Word doc files, Adobe pdf files, MP3 music files, png or jpeg image files. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L2 |
| | | | | | | |
| 3. I can use digital tools such as spreadsheets &/or databases to store information & data. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L2 |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4. I can abide by legislation, guidelines, policies & protocols to protect privacy, copyright & intellectual property in the use and sharing of digital media, information & data. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L2 |
| | | | | | | |
| 5. I can ensure that information, data & content created by me or that I am responsible for is accurate, reliable, safe & secure. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L2 |
| | | | | | | |
| **Capability** | **Self-Assessment** | | | | | **Any further comments to add about your capability in this domain** |
| 6. I am confident & capable in the use of a wide range of digital devices, technologies, software & applications in order to create, access, edit, monitor, store & share information, data & content for personal and/or professional purposes. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L3 |
| | | | | | | |
| 7. I am confident & proactive in the adoption of new/innovative digital devices, technologies, software & applications that promote effective, secure & efficient use & sharing of information, data and content. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 1: INFO/DATA/CONTENT L3 |
| | | | | | | |
| 8. I can create an account, log in & participate in e-learning/online learning activities with little to no assistance. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 2: Teaching/Learning/ Self-Development L2 |
| | | | | | | |
| 9. I can use a range of digital tools & technologies in my online learning, e.g., podcasts, video tutorials, online courses. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 2: Teaching/Learning/ Self-Development L2 |
| | | | | | | |
| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 2: Teaching/Learning/ Self-Development L2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10. I can use a range of devices to support my own learning/self-development, e.g., a desktop computer, a smartphone, a tablet. | | | | | | |
| 11. I can participate in online learning forums or communities e.g. I leave comments, respond to questions in forums. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 2: Teaching/Learning/ Self-Development L2 |
| | | | | | | |
| 12. I can show other people what I know and help increase their knowledge, skills and confidence. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 2: Teaching/Learning/ Self-Development L2 |
| | | | | | | |
| 13. I can work & collaborate with people digitally using a range of tools & technologies, e.g., document sharing, cloud storage systems. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 3: Communication/ Collaboration/Participation L2 |
| | | | | | | |
| **Capability** | **Self-Assessment** | | | | | **Any further comments to add about your capability in this domain** |
| 14. I initiate & manage digital collaborative work with people using a wide range of tools & technologies. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 3: Communication/ Collaboration/Participation L3 |
| | | | | | | |
| 15. I can set up/use a range of digital peripherals, e.g., keyboard, headset, projector, mouse. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 4: Technical Proficiency L2 |
| | | | | | | |
| 16. I can choose between a range of digital devices, technologies, software & applications in order to carry out the most appropriate actions & activities for a desired goal or outcome. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 4: Technical Proficiency L2 |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 17. I am familiar with many day-to-day technical challenges and issues with those devices, technologies, software and applications that I use regularly and can resolve them independently most times. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 4: Technical Proficiency L2 |
| | | | | | | |
| 18. I can carry out routine maintenance tasks associated with the devices, technologies, software & applications that I use regularly e.g., changing passwords, updating, installing new versions. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 4: Technical Proficiency L2 |
| | | | | | | |
| 19. I am confident & proficient in the use of specialist, new & emerging digital devices, technologies, software & applications &/or can become confident & proficient through learning/training/support. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 4: Technical Proficiency L3 |
| | | | | | | |
| 20. I keep up-to-date with digital technology evolution & innovation. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 4: Technical Proficiency L3 |
| | | | | | | |
| 21. I can use a range of digital devices, technologies, software & applications to create &/or edit, modify, refine, improve & integrate items of new content & information to create new & original digital resources, media, information e.g., photo or film creation/editing, social media messages. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 5: Creation, Innovation and Research L3 |
| | | | | | | |
| **Capability** | **Self-Assessment** | | | | | **Any further comments to add about your capability in this domain** |
| 22. I support & inform the development of new & emerging digital tools, technologies & techniques for myself & my organisation. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 5: Creation, Innovation and Research L3 |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 23. I can use digital in ways that promote safety of self & others, including physical security of equipment & devices & digital security online. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 6: Digital Identity, Wellbeing, Safety & Security L2 |
| | | | | | | |
| 24. I understand the different kinds of serious consequences for breaches of safety, security & wellbeing rules & guidelines for me & other people & can act to prevent these. | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Domain 6: Digital Identity, Wellbeing, Safety & Security L2 |
| | | | | | | |

# Appendix 4: Interview guide for staff

## Interview/discussion group guide

**Introduction**

***Researcher to introduce themselves***

***Remind the participant of the purpose of the study:  Evaluation of the iCGA.***

**Consent**

***Gain consent from the participant for this interview/discussion:***

Thank you for attending today. Previously, you read a 'Research study information sheet' and signed a 'Consent form'. Do you wish to view these again?

Do you consent to being interviewed today?

Please remember, participation in the study is voluntary so you may withdraw from the study at any time. This interview is scheduled to last for one hour, but you can terminate it, or withdraw at any time.

**Interview process**

***Explain the interview process:***

Please answer questions as fully as you can. I may ask you to clarify your answers from time-to-time. However, if you wish, you may decline to discuss any topic, or you may introduce any topic that you feel may be relevant.

If you wish to ask me any questions during the interview, please do so.

Your answers will be recorded and I may also write some notes during the interview, but for the purposes of the study, you will be identified by a participant identification number in order that your information remains anonymous.

***Questions/topic areas:***

- How easy was the iCGA equipment to use? Is there anything about the equipment that you would change to make using it easier or more acceptable?
- Were there any barriers to implementing the iCGA?
- Were there any facilitators (anything that made it easier) to implement the iCGA?
- Did using the iCGA support your ability to carry out a CGA? If so, how? If not, why?
- Did using the iCGA support your professional development/skills/knowledge about CGA? If so, how? If not, why?
- Did using the iCGA impact on the CGA process? If so, how? If not, why?

- Did using iCGA impact on case-based discussions? If so, how? If not, why?
- Did using iCGA influence care-planning? If so, how? If not, why?
- Is there anything else you would like to discuss about iCGA?

***At the end of the focus group, thank the participants for attending and for their time.***

# References


Alturki, R. & Gay, V. (2017). *Usability testing of fitness mobile application: Methodology and quantitative results.* In 7th International Conference on Computer Science, Engineering & Applications (ICCSEA 2017), Copenhagen: Denmark.

Bachmann, S., Finger, C., Huss, A., Egger, M., Stuck, A.E., & Clough-Gorr, K.M. (2010). Inpatient rehabilitation specifically designed for geriatric patients: systematic review and meta-analysis of randomised controlled trials. *BMJ;* 340:c1718.

Bellera, C.A., Rainfray, M., Mathoulin-Pélissier, S., Mertens, C., Delva, F., Fonck, M., Soubeyran, P.L. (2012). Screening older cancer patients: first evaluation of the G-8 geriatric screening tool. *Annals of Oncology, Aug;23*(8):2166-2172.

Boyd, P. J., Nevard, M., Ford, J. A., Khondoker, M., Cross, J. L., & Fox, C. (2019). The electronic frailty index as an indicator of community healthcare service utilisation in the older population. Age & Ageing, 48(2): 273-277.

British Geriatrics Society (BGS). (2015). *Fit for Frailty*. Available at: https://www.england.nhs.uk/ourwork/clinical-policy/older-people/frailty/frailty-risk-identification/

British Geriatrics Society (BGS). (2019). *Comprehensive Geriatric Assessment Toolkit for Primary Care Practitioners.* London: BGS. https://www.bgs.org.uk/sites/default/files/content/resources/files/2019-03-12/CGA%20Toolkit%20for%20Primary%20Care%20Practitioners_0.pdf

Brooke, J. (1996). SUS-A Quick and Dirty Usability Scale. In Usability evaluation in industry. Taylor & Francis, Editors: Patrick W. Jordan and Bruce Thomas and Bernard A. Weerdmeester and Ian L. McClelland 189(194): 4–7.

Chang, F. & Gupta, N. (2015). Progress in electronic medical record adoption in Canada. *Canadian Family Physician*; 61:1076–84.

Chang, R., Low, H., McDonald, A., Park, G., & Song, X. (2021). Web-based software applications for frailty assessment in older adults: a scoping review of current status with insights into future development. *BMC Geriatrics*, *21*(1), 1-11.

Charlson, M. E., Charlson, R. E., Peterson, J. C., Marinopoulos, S. S., Briggs, W. M., & Hollenberg, J. P. (2008). The Charlson comorbidity index is adapted to predict costs of chronic disease in primary care patients. *Journal of Clinical Epidemiology, 61*(12), 1234-1240.

Clegg, A., Bates, C., Young, J., Ryan, R., Nichols, L., Teale E, et al. (2013). Development and validation of an electronic frailty index using routine primary care electronic health record data. *Age & Ageing; 45*:353–60.24.

Clegg, A., Bates, C., Young, J., Ryan, R., Nichols, L., Teale, E., & Marshall, T. (2016). Development and validation of an electronic frailty index using routine primary care electronic health record data. *Age & Ageing, 45*(3), 353-360.

Devereux, N., Ellis, G., Dobie, L., Baughan, P. & Monaghan, T. (2019). Testing a proactive approach to frailty identification: the electronic frailty index. BMJ OpenQual;8: e000682.

Devons, C.A. (2002). Comprehensive geriatric assessment: making the most of the aging years. *Current Opinion in Clinical, Nutrition & Metabolic Care*; 5:19.

Dhesi, J., Moonesinghe, S. R., & Partridge, J. (2019). Comprehensive geriatric assessment in the perioperative setting; where next? *Age and Ageing*, 48(5): 624-627.

Dolls, M., Doorley, K., Paulus, A., Schneider, H., & Sommer, E. (2019). Demographic change and the European income distribution. *The Journal of Economic Inequality*, 17(3): 337-357.

Ellis, G., Gardner, M., Tsiachristas, A., Langhorne, P., Burke, O., Harwood, R. H., & Shepperd, S. (2017). Comprehensive geriatric assessment for older adults admitted to hospital. *Cochrane database of systematic reviews*, (9).

Eysenbach,G. (2001). The 10 e's in "e-health". *Journal of Medical Internet Research*, 3(2): e20.

Garm, A., Park, G., & Song, X. (2017). Using an electronic comprehensive geriatric assessment and health coaching to prevent frailty in primary care: the CARES model. *Medical & Clinical Reviews*, 3(S1): 9.

Grindrod, K. A., Li, M., & Gates, A. (2014). Evaluating user perceptions of mobile medication management applications with older adults: a usability study. *JMIR mHealth and uHealth, 2*(1).

Hart, S.G. (2006). *NASA-task load index (NASA-TLX); 20 years later.* In Proceedings of the human factors and ergonomics society annual meeting. Sage CA: Los Angeles, CA: Sage Publications. 50, No. 9: 904-908.

Harte, R., Quinlan, L. R., Glynn, L., Rodríguez-Molinero, A., Baker, P. M., Scharf, T. & vÓLaighin, G. (2017). Human-centered design study: enhancing the usability of a mobile phone app in an integrated falls risk detection system for use by older adult users. *JMIR mHealth and uHealth,* 5(5).

Huss, A., Stuck, A.E., Rubenstein, L.Z., Egger, M., & Clough-Gorr, K.M. (2008). Multidimensional preventive home visit programs for community-dwelling older adults: a systematic review and meta-analysis of randomized controlled trials. *The journals of gerontology, Series A, Biological sciences and medical sciences*; 63:298.

Khurshid, Z., De Brún, A., Moore, G., McAuliffe, E. (2020). Virtual adaptation of traditional healthcare quality improvement training in response to COVID-19: a rapid narrative review. *Human Resources Health, 18:81.*

Kocman, D., Regen, E., Phelps, K., Martin, G., Parker, S., Gilbert, T., & Conroy, S. (2019). Can comprehensive geriatric assessment be delivered without the need for geriatricians? A formative evaluation in two perioperative surgical settings. *Age and Ageing*, 48(5): 644-649.

McDonald, A. P., Rizzotti, R., Rivera, J. M., D'Arcy, R. C., Park, G., & Song, X. (2021). Toward improved homecare of frail older adults: A focus group study synthesizing patient and caregiver perspectives. *Aging Medicine,* 4(1): 4-11.

Micallef, N., Baillie, L. & Uzor, S. (2016). Time to Exercise! An Aide-Memoire Stroke App for Post-Stroke Arm Rehabilitation. *In Proceedings of ACM MobileHCI.*

National Health Service (NHS). (2017). *Identifying frailty.* Available at: https://www.england.nhs.uk/ourwork/clinical-policy/older-people/frailty/frailty-risk-identification/

National Health Service (NHS). (2018). *A health and care digital capabilities framework*. NHS. Accessed on 6.7.22 from https://www.hee.nhs.uk/sites/default/files/documents/Digital%20Literacy%20Capability%20Framework%202018.pdf

National Health Service (NHS). (2019). *The NHS long term plan, 2019*. Available at: https://www.longtermplan.nhs.uk/

National Institute for Health and Clinical Excellence (NICE). (2015). *Older people: independence and mental wellbeing.* NICE guideline [NG32]. Available at: https://www.nice.org.uk/guidance/ng32

Rowland, S. P., Fitzgerald, J. E., Holme, T., Powell, J., & McGregor, A. (2020). What is the clinical value of mHealth for patients*? NPJ Digital Medicine,* 3(1): 1-6.

Royal College of Nursing (RCN). (2022). *What is eHealth?* Available at: https://www.rcn.org.uk/clinical-topics/eHealth

Rubenstein, L. Z., Stuck, A. E., Siu, A. L., & Wieland, D. (1991). Impacts of geriatric evaluation and management programs on defined outcomes: overview of the evidence. *Journal of the American Geriatrics Society,* 39(S1): 8S-16S.

Salai, A. M., & Baillie, L. (2019). A Wee Bit More Interaction: Designing and Evaluating an Overactive Bladder App. *In Proceedings of the CHI Conference on Human Factors in Computing Systems:* 1-14.

Sepehri, K., Braley, M. S., Chinda, B., Zou, M., Tang, B., Park, G., Garm, A., McDermid, R., Rockwood, K., & Song, X. (2020). A Computerized Frailty Assessment Tool at Points-of-Care: Development of a Standalone Electronic Comprehensive Geriatric Assessment/Frailty Index (eFI-CGA). *Frontiers in Public Health, 8*: 89.

Silva, S., Felgueiras, R., & Oliveira, I. C. (2018). Geriatric helper: an mHealth application to support comprehensive geriatric assessment. *Sensors, 18*(4): 1285.

Song, X. (2022). *User Manual: The Standalone Tool of the Electronic Frailty Index based on the Comprehensive Geriatric Assessment (Standalone eFI-CGA) Version 3.*1. Available on request from Dr. Xiaowei Song (xiaowei.song@fraserhealth.ca).

Stuck, A.E., Egger, M., Hammer, A., Minder, C.E. & Beck, J.C. (2002). Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. *JAMA;* 287:1022.

Theou, O., Park, G.H., Garm, A., Song, X., Clarke, B., Rockwood, K. (2017). Reversing frailty levels in primary care using the CARES model. *Canadian Geriatrics Journal, 20*: 105.

Thompson, J., Tiplady, S., McNall, A., Murray, J., Cook, G., Hodgson, P. (2017) Workforce Competency Framework: Enhanced Care for Older People (EnCOP). Available at: https://frailtyicare.org.uk/wp-content/uploads/2021/05/EnCOP-Competency-Framework.pdf

Turner, G., & Clegg, A. (2014). Best practice guidelines for the management of frailty: a British Geriatrics Society, Age UK and Royal College of General Practitioners report. *Age & Ageing, 43*(6): 744-747.

Wood, A. E., Prins, A., Bush, N. E., Hsia, J. F., Bourn, L. E., Earley, M. D. & Ruzek, J. (2017). Reduction of burnout in mental health care providers using the provider resilience mobile application. *Community mental health journal*. 53(4): 452-459.